Monetary Policy in Developing Countries: The Case of Nigeria

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To my adorable children – Emma and Tony...

...and my darling wife – Ann

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Abstract

In recent times, monetary policy has increasingly adopted the interest rate as an instrument and inflation as the ultimate objective. This is congruous with the propositions of the New consensus macroeconomics (NCM) and synonymous with the somewhat widespread practice of inflation targeting. However, the optimality of a monetary policy approach depends critically on its effectiveness and costs; which would differ between developing and developed countries. This thesis investigates the effectiveness and costs of an NCM-type monetary policy in Nigeria. Essentially, it is a systematic study of the implications of monetary policy in Nigeria, while paying attention to the peculiarities of the Nigerian economy and using a rigorous up-to-date framework. Effectiveness is investigated by considering some underlying assumptions of the NCM. First, the assumption of a complete pass-through from the policy interest rate to the market rates (which is critical for the success of monetary policy) is investigated. Here an array of market, retail deposit and lending rates are examined while an attempt is also made to capture the role of financial market (under)development. Second, the effect of monetary policy on aggregate demand is investigated, since it constitutes the intermediate target of policy. Given the high incidence of poverty in Nigeria and our associated assumption that consumption would, in this case, be inelastic to policy changes, the aggregate demand effect is limited to investigating the responsiveness of investment to monetary policy induced changes in the interest rate. Finally, the cost and benefit analysis of monetary policy in Nigeria is investigated by estimating a NCM-type Phillips curve. To understand the dynamics and source of inflation the standard NCM-type Phillips curve is augmented with supply factors. The relative importance of demand vis-à-vis supply factors as well as the cost and benefits of disinflation are thereafter determined. These are analysed using both theoretical and empirical approaches. Results indicated that an NCM-type monetary policy is generally ineffective in anchoring interest rates or aggregate demand and may be conducted at a considerably high cost in terms of output loss and financial instability. These findings and their policy implications are not entirely surprising given the institutional features of the Nigerian economy. They generally suggest that the use of interest rate policies tended to create more problems than it can solve. Hence, to avert the associated problems, there is a need for other instruments which the central bank can control effectively. Moreover, monetary policy focus should be on long-run output expansion and short-run price-stability, rather than the converse. This would have the benefit of moderating poverty and unemployment.

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List of Abbreviations

AD	Aggregate Demand
ADF	Augmented Dickey-Fuller
ADR	Average Deposit Rate
AIC	Akaike Information Criterion
ALR	Average Lending Rate
ARCH	Autoregressive Conditional Heteroskedasticity
ARDL	Autoregressive Distributed Lag
AS	Aggregate Supply
ASI	All Share Index
BOFIA	Bank and Other Financial Institutions Act
BRICKS	Brazil, Russia, India, China, Korea (South), South Africa
CB	Central Bank
CBN	Central Bank of Nigeria
CiC	Currency in Circulation
CoB	Currency Outside Banks
CPI	Consumer Price Index
CRR	Cash Reserve Ratio
DMB	Deposit Money Bank
DR	Deposit Rate
ECB	European Central Bank
FD	Fiscal Deficit
FGN	Federal Government of Nigeria
FOS	Federal Office of Statistics
GARCH	Generalised Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
HAC	Heteroskedastic and Autocorrelation Consistent
IBR	Interbank Rate
IFEM	Interbank Foreign Exchange Market
IRR	Internal Rate of Return
IT	Inflation Targeting
KPSS	Kwaitkowski-Phillips-Schmidt-Shin
LR	Lending Rate
LR-PC	Long-run Phillips Curve
M.A.L	Mean Adjustment Lag
M2	Broad Money Stock
MLR	Maximum Lending Rate
MPC	Monetary Policy Committee
MPR	Monetary Policy Rate
MR	Monetary Rule
MRR	Minimum Rediscount Rate
NAIRU	Non-accelerating Inflation Rate of Unemployment
NARDL	Nonlinear Autoregressive Distributed Lag
NBS	National Bureau of Statistics

NCM	New Consensus Macroeconomics
NIBOR	Nigeria Interbank Offer Rate
NISER	Nigeria Institute of Social and Economic Research
NTB	Nigerian Treasury Bills
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
OMO	Open Market Operations
PC	Phillips Curve
PCA	Principal Component Analysis
PLR	Prime Lending Rate
PSS	Pesaran-Shin-Smith
QTM	Quantity Theory of Money
REER	Real Effective Exchange Rate
RESET	Regression Specification Error Test
RSS	Residual Sum of Squares
SDR	Savings Deposit Rate
SR-PC	Short-run Phillips Curve
T-ARDL	Threshold Autoregressive Distributed Lag
TBR	Treasury Bills Rate
TDR	Term Deposit Rate
VIF	Variance Inflation Factor
WAMZ	West African Monetary Zone
WDAS	Wholesale Dutch Auction System

GENERAL INTRODUCTION

Monetary policy is typically concerned with the way in which monetary authorities use the instruments at their disposal to influence the decision of economic agents with the intention of achieving overall macroeconomic stability. Theoretical debate on the instruments of monetary policy has been based on two major paradigms: monetarist vs. Wicksellian. Under the monetarist view money supply is within the control of the central bank, so that Friedman's rule (of maintaining a target rate of growth of the money supply) is more apt in determining optimal inflation and economic growth (Carlin and Soskice, 2006,ch.5). The Wicksellian paradigm deems money as endogenous so that the interest rate becomes the appropriate instrument of monetary policy. However, recent developments in mainstream monetary policy have led to the refutation of the monetarist framework based on the premise that the interest rate paradigm represents the true behaviour of central banks (Fontana, 2007).

Consequently, modern design of monetary policy has followed the proposition of the *new consensus macroeconomics* (NCM). The basic principle of the NCM is the use of short-term interest rate to achieve price-stability (Meyer, 2001; Arestis, 2007). The objective of price-stability is centred on the supply-side equilibrium and the inability of monetary policy to have any long-run impact on real variables (Bean, 2007; Fontana, 2009a). In the short-run, however, the existence of nominal rigidities means that policy can affect real variables temporarily. At the centre of this is the relationship between price and real variables, as captured by the Phillips curve. Thus, a major feature of the NCM framework is the Phillips curve, which is assumed to be sloped in the short-run (negatively when inflation-unemployment relationship is portrayed; positively when it is inflation-output) but vertical in the long-run. This illustrates the trade-off between output and inflation in the short-run and implies that disinflation would result in temporary output loss and/or increased unemployment (Arestis and Sawyer, 2004; Carlin and Soskice, 2006,ch.3). In the long-run, however, the vertical Phillips curve based on rational expectations and continuous market clearing, suggests that monetary policy can only influence prices and not real variables. Thus, monetary policy should aim exclusively at price-stability. Proponents of the NCM and the objective of price-stability have further argued that it is a requisite condition for sustained growth and employment while high inflation is damaging to the economy (Epstein and Yeldan, 2008).

Typical discussions of monetary policy like this, however, do not distinguish between developed and developing countries (Huang and Wei, 2006). Thus, central banks in developing countries are adopting *inflation targeting* (IT), which is founded on the tenets of the NCM. This is based on the erroneous but widespread belief that policies would have similar outcomes irrespective of the development status of the country (Epstein and Yeldan, 2008). Generally, most developing countries are characterised by weak institutions and financial underdevelopment which ensure that the effectiveness, transmission and implications of policy differ from those of advanced countries (Ghatak and Sánchez-Fung, 2007). Therefore, the gains and costs of low inflation can vary considerably between developing and developed countries.

IT intrinsically requires central banks to be highly averse to inflation – or at least reputably more inflation averse than political policymakers. The degree of aversion has important implications for the cost of disinflation. According to Carlin and Soskice (2006,ch.3), the nonlinearity of the short-run Phillips curve causes the cost of disinflation to increase with the degree of inflation aversion so that IT may be very expensive overall. Hence, even if the NCM/IT approach is effective in stabilising prices it may have adverse consequences on economic growth, employment, equality, and poverty reduction particularly among developing countries (Cordero, 2008; Epstein, 2008a). Under IT, price-stability is normally defined as inflation rate circa 2-3 per cent. For developing countries, the inflation threshold – which is the level beyond which inflation becomes harmful – is variously estimated at 11-18 per cent (Dada, 2011; Khan and Senhadji, 2001; Pollin and Zhu, 2006). In this regard, moderate inflation rate may therefore be optimal for developing countries rather the very low rate advocated for developed countries (Huang and Wei, 2006). There would thus be little justification for low inflation as the dominant objective of monetary policy in developing countries. The negative effect of IT on growth and employment underlies the need for the alternative monetary policy approach, especially for developing countries (Pollin *et al.*, 2007; Epstein and Yeldan, 2008; Cordero, 2008).

In addition to those countries already practicing formal IT, a number of developing countries practice an implicit IT, while some (like Nigeria) propose to adopt the explicit version within the medium term. Nigeria is an oil-driven emerging economy, with moderate inflation, high unemployment, a regional economic and financial hub, and a principal proponent of the West African Monetary Zone (WAZM). Given its policymaker's drive to lower inflation at all cost, this study focuses on Nigeria. In Nigeria, monetary policy is conducted with the use of the short-term interest rate as key instrument, while price-stability is the overriding objective. Price-stability is here defined as achieving and sustaining a "single-digit" rate of inflation; thus, giving the Central Bank of Nigeria (CBN) an asymmetric target below a 10 per cent threshold. Nigeria is, however, characterised by weak institutional features, underdeveloped financial sector and a dominant government sector.[1] These debilitate the conduct of monetary policy and diminish its reliability. Importantly, financial market underdevelopment can enfeeble the ability of policy to influence the money market interest rates. Such ineffectiveness would bring about a weak transmission mechanism and emphasises the need for an alternative approach (CBN, 2007a). In the medium term, thus, the CBN plans to migrate to a full-fledged IT framework. This would entail the announcement of a specific inflation target around which the effectiveness of the Bank's policy actions would be judged. Adopting IT requires CBN independence, credibility, an adequate understanding of the transmission mechanism of monetary policy and the willingness to sacrifice other macroeconomic objectives (such as economic growth and employment) for the attainment of price-stability.

Inadequate knowledge of the economic system can deter policy actions from having the desired effects. Similarly, inadequate understanding of the consequences of monetary policy would lead to misjudgement and would substantially increase the costs of achieving any given goal. In Nigeria, uncertainty about the transmission mechanism and incomplete understanding of the system has remained a major challenge for monetary policy (Uchendu, 2009a). This is compounded by the existence of a vibrant informal sector, the fabric of which remains largely

[1] The weak institutional features are manifested in prevalent corruption in public administration, low credibility of the monetary authorities and gross inability of government to adequately use taxation to generate revenue. This inadequate tax revenue makes government reliant on the CBN for FD financing; hence, the incidence of fiscal dominance. These issues – including the constitutional and legal backing of FD financing – are further discussed in chapter 3.

indiscernible. Monetary policy in Nigeria is, therefore, undermined and characterised by uncertainty and inadequate knowledge (by policymakers and others) of the economy. These challenges are believed to contribute to volatility and slow economic growth in Nigeria (Batini, 2004; Balogun, 2007).

Most studies on the design of monetary policy in Nigeria have generally tended to investigate the effectiveness of the monetary policy – in terms of money supply changes rather than interest rates – with narrow focus on it costs. Feridun *et al*. (2005) found that the monetary policy approach in Nigeria, though ineffective, has resulted in increased instability in inflation and in the exchange rate. This instability, according to Adam and Goderis (2008) and Olubusoye and Oyaromade (2008), can be further attributed to the disruptive effect of crude oil price volatility on monetary policy efforts. Crude oil price volatility impacts on monetary policy through its impact on the fiscal revenue and monetary expansion. The dominance of the fiscal sector and the continued monetisation of crude oil receipts creates liquidity in the system and heats up the economy. Hence, in measuring the effects of monetary policy in Nigeria, Chuku (2009) concluded that the monetary authority should place more emphasis on quantity-based anchors as against price-based ones. In a recent study, Dada (2011) investigated the suitability of an IT framework in Nigeria via a nonlinear IS-LM framework which assumes monetary growth as the CBN policy variable, and found that IT would increase output variability. However, the reality is that the quantity theory of money (QTM) approach which underlies all these studies is obsolete, given the realisation that money cannot be exogenously controlled by central banks. Hence, the practice of monetary policy is not synonymous with managing the level and growth rate of the money supply, and policy effectiveness does not depend on the ability to control the growth rate of money stock.

The current practice of monetary policy, in many countries, is congruous with the assumptions, conclusions and recommendations of the NCM, with the short-term nominal interest rate as instrument and price-stability as objective. This assumes among other things that the financial and/or money markets are adequately developed and capable of effectively conducting policy impulses to the rest of economy. Furthermore, low inflation is assumed achievable at minimal cost. However, Nigeria's financial system is relatively underdeveloped, shallow, bank dominated and characterised by a dearth of market instruments and securities. This can impede the pass-through from policy rate changes to market rates; thus, diminishing policy effectiveness. Besides, the fact that banks may be more willing to hold risk-free government securities rather than lend to private investors implies that monetary policy interest rate changes may not affect aggregate demand as suggested by the NCM. This further undermines the effectiveness of monetary policy. Again, even if the NCM-type policy were effective, the cost of such policy in Nigeria may be severe; especially given the realities of the economy. Though, recent economic growth and the inflation rate (during 2001-2011) averaged 7 and 11 per cent, respectively; unemployment has remained high at about 20 per cent while poverty is rife – with over 60 per cent of the population living below $1.25/day in 2004.[2] At 48 per cent in 2001-2011, average capacity utilisation is also low. An NCM-type policy by depressing demand would further aggravate unemployment and poverty; an enormous cost to bear. This poses a serious concern as to whether an overriding price-stability objective should be pursued.

Recognising the many challenges facing Nigeria, Batini (2004) attempted an *ex-ante* analysis of monetary policy in Nigeria, with a view to recommending an optimal alternative. She noted the undesirable and prevailing effects of fiscal dominance, a subservient central bank, a weak transmission mechanism, and an underdeveloped financial system for monetary policy. However, her analysis held these effects inconsequential, by examining available alternatives if these challenges were successfully resolved. Batini concluded that a long-run inflation target (*à la* NCM) complemented by a freely floating exchange rate regime is the optimal policy option. One major highlight of Batini's study is the assumption that all the underlying problems have been adequately settled. However, the reality is that though resolution of these issues is possible in the long-run, it is more-or-less impracticable in the short-run. Hence, these factors, and others, are a major feature of the Nigerian economy now and in the foreseeable future. Even if NCM-type policy was effective in the absence of these factors, the question still arises: *is the NCM-type monetary policy optimal for Nigeria in the presence of the identified constraints and the country's institutional features?* Optimality requires that a given policy option be both effective

[2] See chapter six

and achievable at a minimal cost. Given the current reality of the Nigerian economy, there is the need to understand the effectiveness and potential costs of an interest rate based IT-type monetary policy. Thus, this study aims to fill the identified gap by investigating the aptness, for Nigeria, of some of the assumptions and recommendations of the NCM; especially those bothering on effectiveness and costs.

The specific goals of this study are to

- Assess the transmission of policy rate changes to market and retail interest rates. The ability of the financial market to act as the pivot of the economy is critically presumed by the NCM. Essentially, the NCM framework is based on the assumption that policy rate impulses are conveyed on a one-to-one basis to the other market/retail rates while these subsequently affect the level of aggregate demand. Hence, an inexact and/or time-varying pass-through may hinder policy effectiveness or policy determinacy.

- Examine the responsiveness of aggregate demand (or its components) to interest rate changes. In the NCM framework, the effectiveness of monetary policy in achieving its target of price-stability depends on the ability to influence demand. An inability to adequately control demand renders policy ineffective. Under the NCM, aggregate demand function is usually derived from household consumption behaviour over time. Nonetheless, this study focuses essentially on the investment component of demand to deduce policy effectiveness.

- Determine the long-run consequences/cost of an NCM-type monetary policy in Nigeria. The NCM is built on the assumption of long-run neutrality of monetary policy. Hence, policy changes can have no permanent effect on output and employment, given a vertical long-run Phillips curve and supply-determined equilibrium. However, if the long-run Phillips curve is oblique (or if inflation is supply-driven), then the cost of disinflation can be enormous. Beside, changes in interest rates may have other ramifications that can increase financial instability.

To achieve these objectives, empirical analyses are conducted using time-series econometrics technique in the relevant chapters. The study principally employs quarterly data (although pass-through analysis adopted monthly data) starting from 1985:1 up to the most recent data that was available at the time of estimation. These data, as much as possible, reflected the oil versus non-oil dichotomy of the Nigerian economy and are sourced mainly from the Central Bank of Nigeria and the National Bureau of Statistics of Nigeria. Stylized facts in the preliminary chapters are, however, discussed using annual data on different variables spanning 1970-2011 (at the longest) for 38 developing countries. These are obtained from the World Development Indicators published by the World Bank.

The thesis is divided into seven chapters excluding the introductory and concluding sections. Chapters one to three contain discussions on the theories of monetary policy, on the general features of developing countries, and on the conduct of monetary policy in Nigeria, respectively; chapters four to seven comprise analytical and empirical exercises. The specific content of these are as follows:

- Chapter one presents an overview of the currently competing theories of monetary policy, an exposition of the key assumptions and equations of the NCM, as well as the implications and limitations of the NCM. The link between the NCM and IT is discussed here, while noting that policy effects and consequences would differ for developing vis-à-vis developed countries.
- Chapter two provides a general discussion of developing countries. It highlights the key distinguishing features of developing vis-à-vis developed countries and presents stylised analyses of important financial and macro-variables in developing countries. Monetary policy frameworks are also compared among thirty-eight developing countries, for inflation targeters versus non-targeters.
- Chapter three narrows the discussions to Nigeria. Here an overview of the monetary policy in Nigeria is provided, covering a historical discussion on the conduct of monetary policy, the features of the Nigerian economy and the relationship between the CBN and rest of the economy.
- Chapter four begins the systematic analysis NCM-type monetary policy for developing countries, the assumptions and implications of which were discussed

earlier. The chapter contains a theoretical discussion on the nature, determinants and implications of the interest rate pass-through in developing countries. Here, we explain the pricing behaviour of banks, the relationship between pass-through and mark-up, and the determinants of market power. The chapter also expounds the implications of inexact pass-through for NCM-type monetary policy.

- Chapter five investigates the pattern of the interest rate pass-through in Nigeria, following theoretical discussions in the preceding chapter. Empirical analysis is conducted for policy-to-market, policy-to-retail, and market-to-retail interest rates. We examine the reliability of pass-through by rigorously applying up to date modelling techniques to an array of interest rates. These enabled the determination of asymmetric and inter-temporal effects in pass-through.
- Chapter six examines the effectiveness of an NCM-type monetary policy via retail lending rates on aggregate demand – proxied by investment. This chapter relates to the preceding chapter by considering real policy effects subsequent to pass-through, and considers a whole range of investment theories. Hence, using an exhaustive eclectic modelling framework, the potential effects of other determinants of investment are examined in order to identify the most important factors. Again, using modern techniques, empirical analyses examine both asymmetric and non-monotonic monetary policy effects.
- Chapter seven analyses the ramification of disinflation for an NCM-type monetary policy reflected in the Phillips curve relationship. This chapter follows from preceding chapters and derives from the core objective of the NCM. Hence, if monetary policy is effective in affecting retail interest rates and aggregate demand (investment), disinflation may still be achieved at a high cost. Essentially, we examine the assumption of long-run neutrality of monetary policy and the welfare implication of non-neutrality in Nigeria. The investigation utilises advanced threshold econometric techniques which allows the concurrent determination of the slope and curvature of the long-run Phillips curve with the associated costs, in a supply-augmented framework.

1 THEORETICAL OVERVIEW OF CONTEMPORARY MONETARY POLICY

1.1 Introduction

Generally, monetary policy is discussed under two paradigms *viz*: the money supply or the interest rate theories (Allsopp and Vines, 2000; Carlin and Soskice, 2006, ch.5). The money supply view is associated with the QTM approach in which money is considered as exogenous and under the control of central banks (CBs).[3] Underlying this is the notion that inflation correlates with the growth rate of money supply so that money becomes the most appropriate instrument of monetary policy (Carlin and Soskice, *op.cit*; Davidson, 2006). The interest rate paradigm generally follows the Wicksellian structure where money is considered as endogenously determined in the economy and outside the control of the authorities (Fontana, 2007). In the absence of shocks, therefore, inflation reflects government interest rate policy decisions (Carlin and Soskice, *op.cit*). Following the proven inability of CBs to control money supply, emphasis has shifted essentially to the short-term nominal interest rate as the instrument of monetary policy; hence, the fall of monetarism.

Contemporary monetary policy is congruent with NCM tenets; with inflation as the overriding objective and the interest rate as the sole instrument of monetary policy. In the NCM model, money supply is treated as residual (set by the demand for money) and inflation as an aggregate demand (AD) phenomenon. The key assumptions underlying the NCM and its major conclusions have been criticised both theoretically and practically (see Davidson, 2006; and Fontana, 2009a). In this chapter, we present an overview of the currently competing theories of monetary policy, an exposition of the key assumptions and equations of the NCM, as well as the implications and limitations of the NCM especially for developing countries.

[3] The QTM postulates a direct and proportional relationship between money supply and the rate of inflation. It is based on the assumption of a constant velocity of money so that the product of money supply and its velocity is equivalent to nominal income (i.e. $M \cdot v = P \cdot Y$). It thus suggests that changes in money supply would lead to proportional changes in nominal income. If real income (Y) is held constant, these changes impact directly on the price level. However, changes in real money balances can affect output given the constant money velocity; so that $M \cdot P^{-1} = Y \cdot v^{-1}$.

1.2 Alternative Theoretical Views

Although there is a general acceptance of the importance of monetary policy for macroeconomic management, there is no consensus on the appropriate approach for its conduct. This disagreement appears both in the scale and scope of monetary policy. For instance, there is considerable division with regards to the variables that are germane to its conduct and its effectiveness over a time horizon. Palley (2007) observed that these differences derive from the various theoretical understandings of competing schools of thought. Following the doctrine of monetarism and the belief that inflation is a monetary phenomenon since the 1970s, the weight of monetary policy in macroeconomic stabilisation increased considerably (Arestis and Sawyer, 2008a). With this came the consensus that CBs have the responsibility of controlling inflation (or at least targeting inflation as the central objective). Debilitation of the monetarist school notwithstanding, the role of monetary policy remained intact, while the debate on how it should be framed and conducted has taken prominence.

Competing ideologies on the role and nature of monetary policy include those of the new-classical, new-Keynesians and post-Keynesians. Critical area of divergence include: the relationship between prices (wages) and output (unemployment) as specified by the Phillips curve (PC); the nature of prices and wages inflexibility; and exogenous/endogenous treatment of demand vis-à-vis real growth (Palley, 2007). The basic conclusion of the new-classical school is that monetary policy only affects inflation but not unemployment, real wages and growth. In essence, real economic magnitudes are self-adjusting so that their equilibrium path is independent of monetary policy (Gali, 2008). In the new-Keynesian analysis monetary policy affects real variables in short-run but not unemployment and growth in long-run, while the post Keynesian model disputes any form of dichotomy in the long-run (Palley, *op.cit*).

The new-classical model has its derivation basically from classical economics which was essentially based on the QTM. In the classical theory, monetary policy is synonymous with money supply or its rate of change based on the belief that interest rates are determined in the real sector (Bain and Howells, 2009,ch.3; Carlin and Soskice, 2006,ch.2). Given the importance of money in the classical framework, Meyer (2001,p.1) argued that “monetarism is the reincarnation of classical macroeconomics, with its focus on the long-run properties of the economy as opposed to short-run dynamics." The QTM underlined the neutrality of money and assumed a stable velocity of money via a stable demand for money. Neutrality entails that real variables are unaffected by money supply and are driven only by real factors like savings and productivity (Bain and Howells, 2009,ch.1; Gali, 2008). The theory suggests that prices are directly related to money supply, the growth of which (in excess of real output growth) is inflationary. The basic conclusion of the classical analysis is that policy is irrelevant; monetary authorities cannot affect the level or growth rate of output. In essence, there is no trade-off between inflation and output. Any intervention by the CB would only distort price-stability.

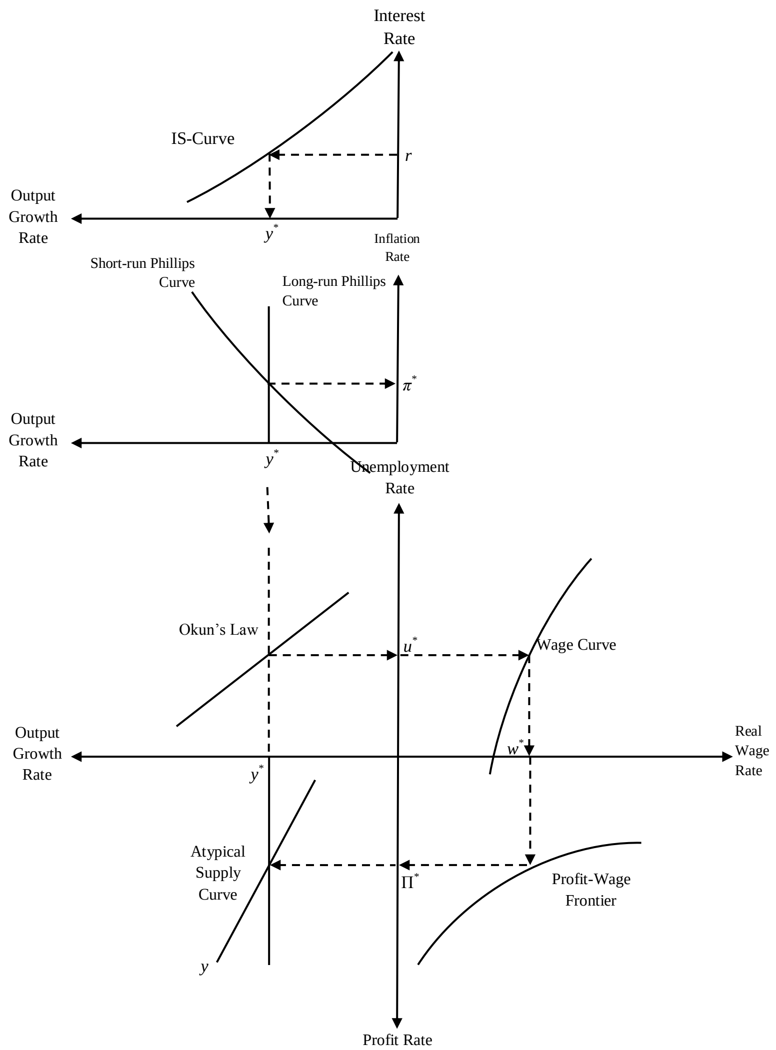
A major departure of the new-classical economists from their classical ancestors is the acceptance of a trade-off between inflation and output in the short-run. This trade-off, captured by the PC, is enriched in new-classical analysis by applying rational expectations hypothesis to the model of continuous market clearing (Bain and Howells, 2009,ch.6). Again with the collapse of monetarism, monetary policy became associated with short-term nominal interest rate management. According to Palley (2007), the new-classical model can be captured by interactions of the interest rate, inflation rate, real wage rate, unemployment rate, output growth and profit rate, with associated microeconomic foundations and the incorporation of rational expectations. Figure 1.1 presents an illustration of the model (at equilibrium) containing: an *IS*-curve (interest rate versus output); a PC (inflation versus output); Okun's relationship (unemployment versus output); supply-function (profit versus output); profit-wage-frontier (profit versus real wage); and the wage-curve (unemployment versus real wage). The model implicitly contains the assumption of continuous market clearing which supposes that prices adjust instantaneously to clear the market. This implies the absence of involuntary unemployment at the market-clearing wage rate. By combining the rational expectation concept with the assumption of continuous market clearing, the new-classical model postulates that unemployment oscillates around its natural level (Bain and Howells, *op.cit*). This further implies that there exists a level of unemployment at which inflationary pressures abate and output is at full employment equilibrium; hence, the non-accelerating inflation rate of unemployment (NAIRU). At the NAIRU the PC is vertical and there is supply-driven equilibrium.

According to the framework, interest rate affects investment and consumption components of the AD which are subsequently transmitted to real growth. The incorporation of the rational expectations hypothesis in the model means that economic agents can (on average) correctly predict policy actions. This has implications for the outcome of policy. Only unexpected policy would have temporary real effects on the economy while anticipated policy actions would have nominal effects. Thus, even under the assumption of rational expectation, provided that markets clear continuously, systematic policy would be incapable of altering real economic activities (Handa, 2000,ch.15; Carlin and Soskice, 2006,ch.3). For instance, (in figure 1.1) if the monetary authorities embarked upon an unanticipated reduction in the interest rate, this would increase AD and inflation. Money wage rises as unemployment declines. However, real wage falls below its equilibrium raising profits and causing output expansion. This is nonetheless temporary as agents, armed with the correct model of the economy, would adjust their expectation in line with the new level of inflation. As the policy surprise dissipates, the short-run Phillips curve (SR-PC) shifts upward, unemployment and real wage rise, and all real variables revert back to their equilibrium level at a higher level of inflation. According to Palley (2007) this, therefore, implies that the goal of monetary policy should be price stabilisation. Hence, monetary policy would only have nominal effect in the long-run when expectations are fully adjusted.

The conclusion of the new-classical framework that expansionary monetary policy would have no effect on unemployment suggests that policy cannot be justified on the basis of the deviations of actual unemployment from the natural rate, since these deviations are random. (Bain and Howells, 2009,ch.6). This reflects “the assumption of continuous market clearing [which accordingly] implies that...all unemployment is voluntary” (*op.cit*, p.164). The new-Keynesians, however, dispute the assumption of continuous market clearing but acknowledge the idea of a long-run equilibrium and the propensity of an economy to revert to this equilibrium. This equilibrium reversion is not instantaneous but may take a considerable time. Unlike the new-classical economists which believe that disequilibrium results from incorrect expectations due to policy surprises, the new-Keynesians argue that disequilibrium results from price rigidities that arise from the institutional features of a market. Consequently, the fulcrum of new-Keynesian analysis is the sticky wage and price model (Carlin and

Soskice, 2006,ch.15). According to this model, wage contracts prevent nominal wage adjustment in the short-run (at least until the contract runs through). Hence, an expansionary monetary policy increases AD and inflation. In addition, it lowers unemployment and real wage while nominal wages remains unchanged due to existing contract. The fall in real wage increase profits and spurs producers to increase output. In the long-run, however, as wage contracts end, nominal wage begins to be adjusted upward thereby increasing real wage. This causes a decline in profit, output and employment. Thus, contrary to new-classical postulations, when prices and wages are rigid, the equilibrium outcome of real variables is not exogenous to monetary policy (Gali, 2008). Monetary policy may, thus, be used to manage deviations of output and employment around their NAIRU-consistent level (Palley, 2007).

Figure 1.1: The New-Classical Framework



Source: Adapted from Palley (2007)

An amalgamation of some of the key assumptions of the new-classical (rational expectations) and the new-Keynesians (short-run rigidities and long-run flexibility) constitutes the bedrock of the NCM model, the policy conclusion of which is that price-stability is the main objective of monetary policy. According to Setterfield (2006), the key elements of the NCM model are the assumption of real wage bargaining, monetary neutrality, supply-driven equilibrium and demand-determined inflation. Following Clarida *et al.* (1999) and Meyer (2001), these elements are typically summarised by three equations – *IS*-type AD, PC, and monetary rule (MR) – with micro-foundations in agents' optimisation procedure (see Gali, 2008; Walsh, 2003,ch.5; and Woodford, 2003,ch.4). The views of the NCM (discussed in later sections) are parallel to those of the new-Keynesians and new-classical in arguing that a CB cannot engage in real output stabilisation in the long-run, since the combination of rational expectation and continuous market clearing ensures the emergence of inflationary pressures without output gains. The CB should thus concentrate on long-run price-stability and short-run output stabilisation (Fontana and Palacio-Vera, 2007).

Post-Keynesians are sceptical of NAIRU as a unique rate of unemployment that is unaffected by the path of demand and consistent with constant inflation. While some like Davidson (2006) totally rejects this concept, others like Arestis and Sawyer (2005) accept the existence of a level of economic activity that is consistent with zero inflation; hence, *inflation barrier*. For Davidson, the argument of price-stability as the key policy objective crumples without the "vague slippery...notion" of NAIRU (p.691). However, unlike NAIRU which emphasises supply-side equilibrium based on labour market dynamics, inflation barrier recognises the interrelationship between the goods market and the labour market. Hence, the barrier is set by product market conditions and productive capacity – rather than by labour market conditions. It also envisaged that this barrier be continuously changing and path dependent, and does not act as a strong attractor for the actual level of unemployment.

Essentially, post-Keynesians posit that inflation derives from conflicts over income share between workers and employers; and supply factors related to productive capacity (Arestis and Sawyer, *op.cit*; Setterfield, 2009). In this regard, attempts by workers or firms to increase their share alter the inflation barrier and are inflationary. Changes in income distribution (between firms' profit and workers' wages) depend on bargaining power which in turn depends on the level of unemployment and can affect economic growth. Investment and capital stock also play a critical role in the economy affecting both AD and aggregate supply (AS), and hence the level of economic activity and unemployment. Changes and/or intensity (i.e. productivity) of capital stock affect incomes distribution and inflation barrier. Hence, the interest rate by affecting investment affects capital stock and productive capacity, and via hysteresis can affect an economy's long-run path.[4] In general, the post-Keynesian framework contains an oblique long-run Phillips curve (LR-PC) implying a long-run trade-off between inflation and output (or unemployment), making IT undesirable and costly. Setterfield (2006) broadly summarise post-Keynesian stance as nominal (rather than real) wage bargaining, monetary non-neutrality, demand-driven equilibrium, cost-determined inflation. Post-Keynesians conclude that the one-instrument-one-objective approach is sub-optimal. Policy should, rather, be conducted in a multi-instrument-multi-objective framework to ensure balanced and socially optimal outcome (Heintz and Ndikumana, 2011).

1.3 Contemporary Issues in the Conduct of Monetary Policy

Following the collapse of monetarism, monetary policy became associated with CBs management of the short-term interest rate. This is viewed by many as a significant alignment of the theories and practice of monetary policy. In fact, as noted by Fontana (2007)

> "One of the greatest achievements of the modern mainstream approach to monetary policy is to have rejected the old quantity theoretic framework and to have replaced it with a[n]...interest rate analysis, which closely reflects the actual behaviour of central banks" (p.43).

The view that money is exogenous (and within the control of CBs) is rejected by many modern economists, particularly the post-Keynesians. Consequently, there is reduced focus on monetary aggregates in many CBs around the world. Nonetheless, the belief remains that inflation is a monetary policy phenomenon and thus the responsibility of CBs. Monetary policy, therefore, has become prominent in macroeconomic

[4] Hysteresis refers to the possibility that output loss (or high unemployment) in time t can lead to lower growth rates (or increased unemployment rate) in period $t+h$; h=1,2,...

management and is conducted in a one-instrument-one-target framework (Arestis, 2007; Arestis and Sawyer, 2008a). In this case, the interest rate is the instrument of monetary policy while inflation is the target.[5] This typifies IT whether explicitly or implicitly (Carlin and Soskice, 2006,ch.3). According to Arestis and Sawyer (2008b) the use of the interest rate as the major instrument of monetary policy has some fundamental elements *viz*: objectives of price-stability; a PC with real economic activity and expectations explaining inflation; incorporation of a variant of the classical dichotomy; and the notion of a supply-side equilibrium. These elements are consistent with the NCM model and constitute features of the economic model on which the justification for IT by an independent CB is based.

Although NCM and IT are broadly treated as congruent in this thesis, there is however some subtle distinctions between these. IT is a conditioning policy framework adopted by an independent CB which is perceived by rational economic agents to be credibly committed to an overriding objective of price-stability. The practice of IT in many countries is associated closely with the work of Kydland and Prescott (1977) and Barro and Gordon (1983) which argued that in an economy characterised by rational expectations, given the problems of time-inconsistency, *discretionary* policies would lead to sub-optimal equilibrium while *rule*-based policies would maximise the social objective function. In these studies, macroeconomic policy is deemed an expectations-game between the policymakers and the rational economic agents. Since policymakers are inclined to expanding economy activities, agents' aim to avoid policy surprises by anticipating policymakers' decisions. Rule-based policies built on pre-commitment to a certain objective eliminate policy surprises where discretionary policies devoid of any commitment create surprises.

In the Kydland–Prescott–Barro–Gordon tradition, given that real economic activities are invariant to policies due to agents' rational expectations, systematic attempts of policymakers to expand economic activities would only create inflation surprises; that is the so-called inflation bias (Gerlach, 2003; Hartely, 2006). Thus, discretionary policies would raise inflation rate above the optimal level that would have been achieved if rules were followed. Under rational expectations, therefore, pre-

[5] Whilst IT has been widely used, there is however, a range of countries in which the exchange rate is of considerable concern for monetary policy.

commitment to an inflation objective ensures that inflation expectations by agents coincide with that defined by the rule (Barro and Gordon, *op.cit*). Following the works of Kydland and Prescott (*op.cit*) and Barro and Gordon (*op.cit*), therefore, IT highlights the role of policy institutions (i.e. CBs) rather than policy choices/tools.

As a conditioning framework, IT is based on an inflation-averse CB legally committed to the objective of price-stability and as such seen to be credible by rational agents in achieving this objective. The basic difference between IT and NCM is that while the former is a conditioning approach that requires commitment and credibility of a CB, the latter is an optimal control framework that does not explicitly require such commitment. Besides, under IT the expectations channel of transmission is deemed important while the AD channel is emphasised by the NCM. Furthermore, under NCM the policy instrument is restricted strictly to the short-term interest rate whereas IT allows the use monetary growth, interest rates or any other feasible monetary policy instrument. However, IT and NCM are somewhat similar; first, in the sense that are both built on the notion of rational expectations; second, they both contain a monetary policy rule, and lastly, they both emphasise an overriding objective of price-stability. In our analysis, the link between both frameworks is due to the contemporary practice of IT, where the short-term interest rate is largely adopted as the monetary policy instrument to combat inflation.

1.3.1 The New Consensus Model

The NCM is a perpetuation of the new-Keynesian principles which also contained some new-classical ideologies (Gnos and Rochon, 2007). It basically highlights the long-run new-classical growth models so that the long-run outcomes of output and employment are supply-driven, while monetary policy remains important in the short-run (Fontana, 2008). Hence, it is based on supply-side driven equilibrium with the business cycle oscillating near this equilibrium (Arestis, 2007). The NCM was developed with the fundamental reasoning that Say's law holds (through the way in which the policy interest rate is set); hence, in the long-run effective demand has no real implications in the economy (Arestis and Sawyer, 2008a). Further underpinnings of the NCM are: the existence of temporal nominal rigidities in wages and prices so that monetary policy would have real effects in the short-run; inflation is a monetary policy phenomenon; there is rational expectations as agents possess correct knowledge of the workings of the economic model; and, due to the concept of *Ricardian equivalence*, fiscal policy is deemed impotent.

Conventionally, the NCM is derived in Woodford (2003,ch.4) from inter-temporal general equilibrium and is represented by AD, PC and MR equations (Arestis and Sawyer, 2008a).[6] These summarise the dynamics of output (or output gap), inflation and the interest rate (Fontana, 2007). Primarily, an AD relationship is represented as

$$y_t = \boldsymbol{A} - \omega(i_t - E_t\pi_{t+1}) \qquad 1.1$$

where y_t is the level of output, $\boldsymbol{A}$ is autonomous demand, i_t represents the short-term nominal interest rate and $E_t\pi_{t+1}$ is inflation expectation. The equation shows that output is an inverse function of the real interest rate. In the NCM model, however, the equation is expressed in the form of deviations from equilibrium. Hence, a canonical NCM-AD relationship is given as

$$\tilde{y}_t = \boldsymbol{A} - \omega(i_t - E_t\pi_{t+1} - \bar{r}) \qquad 1.2$$

$$\tilde{y}_t \equiv y_t - \bar{y}$$

where $\bar{y}$ is (the NAIRU-consistent) equilibrium output and $\tilde{y}_t$ is output gap. The term $\bar{r}$ is the equilibrium real interest rate – analogous to Wicksell's natural rate of interest – congruous with the NAIRU and zero output gap (Fontana, 2007).[7] This implies that monetary policy, by changing the short-term nominal interest rate, can affect the output gap. The AD equation represents the demand side of the economy and basically suggests that the output gap is explained by real interest rate disequilibrium. Under the assumption of nominal rigidities the equation is dynamised multi-period as

$$\tilde{y}_t = \boldsymbol{A} + \sum_{s=1}^{\infty} \varphi_s \tilde{y}_{t-s} - \sum_{h=0}^{\infty} \omega_h (i_{t-h} - E_{t-h}\pi_{t-h+1} - \bar{r})$$

implying

$$\tilde{y}_t = \boldsymbol{A} + \varphi\tilde{y}_{t-1} - \omega(i_t - E_t\pi_{t+1} - \bar{r}) \qquad 1.3$$

[6] Arestis (2007) expanded the model to six equations by incorporating the external sector. This attempted to capture the effect of exchange rate in a NCM framework.

[7] Wicksell's natural rate of interest is perceived to correspond to the rate of interest which would bring savings and investment into equality in a barter (non-monetary) economy. Fontana (2007) provides a detailed discussion of the Wicksellian natural rate and its role in the NCM model.

where $s = 1$ and $h = 0$ are typically assumed. This shows that in addition to real interest rate differentials, previous outcomes of output gap are important in determining its current evolution. However, in a more general form Gali (2008) and Woodford (2003,ch.4) derived the NCM-AD from household optimisation behaviour by log-linearising the associated Euler equation approximately as

$$\tilde{y}_t = \boldsymbol{A} + \varphi\tilde{y}_{t-1} - \omega(i_t - E_t\pi_{t+1}) + \eta_{AD} \qquad 1.4$$

where $\eta_{AD} \sim iid\left(0, \sigma^2_{\eta_{AD}}\right)$ represents random errors. This shows that the short-term real interest rate (rather than its disequilibrium) explains AD dynamics and represents the prevalent characterization of NCM-AD. By emphasising household utility, the NCM-AD supplants firms' investment behaviour and the equilibrium interest rate in the economy; thus, suggesting that household consumption and savings patterns vis-à-vis the prevailing real interest rates are sufficient determinants of AD. This point is, however, discussed further in chapter 6.

The second NCM equation is a PC describing supply-related effects. Allowing for sticky prices and rational expectations, it is simply written as

$$\pi_t = a_1E_t\pi_{t+1} + a_2\pi_{t-1} + \kappa(y_t - \bar{y}) + \eta_{PC} \qquad 1.5$$

Inflation (π_t) is depicted as a positive function of output gap, future expectations of inflation $(E_t\pi_{t+1})$ and inflation inertia (π_{t-1}). The model suggests an output-inflation trade-off in the short-run – where $a_1 + a_2 = 1$ implies that such trade-off disappears in the long-run. In essence, the NCM postulates a vertical LR-PC at the NAIRU. Therefore, as Meyer (2001) puts it

> "... the [NCM-PC] pins down the degree to which prices are sticky in the short run, allowing scope for both short-run movements in actual output relative to potential and for stabilization policy, while providing a mechanism that ensures a transition to the long-run classic equilibrium" (p.3).

By postulating a continuous supply-side equilibrium, the NCM model assumes that inflation is demand driven. Accordingly, the model suggests that supply shocks –

$\eta_{PC} \sim iid\left(0, \sigma^2_{\eta_{PC}}\right)$ – are transient, stochastic and neither affect inflation nor inflation expectations (Arestis and Sawyer, 2006). In essence, the NCM assumes that inflation can be controlled by AD management and that the interest rate is the appropriate monetary policy instrument. It further suggests that at the equilibrium rate of interest the output gap is zero (implying also that AD equates AS) and inflation constant. Consequently, deviation of the interest rate from its natural level impacts on the output gap which in turn influences the level of inflation. The assumption of random supply shock with zero mean complements the premise of a constant NAIRU so that the natural level of output is unaffected by monetary policy shocks (Gali, 2008). Expansionary monetary policies are, thus, steered at demand shocks in order to increase economic activity thereby raising the rate of inflation (Smith and Wickens, 2007). Hence, the final impact of monetary policy is on the rate of inflation and as such this should constitute the policy target. The fundamental trust of the NCM is that the short-term interest rate management would only be effective (i.e. affect inflation rate) if it impacts on the level of AD (Bain and Howells, 2009,ch.8). By assuming that inflation is a demand phenomenon, the NCM critically undermines other sources of inflation particularly cost related factors (Gnos and Rochon, 2007).

The last equation of the NCM model is the monetary policy rule (which is CBs' reaction function) illustrating the process of interest rate determination in the economy and represented simply as

$$i_t - E_t\pi_{t+1} - \bar{r} = \rho(\pi_t - \pi^T) + \lambda(y_t - \bar{y}) \qquad 1.6$$

This shows that the difference between the actual and the equilibrium real interest rate depends on deviations of actual inflation from inflation target (π^T) and the output gap. Equation 1.6 is a Taylor-type-rule that endogenises interest rate adjustments by CBs and has two distinct derivations (Arestis and Sawyer, 2008a; 2008b). The first is a methodical search (for ρ and λ)that generalises CBs' behaviour (Allsopp and Vines, 2000). Alternatively, it is derived (as in Carlin and Soskice, 2006,ch.5; Clarida *et al.*, 1999; and Svensson, 2003) by minimising a CB's quadratic loss function of the form

$$\boldsymbol{\mathcal{L}} = (\pi_t - \pi^T)^2 + \theta(y_t - \bar{y})^2 \qquad 1.7$$

where the parameter $\theta > 0$ is the weight assigned to output deviations from its trend. If $\theta > 1$ then more weight is placed on output stabilisation vis-à-vis price-stability. Conversely, $\theta < 1$ implies inflation aversion while $\theta = 0$ indicates strict IT. Generally, $0 < \theta < 1$ is assumed so that the objective of CBs is to minimise output loss associated with disinflation.

The operating rule, thus, depicts the policy "instrument [as] a function of a small subset of the information available to [CBs]" with inflation and output gaps as operating targets (Svensson, 2003, p.426). According to Clarida *et al.* (1999, p.1670), "the policy problem is to choose a time path for the instrument i_t to engineer time paths of the target variables...that [minimises] the objective function." The operating rule therefore shows that the CB reacts to economic developments in a systematic and predictable manner (Arestis, 2007; Gnos and Rochon, 2007; Svensson, *op.cit*). Hence, a rise in inflation above target would lead to higher interest rate to slow the economy and reduce inflation and vice-versa. One important implication of the monetary rule is that if $\pi_t = \pi^T$ and $y_t - \bar{y} = 0$, then CBs actually fix $\bar{r} = i_t - E_t\pi_{t+1}$. This presupposes that $\bar{r}$ is unique, attainable and known thereby enabling CBs to steer the economy towards equilibrium (Arestis and Sawyer, 2008a). Precise knowledge of the equilibrium real interest rate is, however, impossible. [8]

Nonetheless, the NCM-MR relationship suggests that accurate knowledge of $\bar{r}$ alongside inflation expectations enable CBs to fix the short-term nominal interest rate. This is seen by re-arranging the monetary rule

$$i_t = \bar{r} + E_t\pi_{t+1} + \rho(\pi_t - \pi^T) + \lambda(y_t - \bar{y}) \qquad 1.6`$$

which, by incorporating interest rate smoothing, is sometimes modified as

$$i_t = (1 - \delta)i_{t-1} + \delta[\bar{r} + E_t\pi_{t+1} + \rho(\pi_t - \pi^T) + \lambda(y_t - \bar{y})] \qquad 1.8$$

This represents a prototype operating rule contained in contemporary literature of monetary policy where equations 1.6` and 1.8 become identical if $\delta = 1$ holds. The robustness of this rule relies on a number of interrelated and requisite properties. Svensson (2003) highlighted these properties to include: satisfaction of the "Taylor

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[8] It is evident from equation 1.4 that when $y_t - \bar{y} = 0$ then $\bar{r} = i_t - E_t\pi_{t+1} = \boldsymbol{A} + \eta_{AD}$ and may not be unique.

principle" (i.e. the requirement that the interest rate respond more than proportionately to changes in inflation) to ensure determinacy; use of interest rate smoothing to improve performance; response of instrument to determinants of operating targets (rather than directly at the targets); parameters of equation 1.8 depend on the weight (θ) in 1.7; and ability to fit adequately into competing macro-models while approximating reality. A simple Taylor-rule is in this regard deemed optimal.

Taylor (1993) approximated the behaviour of the Federal Reserve by assuming that $\bar{r} = 2$ per cent, $\rho = 1.5$ and $\lambda = 0.5$. The coefficients ρ and λ indicate the required adjustment of nominal interest rates following non-zero inflation and output gaps, respectively. To guarantee unique equilibrium and model stability, Taylor (*op.cit*) suggested that $\rho > 1$ and $0 < \lambda < 1$; so that the short-term nominal interest rate adjusts by more than one-to-one to inflation changes. By implication the rule expects that CBs are largely inflation averse so that $\theta < 1$ holds based on the supposed costs of inflation. According to Mishkin (2007), the proponents of the goal of price stabilisation argue that inflation causes uncertainty in relative prices and makes firms to take sub-optimal decisions which affect the real economy. This is in addition to the new-classical claim of monetary policy long-run neutrality.[9] However, the weight that CBs place on inflation stability cannot be justified on the bases of the inability of monetary policy to affect economic activity in the long-run (Fontana and Palacio-Vera, 2007). In reality the weight that CBs place on the inflation and output stabilisation should depend on their mandate, preferences, business cycle, country-specific institutional features, and level of economic development. This weight may be asymmetric around equilibrium (Nobay and Peel, 2003) and given the nature of economic shock (Fontana and Palacio-Vera, 2007).

Furthermore, the outcome of monetary policy based on this type of rule depends on the interest rate sensitivity of AD and the slope of the PC (Carlin and Soskice, 2006,ch.5; Walsh, 2003,ch.5). These imply that the interest rate may respond by more than one-to-one to output deviations so that the condition $\lambda > 1$ (and $\theta > 1$) holds.

[9] This connotes somewhat a contradiction in the underlying new-classical principles *viz*: inflation causes sub-optimal decisions affecting the real economy; monetary policy influences inflation and hence real agents' decisions; decisions lead to actions which affect real economy; therefore, monetary policy affects real quantities and is non-neutral.

According to Woodford (2003,ch.4) the model may have a unique and stable equilibrium even under this condition.

Endogenising interest rate determination within the model is based on obtaining feedback from real output; hence, the interest rate is essentially policy-determined (exogenous) within the NCM policy framework. This implies that money supply becomes endogenous and is determined as a residual based on the requirements of the economic system (Meyer, 2001; Arestis, 2007, Arestis and Sawyer, 2008b; Gnos and Rochon, 2007).[10] Nonetheless, policy rules should not be used mechanically but regarded as a framework applied with informed discretion (Svensson, 2003)

1.3.2 Implication of the NCM Framework: Inflation Targeting

A major conclusion from the NCM is that inflation is not only a monetary policy phenomenon but also a demand management phenomenon. Inflation should therefore remain the ultimate target of monetary policy while the short-term nominal interest rate is the operating target. Attempts to use monetary policy for long-run output expansion (beyond the equilibrium) would lead to inflation bias as output would revert back to the NAIRU-consistent level while inflation increases above its optimal level (Carlin and Soskice, 2006,ch.5). This implies that since the monetary authorities cannot influence the path of long-run growth, monetary policy should be confined to long-run price-stability and short-run output stabilisation (Fontana and Palacio-Vera, 2007).

Long-run output growth is assumed to be independent of monetary policy action so that the supply-side is always in equilibrium. In essence, while AD can fluctuate in the short-run, it ultimately converges to AS in the long-run. As Fontana and Palacio-Vera (2007, p.273) noted, "...the natural...growth rate of output is assumed to be independent of the level and time path of [AD], ideally current output should grow in line with potential output." When actual output surpasses its trend, AD would exceed AS and would culminate in inflationary pressure. This implies that monetary policy should be the key tool for macroeconomic management and should be conducted in a one-instrument-one-target framework. Essentially, other tools of macroeconomic

[10] Operating rule based on monetary aggregate was suggested by McCallum (1988). Taylor (2000) noted that uncertainty in the measurement of the interest rate, substantial shocks to investment and net exports, and inability to correctly estimate the equilibrium real interest rate are some justifications for such a rule.

management, like fiscal policy, are relegated, while a monetary aggregate is discarded as instrument of monetary policy. Within the NCM framework, no importance is accorded to the exchange rate as it is considered to play no direct role in the CB's interest rate determination process (Arestis, 2007).[11]

The NCM therefore constitutes the major theoretical foundation of an IT monetary policy framework. The proponents of IT argue that low and stable inflation is required for sustainable growth and market efficiency. This removes money illusion and uncertainties in relative prices thereby allowing economic agents to take optimal decisions (Mishkin, 2007). In practice, IT is associated with CB independence (devoid of political interference), public announcement of inflation targets, accountability and transparency in the monetary policy process; which jointly ascertain rational expectations among agents. The CB is accordingly committed to its overriding objective of price-stability. IT, therefore, suggests a high degree of inflation aversion by CBs so that even the slightest deviation of inflation from target is corrected by the willingness to sacrifice larger fall in output and or faster rise in unemployment (Carlin and Soskice, 2006,ch.3). Hence, even during stagflation, the policy choice is to combat inflation irrespective of deepening recession and regardless of the source of inflation. According to Bain and Howells (2009,ch.8),

> "...even if we are willing to accept the control of inflation as the dominant macroeconomic objective, we may well require [a] strong justification for propositions that it should take precedence...irrespective of the...level of unemployment" (p.224).

Though the framework to monetary policy is instituted on the AD and expectations channels of monetary policy, its success rests crucially on the significance of the latter. Since monetary policy operates with a lag, the ability of CBs to effectively anchor expectations is therefore critical to the attainment of the inflation target (Gnos and Rochon, 2007). In the monetary rule, inflation target provides a direction for expected inflation and as such steers expectations. Agents base their economic decisions on the announced target as long as it sees the CB as credible. However, given the lag in the

[11] Indeed, conventional NCM model is derived for a closed economy.

transmission of monetary policy, CBs in practice announce inflation forecast, which guides the expectation of agents. In view of the imperfect control of inflation, this forecast then becomes the intermediate target of policy (Arestis, 2007). If expectations are formed on the basis of the announced forecast, then actual inflation may coincide with the forecast. Thus, there is "a self-adjusting element to inflation forecasting in so far as inflation expectations build on forecasts, which then influence actual inflation" (Arestis, *op.cit*, p.30). Inflation expectations are deemed to lower the cost of IT in terms of output lost. This indicates that a strong expectations channel would reinforce the AD channel of monetary policy transmission (Fontana, 2010).

In countries where low and stable rate of inflation is the foremost objective of monetary policy, optimal inflation rate usually below 5 per cent is assumed. In many cases, the target revolves around 2 per cent based on the argument that this is close enough to zero. Particularly if the measured rate of inflation is seen as upwardly biased, this helps to avoid slipping into deflation and also accounts for price increases due to quality improvement. The underlying argument is that lower variability in inflation would lead to higher stability of output. However, if the PC is nonlinear disinflation is not costless. In reality, the PC may be convex (Clark *et al*., 1996). Accordingly, the slope and curvature of the PC connote a higher sacrifice ratio at lower levels of inflation (Carlin and Soskice, 2006,ch.3). Being quadratic, the CB's loss function quantifies somewhat the nonlinearity in the relationship where "a doubling of inflation [gap] leads to a quadrupling of losses" in terms of social welfare (Arestis and Sawyer, 2008b, p.766). Khan and Senhadji (2001) and Pollin and Zhu (2006) indicated that this relationship contained two different nonlinearities. They showed that there is a threshold in the relationship below which inflation and output are positively associated and above which they correlate inversely. Particularly they conclude that since this threshold vary significantly between countries very low inflation targets cannot be justified across all countries. Similarly, Masson *et al.* (1998) reasoned that for countries where inflation has remained between 15-25 per cent for a number of years this kind of monetary policy would be inappropriate. IT may, therefore, only be applicable in an environment of low and stable inflation especially in the absence of a business cycle downturn (Buiter, 2008; Fontana, 2009a). In essence, disinflation may not be desirable simply because inflation is high but may be justified by high and rising inflation so that the goal is basically that of stabilising inflation at a lower rate (Carlin and Soskice, 2006,ch.5).

1.3.3 Limitations and Critiques of the NCM

The NCM model integrates the short-run new-Keynesian views with the long-run new-classical postulations. By incorporating forward-looking rational expectations, it implied that even the slightest consideration for real output vis-à-vis price-stability by a CB is inflationary and without long-run growth benefits. Besides, output and inflation exhibit a trade-off only in the short-run while “exogenously-driven changes in [AS] determine the long-run, full-employment equilibrium position of the economy” (Fontana, 2010, p.525). This implies that the economy also possesses automatic stabilising properties which ensure that it reverts back to real equilibrium after episodes of shocks. Hence, changes in AD do not affect the long-run equilibrium since they cannot influence potential levels of output.

Criticisms of the NCM, according to Fontana (2009a), derive both from within and outside the school. For instance, Posen’s (2008) denunciation of rational expectations within the NCM framework (and its undermining of activist monetary policy for long-run output stabilisation) represents internal disapproval. Posen (*op.cit*) asserted that assumption of rational expectation is both exaggerated and misleading thereby causing unwarranted and excessive fear of inflation explosion. This associates NCM-type policies to the problem of unemployment bias which is the tendency to constrain real output and employment as long as inflation is above target. Even if forward-looking expectations were accepted, the reality that *heterogeneous* agents lack *accurate* knowledge of the CB model, means that expectations are not exactly fulfilled; thus leaving room for long-run output objective. Hence, CBs may assign more weight to output (and employment) vis-à-vis inflation without incurring inflationary pressure (Fontana, *op.cit*; Fontana and Palacio-Vera (2007). Blanchard (2008), in another internal assessment, indicated that the NCM contains inadequate treatment of the financial *cum* credit market, labour market and goods market. This according to Fontana (*op.cit*) emanates from overlooking financial instability, the assumptions of workers’ non-exiting of the labour market, and constant mark-up in the goods market.

Outsiders' critique of the NCM framework (mainly by post-Keynesians) lies in the rejection of its underlying tenets. A major theoretical criticism of the NCM is the assumption that supply-side equilibrium holds while monetary policy (which operates via the AD channel) is incapable of ensuring output stabilisation. Post-Keynesian economists question the NCM conclusion that monetary policy should focus on short-run output stabilisation and long-run price-stability. Fontana and Palacio-Vera (2007) argued that real shocks can change output and (un)employment permanently. Monetary policy can affect the time path of demand thereby having long-lasting effect on its long-run trend level. Since an implicit assumption of the NCM model is that interest rate changes would affect investment, then it can consequently affect the future outcome of AS in the economy. Arestis and Sawyer (2008b) argued that if investment is responsive to monetary policy interest rate shifts, its dynamics would affect the capital stock in the economy which would subsequently influence the productive capacity. Essentially, changes in investment, by altering the time path of the capital stock, cause variations in the long-run supply-side outcomes of the economy.

The foregoing nullifies the assumption of a zero long-run trade-off in inflation and output. It shows that the LR-PC may not be vertical as postulated by the NCM model. In fact, according to Arestis and Sawyer (2008a; 2008b), there is no empirical support for the assumption of a vertical PC. For instance, Akerlof (2000), Eisner (1997), and Turner (1995) provided evidence of non-vertical LR-PC. Similarly, Karanassou *et al.* (2008) demonstrated that the emergence of a vertical LR-PC depends on the assumptions of no inflation persistence, a zero cost of disinflation and a zero discount rate. These assumptions, especially that of a zero discount rate, are implausible (Carlin and Soskice, 2006,ch.3; Arestis and Sawyer, 2008a). Karanassou *et al*. (*op.cit*, p.38), therefore, asserted that "in the presence of time discounting the [LR-PC] is downward-sloping and there is inflation persistence." Changes in the monetary policy interest rate would affect the time discounting rate and the inter-temporal consumption and investment decisions of economic agents. In this way the slope of LR-PC would depend on the discount rate and the sensitivity of demand. The existence of an oblique PC demolishes the arguments of a unique NAIRU and enfeebles the basis for an overriding objective of price-stability.

Analysis within the NCM is simplified on the further assumption that the SR-PC is linear. However, empirical studies have shown nonlinearity in the relationship between output and inflation. A nonlinear PC implies a positive relationship between the sacrifice ratio and degree of inflation aversion. Linearity presupposes that the sacrifice ratio is unaffected by the degree of inflation aversion (Carlin and Soskice, 2006,ch.3). The NCM-PC, therefore, obscures the true cost of disinflation. In principle high inflation aversion as recommended under the IT is costly. As CBs move towards IT they may suffer greater losses in terms of output and employment.

The supply-side of the economy is reflected in the NCM framework by the potential/natural output; upon which its analysis critically rests. Davidson (2006) and Setterfield (2006) imply that the NCM recommendation of IT is impracticable without this concept. Besides the debate on its existence, the question of definition and measurement also arise. Potential output is sometimes depicted as a country's productive capacity; in which case it would reflect a production possibility frontier (PPF). The problem here is that feasible region of the PPF does not contain overheating so that inflation may not necessarily be attributable to excess demand. Another characterisation of potential output is in terms of the trend or long-run path of output, which is usually dependent on business cycles and actual outcomes of output (Arestis and Sawyer, 2008b). [12] Moreover, this level of output is unobservable and can only be estimated *ex post* (Fontana and Palacio-Vera, 2007). The inability to measure this variable *ex ante* undermines the potency of monetary policy under the NCM. In addition, the measure of potential output depends on the method of its estimation. Different methods produce different estimates with no indication as to which is the best technique. This makes potential output an unreliable policy variable (Gnos and Rochon, 2007).

By assuming a random supply-side shock with zero long-run average, the NCM asserts that inflation is an AD phenomenon. Essentially the exchange rate and other possible causes of inflation are overlooked. In reality, inflation can emanate from a number of sources particularly the cost-push factors like wages, exchange rate

[12] Thus, the issue essentially between how potential and trend output are characterised. Whereas the trend derives from some average rate of growth, potential has connotations of maximum output or, at least, cost minimising level of output.

gyrations, import prices and inadequate productive capacity (Arestis and Sawyer, 2006). The implicit assumption is that shocks from this source are transitory and as such requires no policy action. However, changes in the exchange rate can have long-lasting effect on capital flows and on the productive capacity of the economy, especially for developing countries. In reality supply shocks may not be transitory so that other sources of inflation then have permanent effects in the economy. Applying demand driven policy to such shocks would have adverse consequences for the economy so that recessions can become policy induced. In addition, by impacting on investment, productive capacity, output and employment, the deflationary monetary policy under the NCM framework can have long-lasting depressing effect on the economy (Arestis and Sawyer, 2008b; Fontana and Palacio-Vera, 2007).

The use of interest rate as a policy variable in the NCM model has also been criticised for its distributional effect and its implication for financial stability. With its micro-foundations in household utility optimisation, the NCM obscures the effect of interest rate changes on production costs. For borrowing firms, interest rates changes affect overhead costs: the burden thereof can be transferred to consumers thereby exacerbating the original problem (Fontana, 2009a). Besides, interest rate changes would also affect the income of rentier households who own financial assets so that rising interest rate increases demand and inflation thus negating the policy outcome (Fontana, *op.cit*). These distributional effects indicate that interest rate manipulations may fuel rather than curb inflationary or deflationary pressures. In addition, Setterfield (2009) showed that the NCM framework can be modified to accommodate a policy rule that allows the CB to set the interest rate at constant level regardless of macroeconomic conditions.[13] This corresponds with some post-Keynesians' views that the CB should permanently fix the policy rate at approximately zero given that constant manipulation of interest rates leads to speculation and fuels financial instability (Fontana, *op.cit*).[14]

1.4 Relevance of the NCM for Developing Countries

The implications and applicability of the NCM approach is different for developing countries vis-à-vis developed ones. While the proponents of the theories postulated

[13] In this regard, Setterfield proposed the use of income policy to manage aspiration gap (i.e. the difference between workers' actual and target wage) and price inflation.
[14] See also Minsky (1982) and Wray (2004).

based on the conditions of advanced countries, a number of the assumptions are incongruous with the realities of developing countries. This is essentially because the characteristics of developing countries differ considerably from those of developed countries. Acknowledging price-stability as the foremost policy objective in an environment of slow (or no) growth, under-production and high unemployment is simply unjustifiable. Besides, the reliance on the interest rate as the sole policy instrument in an underdeveloped financial system vulnerable to foreign capital flows can propagate uncertainty and instability (given the volatile nature of interest rate sensitive portfolio investments). Nonetheless, since the introduction of IT by the Reserve Bank of New Zealand in 1990, a number of countries (both developed and developing) have adopted the approach. The success of this approach differs substantially among countries.

Developing countries are generally characterised by weak public governance and a of lack policy credibility vis-à-vis their developed counterparts (Huang and Wei, 2006). In addition, most developing countries experience episodes of moderate inflation within the low double digit region. These features have implications for the cost of disinflation in these countries. A costless disinflation requires that the economy operate without nominal rigidities and that the CB is credible (Carlin and Soskice, 2006,ch.3). These conditions are generally not met by developing countries so that attempts at disinflation can raise the real costs asymptotically. Generally, low inflation is desirable, but its benefits must be weighed against its costs. Studying the suitability of IT among African countries, Heintz and Ndikumana (2011) noted that

> "there is nothing intrinsically desirable about inflation. If [developing] countries could experience rapid growth and development with 2% inflation or the same rate of development with 15% inflation, it would be rational to choose the lower inflation rate. However, if maintaining a 2% rate of inflation slows the rate of economic development, then it is unclear whether keeping inflation at that level is the best option" (p.72).

Hence, although low and stable inflation is desirable, the emphasis should be on *stable* rather than on *low*. Disinflation should be pursued in the presence of high and volatile inflation. Thus, CBs in these countries may be less inflation averse and less willing to sacrifice output/employment for disinflation. In countries with weak institutional qualities, optimal inflation may be relatively higher (Huang and Wei, *op.cit*). For developing countries, the proposition that monetary policy should focused on low inflation is, therefore, untenable.

Given that the LR-PC may be sloped so that inflation-output trade-off is nonzero, developing countries can concentrate their monetary policy efforts on economic growth. These set of countries are characterised in so many instances by low capacity utilisation and, consequently, low AS.[15] Monetary policy might give more weight to the goal of economic growth, while ensuring that inflation does not become unmanageable. Studies like Khan and Senhadji (2001) and Pollin and Zhu (2006) show that moderate (rather than low) levels of inflation are beneficial to these countries growth so that there is no justification for them to target price-stability primarily. Furthermore, Heintz and Ndikumana (2011) and Epstein (2008b) argued that the long-run goal of developing countries should be economic development and poverty reduction. Provided that disinflation slows down economic growth, IT would be a sub-optimal approach among these countries (Heintz and Ndikumana, *op.cit*). This is due to the prominence of supply shocks in such countries which, coupled with hysteresis, implies that IT can deepen poverty and undermine long-run socio-economic development.

The NCM framework also presumes a stable relationship between monetary policy rate and other rates in the economy (Bain and Howells, 2009,ch.5; Fontana, 2007). The CBs change their policy rate trusting that it would affect retail rates, including lending rates, so that lending to the private sector is influenced. It is therefore important to gauge the responsiveness of private sector credit to changes in policy rate. The effectiveness of this kind of monetary policy depends on the pattern of the interest rate pass-through, viability of the market for government securities and the willingness *cum* ability of the banking system to lend to the private sector. In many

[15] Though low capacity utilisation generally reflects bottlenecks in the supply capacity of the economy, it can in a few instances be a product of depressed demand.

developing countries, underdeveloped financial markets coupled with weak institutional features diminishes pass-through and the ability of the interest rate to affect private sector credit. High credit risk ensures that commercial banks are averse to funding private sector investments even if such investments are viable and productive. These banks are rather more willing to hold risk-free government securities even at low yield (Weeks, 2010). Attempts to raise interest rates to combat inflation would, in this situation, only encourage further holding of government securities. Low pass-through and poor responsiveness of domestic credit also implies that interest would have to be raised more than proportionally to have the desired effect on output.

Underdeveloped financial markets further make developing (vis-à-vis developed) countries fragile and vulnerable to external and internal shocks. As earlier mentioned, frequent changes in interest, by furthering uncertainty and speculation, exposes these countries to even more severe financial instability. Besides, the linkage among interest rates, the exchange rate and capital flows weighs on the minds of policymakers in developing countries than it generally does in developed countries. The exchange rate level and volatility are deemed important in the evolution of growth and inflation in these countries (Barbosa-Filho, 2008); Galindo and Ros, 2008). Given the moderate inflation rate (versus developed countries), near-zero inflation requires a substantial rise in the interest rate (Epstein, 2008b). The high interest rate, besides deterring investment (and thereby growth and development), attracts rent-seeking foreign capital. This can cause real exchange rate appreciation which subsequently reduces net exports and domestic production. Being usually short-tem, these inflows increase the risk of financial fragility, such that a reversal of policy causes massive outflow which can crash the domestic currency and cause economic crises (Heintz and Ndikumana, 2011). Hence, frequent changes in the interest rate to manage inflation can lead to both financial and economic volatility in these countries.

Besides, the NCM framework presupposes the existence of a perfect capital market and the absence of credit rationing (Arestis and Sawyer, 2008b). However, not only are capital markets in developing countries imperfect they are grossly underdeveloped. They are also prone to large volatilities vis-à-vis developed countries (Batini, 2004; Calvo and Reinhart, 2000; Ghatak and Sánchez-Fung, 2007; Mishkin, 2004). In addition, a good number of these countries are characterised by some form of credit rationing, which impedes the transmission mechanism as delineated in the NCM model. Existence of dual economies reported in some developing countries can also weaken the transmission of monetary policy. While it may be possible to predict the response of the formal section of the economy to policy changes, the reaction of the informal sector is unrecorded and at best ambiguous. Hence, the overall impact of policy would be difficult to assess.

Many developing countries are under-industrialised and specialise in the production of primary sector commodities. These sectors, for instance agriculture, are prone to substantial shocks, which exposes the economy to enormous supply-side shocks. The NCM model posits that such shocks are transient and as such should be accommodated (Clarida *et al*., 1999). However, Morling (2002) found that supply shocks can have permanent effects in developing countries while accounting for a substantial amount of output variations. Since these shocks are usually not transitory they would require policy actions to rescue the economy. Considering the low productive capacity of these countries such supply shocks can quickly transmit to higher prices. If misinterpreted, the monetary authorities may apply deflationary policies which contract the economy and exacerbate the condition.

1.5 Concluding Remarks

Overall, underlying the three equations of the NCM framework is the assumption of complete pass-through from the policy interest rate to other interest rates in the economy (Fontana, 2007). Owing to nominal rigidities and rational expectations, the CB by controlling the nominal interest rate actually alters the real market interest rates (Clarida et al., 1999; Fontana and Palacio-Vera, 2007). Markets interest rate in the analysis is assumed to be a mark-up over the monetary policy and it is this mark-up rate that affects investments (Arestis and Sawyer, 2006; 2008a). Hence, a change in policy rate transmits through the market rate to investment, AD and finally the rate of inflation. Arestis and Sawyer (2008a), however, argued that credit market investment decisions are not based only on the dynamics of interest rates but also on the availability of credit. Besides, the success of the NCM framework depends on country idiosyncrasies and institutional features, particularly regarding developed versus developing countries, heterogeneity. These issues are treated further in subsequent chapters.

2 COMMON IDIOSYNCRASIES OF DEVELOPING COUNTRIES

2.1 Introduction

Institutional features of monetary policy differ widely between advanced and developing countries. Appreciation of the challenges of these peculiar features would be impaired if these sets of countries are treated alike; especially if models built for advanced economies are simply adopted for developing ones. Generally, most developing countries are characterised by financial underdevelopment, fiscal dominance, low credibility of monetary authorities, and considerable financial and exogenous shocks (Ghatak and Sánchez-Fung, 2007). These features ensure that the transmission of policy decisions differs from that obtainable in advanced countries. In this chapter we highlight the key features that distinguish developing countries from developed ones and also conduct stylised analyses of important financial and macro-variables for developing countries. Monetary policy frameworks are also compared among thirty-eight developing countries, for inflation targeters versus non-targeters.

2.2 Prevailing Characteristics

In many developing countries, the financial sector is relatively underdeveloped and fragile thereby exposing them to considerably protracted consequences of financial shocks. In addition, regulatory arrangements are in many cases inadequate. While it is not uncommon to have poor prudential procedures, attempt to ensure control of financial developments have resulted in repressive systems. Consequently, many developing countries have experienced shortages of financial intermediation and the emergence of informal markets. Although, the global financial market is becoming increasingly sophisticated and deep, those in developing countries – particularly the capital markets – remain arguably shallower than in more advanced countries.

The legal framework for conducting monetary policy can undermine policy effectiveness, especially for developing countries. This is especially true in the area of fiscal management. Poor fiscal management and inappropriate legal framework has culminated in fiscal dominance in these countries.[16] Hence, CBs are often obliged to finance fiscal deficits (FD) and are sometimes required to underwrite government debts as well as print money to repay these debts (Ghatak and Sánchez-Fung, 2007). Though there are increasing attempts at fiscal prudence, some countries like Nigeria and Ghana are confronted with non-binding fiscal constraints.[17] Accordingly, excessive FD have resulted in severe macroeconomic instability characterised by growing inflationary pressure (Ghatak and Sánchez-Fung, *op.cit*; CBN, 2009b; Narh, 2010).

Since the introduction of IT in New Zealand in 1990 the desirability of an independent CB has gained increasing prominence in monetary policy literature. Several studies including Cukierman (1992), Cukierman *et al.* (1992), Alesina and Summers (1993), McCallum (1997), Fry (1998), and de Haan and Kooi (2000) attempted to investigate the importance of CB independence for macroeconomic outcomes and reached no consensus particularly for developing countries. Forder (2000) presented a critical view of CB independence, arguing its irrelevance for monetary policy effectiveness. Nonetheless, the IMF regards autonomy as conducive for sustainable economic growth (Lybek, 2004). A number of CBs in developing countries enjoy some form of autonomy in the conduct of monetary. However, inadequate legal restrictions on deficit financing have negated the operational autonomy of these banks. Ghatak and Sánchez-Fung, (2007), therefore argued that fiscal dominance and lack of adequate autonomy have combined to ensure low credibility of monetary institutions in many developing countries. In addition, they noted that these features have impeded monetary policy efforts at attaining macroeconomic stability.

Given the idiosyncrasies of developing countries, studies have been conducted to understand the statistical relationships between macroeconomic variables in these countries. In a study of forty-four developing countries, Fry *et al.* (1996) found that CB deficit financing is inflationary and retards economic growth, while inflation and growth are inversely related in the short- and long-run. Similarly, Agénor *et al.* (2000) studying twelve developing countries confirmed the importance of private sector

[16] Fiscal dominance implies the extent to which the monetary authority finances FD or backs/underwrites government debts (Nachega, 2005; Resende, 2007). Hence, government's needs for deficit financing by the central bank are considered to be crucial irrespective of its impact on the objectives of monetary policy.

[17] These constraints are non-binding because the central banks cannot enforce it legally. It is based rather on persuasion and moral suasion of the fiscal authorities by the bank.

credit for economic growth, and also found high output volatility vis-à-vis the advanced economies. These studies jointly imply that domestic government borrowing from the banking system would reduce economic growth via the crowding-out of the private sector. The inverse relationship between growth and inflation has implications for supply-side shocks. However, other studies have argued that the inverse relationship would depend on the inflation threshold of 11-12 per cent (Khan and Senhadji, 2001) or 15-18 per cent (Pollin and Zhu, 2006) for developing countries.

Furthermore, developing countries are subject to more financial and exogenous shocks than advanced countries (Ghatak and Sánchez-Fung, 2007). These, in conjunction with substantial supply shocks, prolong and complicate the resolution of macroeconomic instability. In order to curb macroeconomic volatility and ensure price-stability, many CBs in developing countries, including the Bank of Ghana, has resorted to IT (Narh, 2010). However, these countries encounter enormous difficulties in their endeavour to maintain inflation within its target largely because of the frequency and size of supply shocks. In addition, following a supply shock, monetary policy aimed at lowering inflation may inadvertently worsen macroeconomic outcomes and increase instability (Pollin *et al*., 2007).

2.3 Some Stylised Facts

Using a sample of thirty-eight developing and emerging market economies, stylised facts about the key economic relationships in these countries are reported in this section. The countries include seventeen inflation targeters and twenty-one non-targeters. The relationships of interest are explored using annual data for 1970-2011 (at the longest) obtained from the World Development Indicators of the World Bank.

Given the importance of supply-side shocks in developing countries, a dynamic correlation of inflation and output is presented in table 2.1. While Fry *et al.* (1996) argued that inflation and growth are inversely related in the short- and long-run for developing countries, table 2.1 shows a slightly different result. The dynamic relationship between output and inflation differ between leads and lags. For most of the countries in the sample, inflation and output relate inversely in the contemporaneous period. However, the lagged growth of GDP correlated positively with inflation while future growth rate correlated inversely with inflation. This difference shows that the source of a change is important for its impact.

Table 2.1 Dynamic Correlations of Inflation Rate and Output Growth for Selected Developing Countries

	Cross Correlation with GDP_{t+k}										
	-5	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**
IT Countries											
Brazil	0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2
Chile	-0.3	-0.3	-0.4	-0.3	-0.3	-0.2	-0.1	-0.1	-0.1	0.1	-0.1
Colombia	0.4	0.4	0.4	0.3	0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2
Czech Republic	-0.4	-0.4	-0.3	0.0	-0.2	-0.4	-0.5	-0.6	-0.7	-0.7	-0.5
Ghana	-0.3	-0.3	-0.2	-0.4	-0.6	-0.4	-0.2	-0.1	-0.1	-0.1	0.1
Hungary	-0.6	-0.6	-0.6	-0.6	-0.6	-0.7	-0.6	-0.3	-0.1	0.1	0.3
Israel	0.1	0.1	0.1	0.0	-0.2	-0.1	-0.1	-0.2	-0.1	0.0	0.1
Korea, Rep.	0.2	0.3	0.3	0.3	0.1	-0.2	0.1	0.2	0.3	0.1	0.0
Mexico	0.2	0.1	0.0	-0.1	-0.3	-0.4	-0.2	-0.2	-0.2	-0.1	-0.2
Peru	-0.1	-0.2	-0.3	-0.3	-0.4	-0.4	-0.3	-0.3	-0.3	-0.3	-0.3
Philippines	0.1	0.1	0.2	0.2	0.0	-0.5	-0.4	0.0	0.0	0.1	0.1
Poland	-0.6	-0.6	-0.5	-0.5	-0.5	-0.4	-0.4	-0.3	-0.2	0.1	0.2
South Africa	0.0	-0.2	-0.2	-0.2	-0.2	-0.5	-0.5	-0.4	-0.4	-0.4	-0.3
Thailand	0.1	0.4	0.3	0.2	0.2	0.0	-0.1	-0.1	0.0	0.1	0.0
Indonesia	0.1	0.1	0.2	0.2	0.0	-0.5	-0.1	0.0	0.0	0.1	0.0
Romania	-0.2	-0.3	-0.5	-0.7	-0.7	-0.7	-0.6	-0.4	-0.3	-0.4	-0.5
Turkey	0.2	0.1	0.0	-0.1	-0.3	-0.3	-0.3	-0.1	0.0	0.0	0.1
AVERAGE	**0.2**	**0.2**	**0.1**	**0.2**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.3**	**-0.2**	**-0.2**
Non-IT Countries											
Argentina	0.0	-0.1	-0.2	-0.2	-0.3	-0.2	-0.1	0.0	-0.1	-0.1	-0.1
Bulgaria	-0.3	-0.3	-0.4	-0.6	-0.8	-0.7	-0.5	-0.3	-0.1	0.0	-0.1
China	-0.3	-0.1	0.1	0.4	0.6	0.3	-0.2	-0.2	0.0	0.0	-0.1
Costa Rica	0.1	0.2	0.1	-0.1	-0.5	-0.7	-0.4	0.0	0.2	0.2	0.1
Cote d'Ivoire	0.3	0.3	0.3	0.3	0.3	0.2	0.4	0.3	-0.1	-0.1	-0.3
Dominican Republic	-0.2	0.0	-0.2	0.0	-0.3	-0.6	-0.2	0.1	0.1	0.1	-0.2
Ecuador	-0.2	-0.2	-0.3	-0.4	-0.5	-0.4	-0.3	-0.3	-0.2	-0.1	0.0
Egypt, Arab Rep.	0.2	0.3	0.2	0.1	0.2	0.2	0.1	0.1	-0.1	-0.3	-0.4
El Salvador	-0.6	-0.4	-0.2	-0.1	-0.2	-0.2	-0.2	-0.1	0.0	0.1	0.0
India	0.1	0.1	0.0	-0.2	-0.4	-0.1	0.1	-0.1	0.2	-0.1	-0.5
Malaysia	0.2	0.1	0.1	0.3	0.4	0.2	-0.1	0.0	0.0	-0.1	-0.1
Morocco	0.1	0.2	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.0	0.0
Nigeria	0.1	0.2	0.1	0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1
Pakistan	0.3	0.2	0.0	-0.2	0.0	0.0	0.0	-0.2	-0.1	-0.1	0.1
Panama	0.0	0.1	0.2	0.3	0.2	0.1	0.0	-0.1	-0.3	-0.1	-0.1
Russian Federation	-0.5	-0.6	-0.7	-0.8	-0.9	-0.7	-0.5	-0.8	-0.7	-0.3	-0.2
Saudi Arabia	0.4	0.6	0.8	0.8	0.6	0.5	0.3	0.1	0.1	0.1	0.1
Tunisia	0.0	0.0	-0.2	-0.4	-0.3	-0.1	-0.1	-0.3	0.0	-0.4	-0.1
Venezuela, RB	0.0	0.1	0.2	0.0	-0.1	-0.2	0.1	0.0	0.0	-0.1	-0.3
Vietnam	-0.4	-0.1	0.2	0.4	0.5	-0.1	0.2	0.1	-0.2	-0.7	-0.5
Singapore	-0.2	0.2	0.3	0.4	0.4	0.1	-0.1	-0.1	0.1	0.0	0.0
AVERAGE	**0.2**	**0.3**	**0.2**	**0.1**	**-0.2**	**-0.1**	**-0.2**	**-0.2**	**-0.3**	**-0.4**	**-0.4**
OVERALL AVERAGE	**0.2**	**0.2**	**0.1**	**0.2**	**-0.3**	**-0.4**	**-0.5**	**-0.5**	**-0.5**	**-0.4**	**-0.4**

Source: Author's computations based on data from the World Development Indicators.
Note:
(1) Data is for the period 1970 to 2008. Given the incidence of hyperinflation some of the countries in the sample, an inflation threshold was set at 50% to reduce artificial noise in the relationships; hence, inflation rates above the threshold are converted to 50%.
(2) Averages above are the correlation of average inflation and average output growth for the respective groups.

The result for lagged output may imply that increases in output are inflationary; thus, showing the importance of AD. Nonetheless, lagged inflation tended to relate inversely with output growth. Rising inflation in the current period relates with a fall in future output. This may imply the importance the supply-side shocks. Exogenous factors that cause inflation to rise also reduce output in the current and future periods. Though the coefficients are somewhat low on the average, those for the contemporaneous and future output were generally higher than those of lagged outputs;

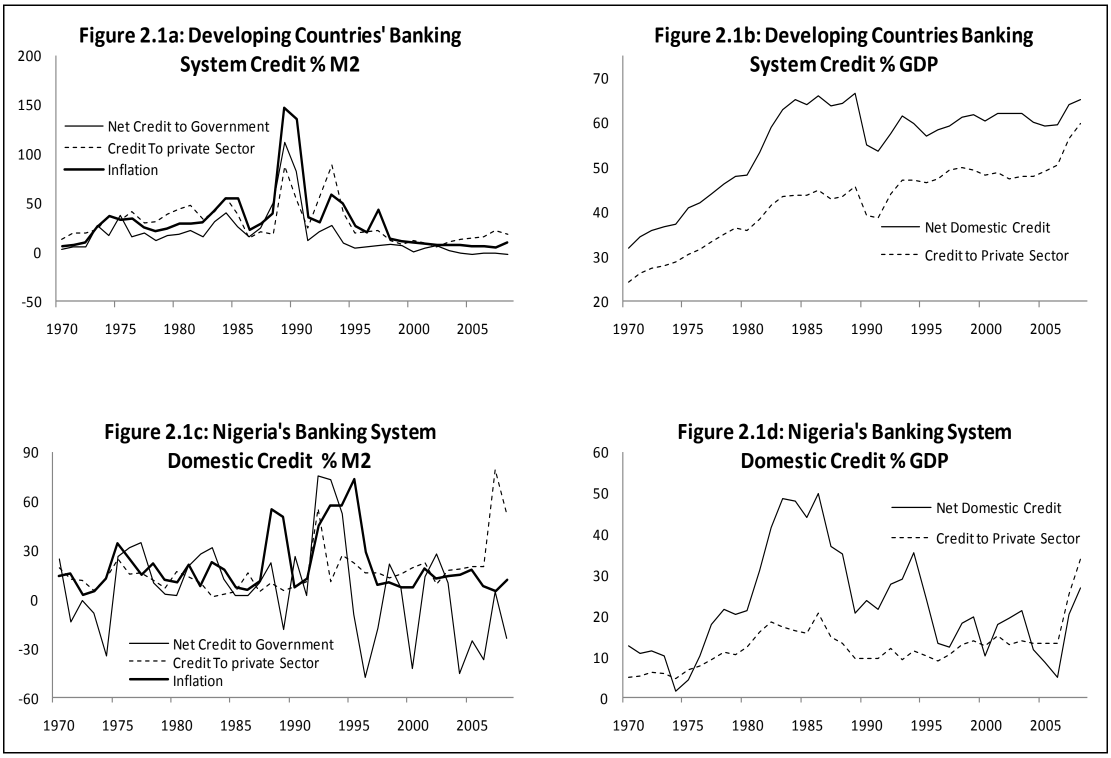
thereby implying that supply shocks are more prominent in these set of developing countries than the demand shocks.

Although the result holds moderately well for the broad groups of inflation targeters and non-targeters, it differs somewhat across countries. Saudi Arabia, on one extreme, shows positive relationship at all leads and lags implying the absence of significant supply shocks, while other countries like Cote d'Ivoire, Egypt and Morocco showed considerable net positive relationship indicating the prominence of demand shocks. Conversely, data for Peru, Romania, and Russian suggests entirely negative relationship at all periods. For Nigeria, the result shows a rather weak association between inflation and output. Nonetheless, the sign of the relationship indicate that demand shocks were important in the lags 2 to 5 of output, while it reverses at lag one and is sustained until the fifth lead.

To control inflation, many CBs attempt to affect AD by varying the price and quantity of credit in the system. However, the flow of credit in the economy to the public and private sector has important implications for the evolution of inflation as shown in figure 2.1a. For the sampled countries, the average banking system credit to government as a percentage of broad money (M2) is slighty lower than that to the private sector, although both had tended to swing sympathetically. Moreover, the covariance of these credits with average inflation may portend the importance of the credit channel in the transmission mechanism of monetary policy. This connotes that policy decisions that reduces credits may also moderate inflation. As a percentage of GDP, aggregate credit to the domestic economy was substantially different from that to the private sector implying the sizeability of credit to government.

In Nigeria, although the pattern is a bit more difficult to discern, it nonetheless shows that credit to government has reduced considerably in the recent past. This has important implications for inflation dynamics as inflation has generally followed net government credit, *albeit* weakly in some instances. The oscillations in inflation and net claims on government may be related to developments in the international crude oil market, as this affects government FD significantly. Besides, while oil rich countries like Ecuador, Nigeria, Russia and Saudi Arabia have occasionally recorded negative net claimes to government (indicating increased deposits), others like Argentina, Egypt, Ghana and Turkey have hardly posted net deposit positions.

Figure 2.1: Developing Countries' Credit Ratios and Inflation



Data Source: World Development Indicators

The implication of the credit channel of monetary policy is elaborated by the level of financial depth in these countries. Batini (2004), Mishkin (2004), Ghatak and Sánchez-Fung, (2007) acknowledged the adverse consequence of low financial depth for monetary policy outcomes in developing and emerging market. While the degree of liquidity, monetisation, and intermediation can be measured by the ratio of money supply to GDP, the depth of the capital market is captured by the market capitalisation GDP ratio. Though these measures have limitations, they nonetheless provide indicators as to the extent of financial developments in a country. Typically, a ratio below 50 per cent is interpreted to indicate shallowness of the financial market.

On average, the countries in our sample showed inadequate depth in terms of stock market valuation, while they maintained a moderate level of liquidity as shown by the M2-GDP ratio. Inter-country comparisons, however, showed South Africa, China, Malaysia and Singapore as having adequate financial depth while others like Indonesia, Mexico, Nigeria and Turkey were considerably shallow in terms of both ratios. For inflation targeters, a sound and adequately developed financial system is often considered a prerequisite. Of the seventeen IT countries in our sample, eight have ratios of less than 50 per cent for both indicators, while only four satisfy the condition in both cases.

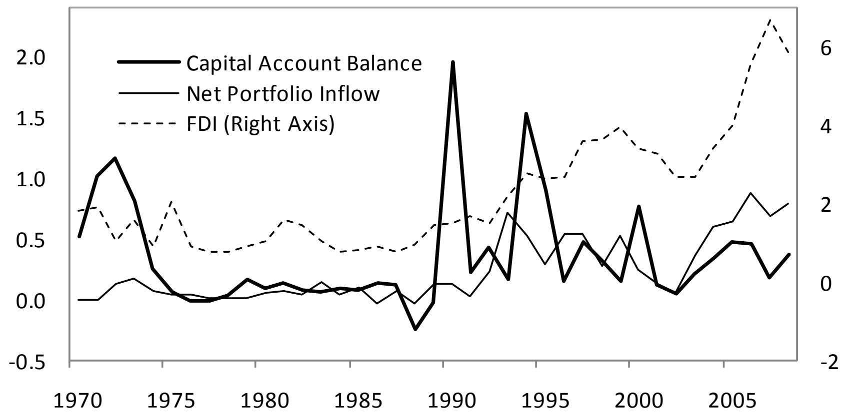
Table 2.2 Measures of Financial Depth for Selected Developing Countries

	M2 GDP Ratio			Market Capitalisation GDP Ratio		
	1990-1999	**2000-2008**	**2008**	**1990-1999**	**2000-2008**	**2008**
IT Countries						
Brazil	31.5	49.6	61.5	21.5	49.4	37.4
Chile	37.9	50.9	58.6	84.0	101.6	78.1
Colombia	29.4	20.6	21.2	14.1	24.9	35.7
Czech Republic	63.4	67.5	73.2	22.3	25.9	22.7
Ghana	17.9	26.3	NA	14.8	17.5	20.4
Hungary	44.6	46.6	54.2	13.6	25.0	12.0
Israel	68.5	91.4	90.9	39.0	78.2	66.5
Korea, Rep.	39.0	65.1	62.6	38.2	62.5	53.2
Mexico	26.2	25.3	25.6	31.9	24.8	21.4
Peru	19.6	29.3	30.7	16.7	41.2	43.1
Philippines	45.0	54.8	NA	55.5	45.3	31.2
Poland	30.4	42.6	48.6	5.8	25.8	17.1
South Africa	49.4	56.2	64.3	147.4	199.1	177.7
Thailand	84.7	107.3	98.3	54.6	56.1	37.7
Indonesia	43.6	42.9	35.7	22.4	25.8	19.3
Romania	28.7	27.7	31.9	1.2	14.1	10.0
Turkey	23.5	35.8	43.7	18.6	26.3	16.0
AVERAGE	**40.2**	**49.4**	**53.4**	**35.4**	**49.6**	**41.1**
Non-IT Countries						
Argentina	18.3	28.0	25.2	14.9	45.7	15.9
Bulgaria	47.6	50.3	67.9	2.8	17.5	17.8
China	89.8	139.5	146.1	12.9	63.3	64.6
Costa Rica	24.7	21.4	24.8	7.8	11.4	6.4
Cote d'Ivoire	24.9	24.7	27.8	7.6	18.9	30.2
Dominican Republic	21.6	22.5	21.3	0.7	NA	NA
Ecuador	22.1	21.9	25.3	7.7	7.7	8.3
Egypt, Arab Rep.	76.6	85.3	84.5	16.1	55.6	52.9
El Salvador	37.7	41.3	39.7	9.5	19.0	21.1
India	42.8	61.6	73.4	29.7	61.2	55.7
Malaysia	102.2	120.1	111.9	195.4	135.8	84.4
Morocco	59.9	83.3	98.7	19.2	48.9	74.0
Nigeria	16.9	20.2	30.1	7.7	19.6	24.0
Pakistan	41.2	42.2	NA	15.5	24.5	14.3
Panama	58.5	78.8	79.5	16.6	27.1	28.4
Russian Federation	16.5	27.8	37.7	10.0	60.9	78.7
Saudi Arabia	44.5	47.5	49.3	34.1	88.2	52.5
Tunisia	46.1	56.1	60.8	11.8	12.3	15.8
Venezuela, RB	22.4	20.7	26.0	12.6	4.9	NA
Vietnam	21.7	64.5	93.6	NA	9.4	10.6
Singapore	89.8	112.2	122.6	152.4	187.4	98.9
AVERAGE	**44.1**	**55.7**	**62.3**	**29.2**	**46.0**	**39.7**
OVERALL AVERAGE	**42.3**	**52.9**	**58.5**	**32.1**	**47.6**	**40.4**

Source: Author's computations based on data from the World Development Indicators.

Financial market underdevelopment exposes these countries to the vagaries of the international capital market. A key feature of most developing and emerging market economies is the phenomenon of sudden changes in capital flows, usually associated with large negative changes in the flow (Calvo and Reinhart, 2000). This phenomenon, *à la* Mishkin (2004), is confined to developing countries because of the weak fiscal and financial institutions. Though the degree of vulnerability differ from country to country, the average capital account balance as a percentage of GDP, in the thirty-eight countries, has experienced wild oscillations particularly since late-1980s (figure 2.2). The different spikes noticeable between 1990 and 2000 coincided with the various crises experienced by developing countries in Asia and Latin America. Though, a number of countries like China and India have attracted more stable inflows in the form of foreign direct investment, the capital account balance are largely driven by the more volatile portfolio investment. The considerable volatility in portfolio investment and the consequent swings in the capital account expose developing countries to international financial market shocks. Weak fiscal and financial institutions coupled with shallow domestic financial markets complicate the ability of these countries to cope with such shocks.

Figure 2.2: Capital Accounts Components
% GDP

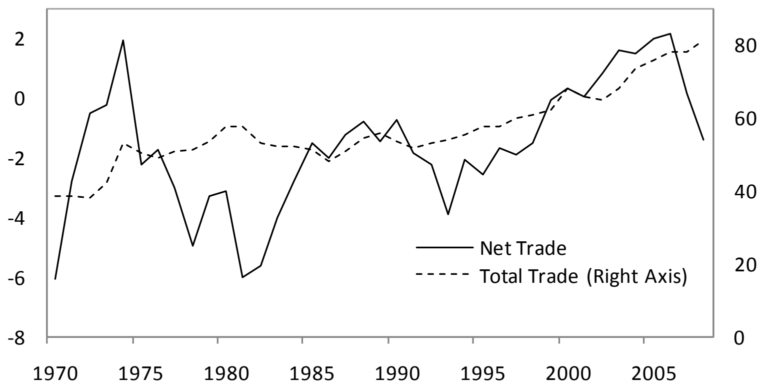


Data Source: World Development Indicators

The size of capital inflows to developing countries depends on a number of factors which include returns on investment, perceived risk premium on countries' sovereign debt, political and macroeconomic stability, and the degree of openness of an economy. While a number of these indicators can vary substantially among the sampled countries, trade openness has been considerably high in most cases.

Measured simply as the ratio of merchandise trade to GDP, the average degree of openness stood at 64.2 per cent during 1970-2008, while the end-2008 average is 81.4 per cent. According to Batini (2004), "openness subjects [an] economy to both financial and market shocks...[such that] high interchange with the rest of the world suggests...[exposure] to external shocks like shocks to commodity prices, exchange rates and/or relative prices of imported intermediate or final goods" (p.12). The degree of openness can also cause a decline in countries export and depress domestic growth in income and output. For instance, increases in the domestic interest rate may attract foreign capital inflow, which consequently causes exchange rate appreciation; weakens export competiveness and increases imports. It is therefore not surprising that while total trade has maintained a high and increasing trend, net trade has been negative on the average for these countries (see figure 2.3).

Figure 2.3: International Trade
% GDP



Data Source: World Development Indicators

Batini (2004), Mishkin (2004), Ghatak and Sánchez-Fung, (2007) also outlined the importance of fiscal stability in developing economies. While this affects key macroeconomic variables like exchange rate (Batini, *op.cit*), and inflation rate (Mishkin, *op.cit*), it is affected by political and legal systems in those countries. Although, many developing countries have democratically elected government, some of these operate dictatorially. This has implication for the vulnerability of CBs, the conduct of monetary policy, and overall macroeconomic stability. As shown by Sikken and de Haan (1998), political vulnerability of the CBs coupled with high turnover rate of its governors are key determinants of CBs credit to government. This alongside political instability affects inflation and growth adversely (Cukierman and Webb, 1995). Political and fiscal instability increases the perceived risk premium on the country's sovereign debt which in turn increases the volatility of capital flows and the exchange rate, and can complicate the conduct of monetary policy.

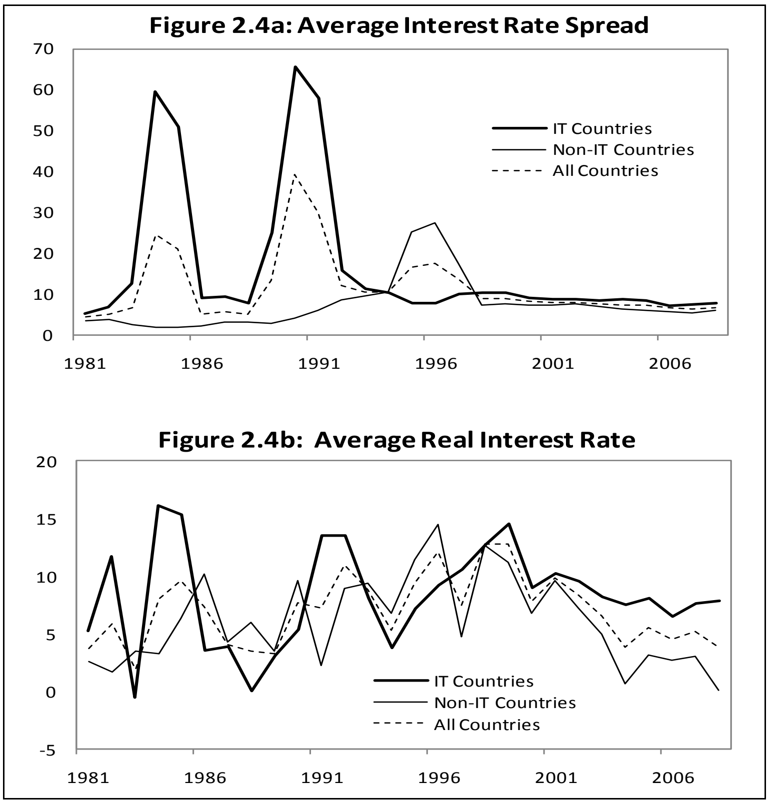
2.4 Monetary Policy in Developing Economies

In many developing countries, the explicit objectives of monetary policy include either the achievement of price and/or exchange rate stability. For instance, while monetary policy in South Africa is designed to achieve price-stability, in China its objective is to maintain a stable value of the domestic currency, and in Nigeria it is expected to accomplish price and exchange rate stability. Historically, the framework of monetary policy in many developing countries has followed the monetary targeting or exchange rate targeting approaches. However, over the last two decades a number of developing countries have adopted IT. This is principally due to the alleged reduction in inflation and interest rate variability, together with the achievement of sustainable growth associated with IT (Gonçalves and Salles, 2006). Generally speaking, IT is based on the use of monetary policy (the prevailing practice being the use of short-term interest rate) to control inflation contingent on the ability of the CB to effectively anchor inflation expectations. Given the susceptibility of developing countries to AS shock this approach to monetary policy may be pro-cyclical. A number of studies have presented the *pros* and *cons* of IT for developing countries. For instance, Fraga *et al.* (2003), Frenkel *et al.* (2006), and Epstein and Yeldan (2008) presented critical views of IT in developing countries while Gonçalves and Salles (*op.cit*) and Khan (2009) hold favourable dispositions. However, a comparison of IT countries and non-IT countries provides some insights.

Interest rates in many developing countries have been historically high, mainly because of the desire to disinflate, especially when compared with those in advanced countries (Dymski, 2003). This has the potential of reducing investment through the output gap channel (Batini, 2004). Similarly, the spread between lending rates and deposit rates in the countries has been high; thereby discouraging both savings and investments. High spread in developing countries has been attributed to imperfect information and potential high default risk among borrowers (Dymski, *op.cit*), inadequate regulatory framework and high required reserve ratios (Crowley, 2007), underdeveloped and weak financial sector (Jayaraman and Sharma, 2003), and the crowding-out effect of government borrowing (Folawewo and Tennant, 2008).

Although, the spread reduced in IT countries, it nonetheless surpassed that in non-IT countries converging to about 7.9 percentage points in 2008 (see figure 2.4a). In addition, real interest rates have remained high and volatile especially among targeters. While the level has been declining in both groups since 2001, it nonetheless stayed higher for IT countries (figure 2.4b).

Figure 2.4: Developing Countries Interest Rate Trends

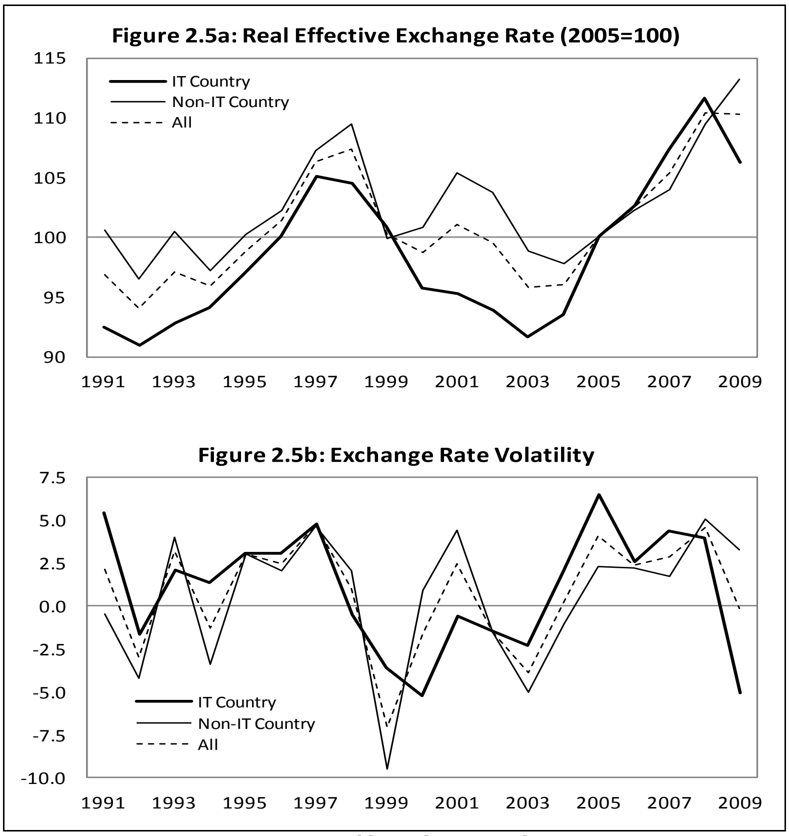


Data Source: World Development Indicators

It can therefore be argued that though IT countries have experienced a declining real interest rate, this development cannot be attributed to the adoption of IT. Other non-IT countries have not only experienced less volatile interest rate they have also enjoyed lower levels of real interest rates. Hence, the alleged IT gains of low and stable interest rates may not be a robust premise. Studying the Brazilian IT experience, Barbosa-Filho (2008) noted that although IT has led to modest gains in the real interest rate, the rate has remained relatively high. This has reduced productive investment in Brazil and has increased the burden of government debt servicing. For South Africa, Esptein (2008) proposed a targeted reduction in the real interest rate to reinforce the government's objective of increased employment generation.

The high interest rate, as noted earlier, also has implications for capital flows and exchange rate volatility. Between 1991 and 2007 real effective exchange rate (REER) of sampled countries showed considerable swings. Nonetheless since 2003, IT countries have witnessed an increasing rate of appreciation compared to non-targeters, and began to record a higher level of REER by 2005. In both groups, the exchange rate has not only shown some degree of overvaluation but considerable volatility, especially among the IT countries (see figure 2.5).[18] Overvalued exchange rate reduces the competitiveness of exports while making imports more attractive.

Figure 2.5: Exchange Rate Level and Volatility



Data Source: World Development Indicators

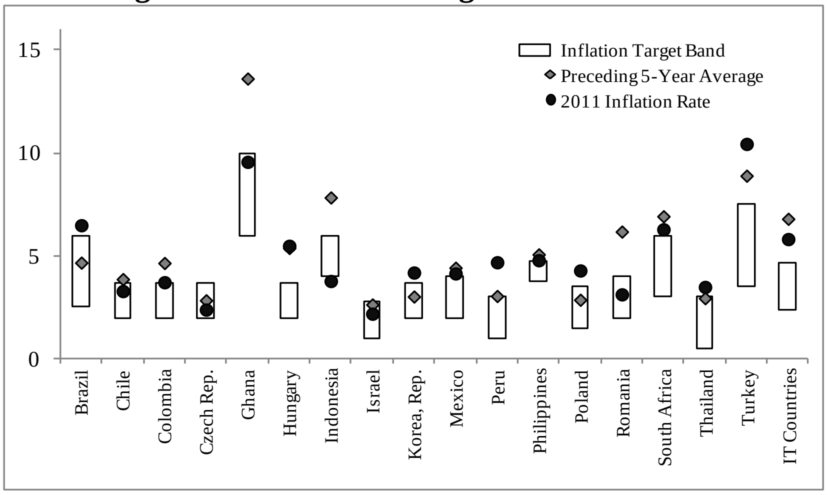
Galindo and Ros (2008) showed that IT in Mexico is conducted with a bias toward overvalued exchange rate which has adverse effects on output. In various studies of IT Barbosa-Filho (2008), Galindo and Ros (*op.cit*), Telli *et al.* (2008), and Lim (2008) advocated the inclusion of a competitive real exchange rate to replace or complement the current IT framework in Brazil, Mexico, Turkey and Philippines, respectively. Similarly, Frenkel and Rapetti (2008) underscored the success of exchange rate

[18] Volatility reflects appreciation/depreciation, where positive outcomes depict appreciation.

targeting in Argentina in aiding employment and growth, as Packard (2005) opined that exchange rate-focused approach is superior to an IT framework in Vietnam.

A key argument in favour of IT is that it helps to lock-in inflation expectations in order to maintain inflation within a given range. Fraga *et al.* (2003) however noted that IT has been less successful in developing countries due to challenges confronting these countries. As shown in figure 2.6a, of the seventeen IT countries, only Czech Republic and Israel kept inflation within target range. Brazil, Korea and Poland were the only other countries able to maintain their target in the medium-term, while few of the remaining had their end-2011 outcome within target. For about half of the countries, both the 5-year average and the end-period outcomes were off-target. Kahn (2009) identified the cost of meeting the preconditions and the vulnerability to external shocks as the possible reasons for this development.

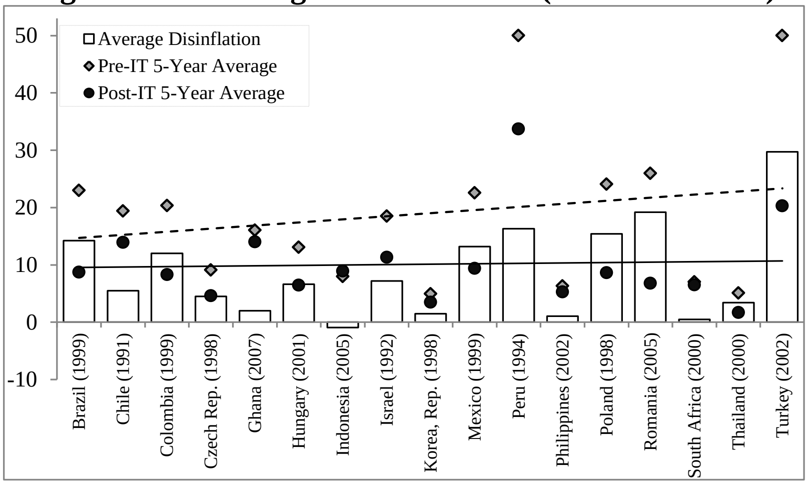
Figure 2.6a: Inflation Targets and Outcomes



Source: Author's computation based on data from respective CBs and the World Development Indicators

This non-realisation of targets notwithstanding, the reality is that average inflation fell significantly among the IT countries after adopting the framework. For instance, as shown in figure 2.6b, average inflation during the five years preceding IT was considerably higher than average inflation in the five years following its adoption in each of the IT-countries. This is illustrated by the fact that the broken trend-line in figure 2.6b, which depicts pre-IT trend, lies noticeably above the solid line that shows post-IT average level for all the countries. The data from the above chart suggests that, on the average, inflation among these countries fell from a five-year average of 9.03 per cent pre-IT to a five-year average of 10.21 per cent post-IT, indicating an average disinflation of 8.91 per cent following the adoption of IT. Indeed, these figures are consistent with the arguments in favour of IT; that it lowers average inflation trend. However, robust conclusion on whether the observed disinflation was due entirely (or somewhat) to IT requires that an unbiased comparison of inflation outcome between the IT and the non-IT countries.

Figure 2.6b: Average Inflation Rates (Pre- vs. Post-IT)



Notes: 1/ Dates in bracket are the year of respective countries adopted IT
2/ Czech Rep. pre-IT average is for 4 year.
3/Peru and Turkey pre-IT averages capped at 50 per cent for analytical convenience – actual averages are 2408 per cent and 68 per cent, respectively.

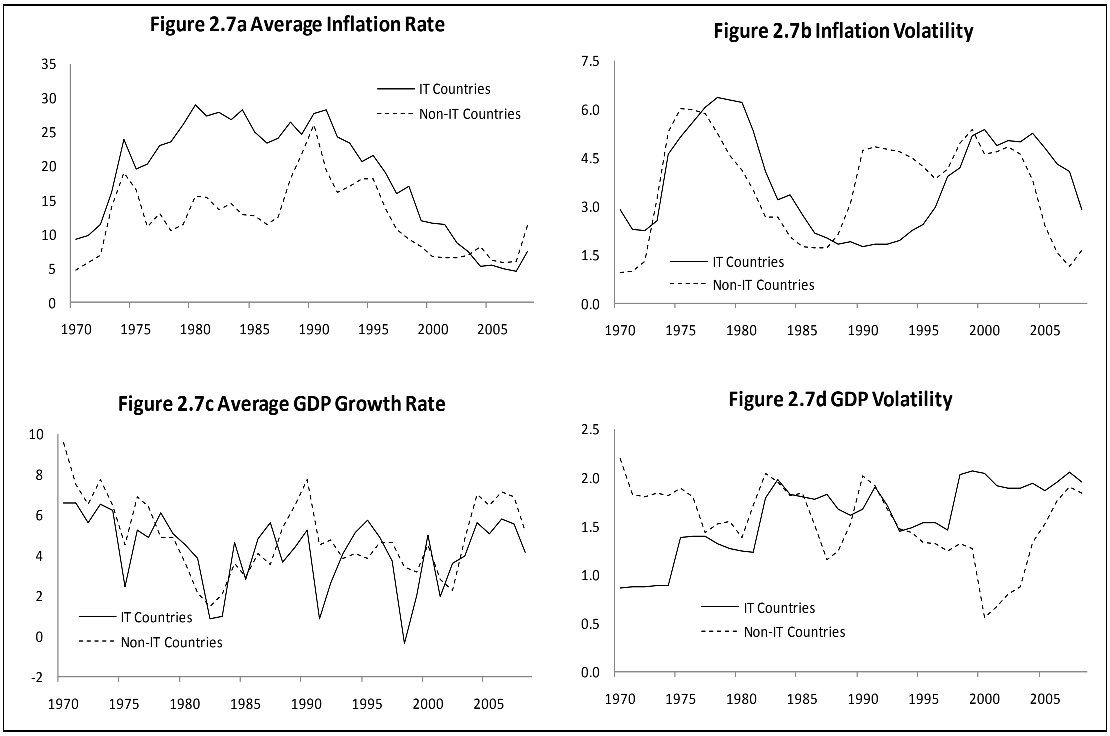
Source: Author's computation based on data from respective CBs and the World Development Indicators

Comparing inflation and output outcomes between targeters and non-targeters, diverse views have been expressed in the literature. Gonçalves and Salles (2008) and Khan (2009) opined that even when inflation targets have been missed in IT countries, the framework has reduced output and inflation volatility in these countries below those of non-targeters. However, Ball and Sheridan (2003) showed that declining inflation may be attributable to mean reversion, particularly for countries that experienced very high inflation prior to adopting IT.

Although figure 2.6b indicates a sizable benefit of IT, analysis of available data however shows that this episode of disinflation is not confined to the IT countries alone as the non-IT countries also experienced significant decline in average inflation. To evaluate inflationary trends among both groups of countries, it is important that comparison is conducted over identical periods. Given that the earliest adoption of IT among the sampled countries occurred in 1991 (i.e. in Chile) and the latest was in 2007 (i.e. in Ghana), we compare five-year average inflation prior 1991 and since

2007 for IT vis-à-vis non-IT countries. This removes any bias in our analysis. Hence, the average inflation for the period 1986-1990 (before IT began in any developing country) is compared with the average inflation during 2007-2011 (when IT is already being fully practiced in the sampled countries) for both groups of countries. The analysis indicates that for the targeters, average inflation rate fell from 27.0 per cent pre-IT to 5.20 per cent post-IT, implying an average disinflation of 21.67 percentage points. For the non-targeters, the decline is from 18.35 to 5.86 per cent with average disinflation of 12.49 percentage points.[19] Thus, disinflation may not be attributed to IT, as average post-IT inflation is low for both groups of countries. This is further highlighted in figure 2.7 which shows the path since 1970 for both groups.

Figure 2.7: Average Inflation and GDP Volatilities



Data Source: World Development Indicators

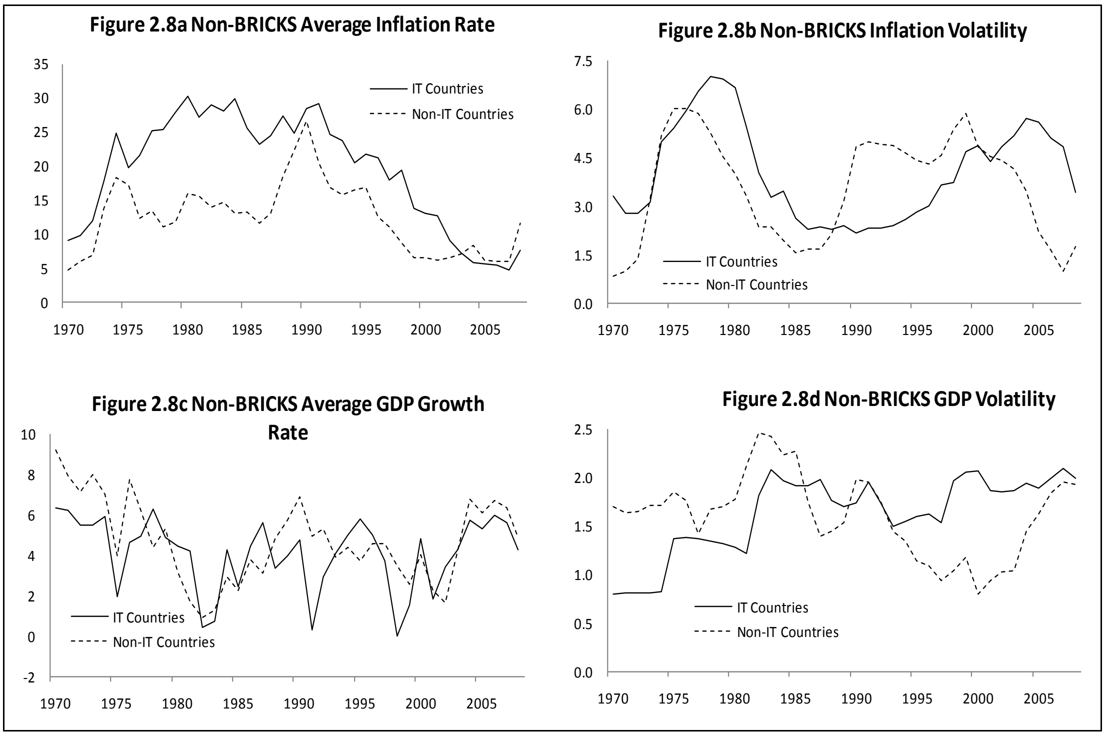
In the four panels of figure 2.7, a comparison of inflation and output outcomes between the IT countries and the non-IT countries is performed. Average inflation in IT countries is observably higher vis-à-vis non-IT countries over the sample period until 2004 when the trend reversed. Nonetheless, average inflation in both groups began to trend downward since 1991. This seems to corroborate the findings of Ball

[19] To compute average inflation consideration was given to episodes of hyperinflation in some of the sampled countries. In order to control for these outliers while retaining the essence of the analysis, an inflation threshold of 50 per cent was set for all countries. Consequently, inflation rates above threshold were capped at 50 per cent.

and Sheridan (*op.cit*) that lower inflations may not be attributable to the IT framework. Beginning from 2000, however, inflation variability became higher for IT vis-à-vis non-IT countries. [20]

Although, disinflation is generally preferred among all countries, an important question that arises is that relating to the costs of disinflation in terms of output loss or economic slowdown incurred. Consequently, we appraise GDP and its relationship with inflation among these countries. Generally, economic expansion has been similar for both groups of countries on the average, although it has been fairly higher among non-IT countries particularly since 2003. While growth dissimilarity is less discernible in both groups that of volatility is quite apparent. Essentially, the IT countries have experienced high variability in output as a group relative to their non-IT counterparts.

Figure 2.8: Non-BRICKS Average Inflation and GDP Volatility



Data Source: World Development Indicators

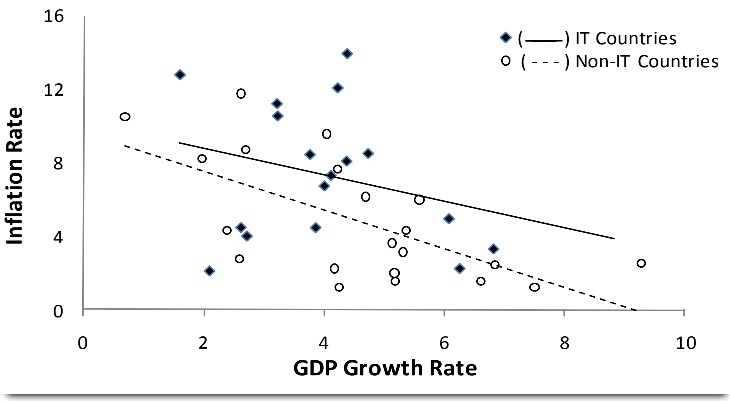
Recognising that some emerging economies had performed better than others, it can be argued that this group would have an overriding impact on the overall analysis. Consequently, countries in the BRICKS group – Brazil, Russia, India, China, South Korea, and South Africa – were temporarily removed from both IT and non-IT categories. Excluding the BRICKS countries from the analysis did not change the

[20] Volatility is computed as the 10-year rolling standard deviation of average inflation among the different groups.

comparative outcomes as figure 2.8 shows. Hence, reduction of inflation and output variability in developing countries may not be attributable to IT.

The similarity of the observed trends among both targeters and non-targeters suggests the existence of a common vulnerability among these countries. Key among the common idiosyncrasies of these countries is the inherence of exogenous shocks. As shown earlier these sets of countries are exposed to considerable supply-side shocks. In fact, Khan (2009) stated that while supply shocks are not unique to inflation targeters, dealing with it is especially difficult. The coordinates of average inflation and output growth for all countries between 1970 and 2008 is depicted in figure 2.9. As shown by the trend-lines, inflation and output maintained a negative relationship in both countries indicative of a prominent supply-shock. The AD focus of contemporary monetary policy frameworks implies that output would be hurt if inflation is forced down. It can also imply that disinflationary policies may be inherently inflationary. This is because by depressing demand, investment may fall; thus, constraining supply. The resulting shortage is inflationary. Hence, even if IT is successful in stabilising prices it may have adverse consequences for economic growth, employment, equality, and poverty reduction particularly among developing countries (Cordero, 2008; Epstein, 2008b).

Figure 2.9: Inflation-Output Correspondence

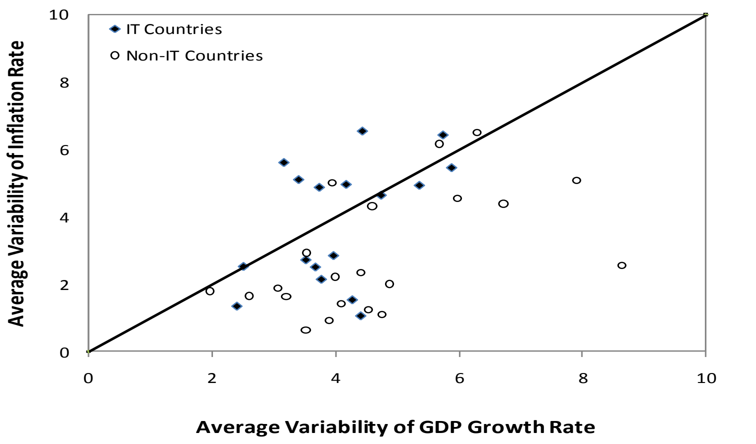


Data Source: World Development Indicators

The extent to which economic growth is reduced depends on the inherent trade-off between inflation and output. If output loss due to disinflation is significant, then growth enhancing frameworks (tolerating moderate inflation) are beneficial. In figure 2.10 the average changes in inflation is plotted vis-à-vis that of output for all countries. The chart also includes a 45 degree line which represents the points of zero-cost;

hence, along this line inflation and output would bear equal weight in a loss function. However, points above the line show lower cost of disinflation because for higher changes in inflation output responds less proportionately. For points below the line the converse holds. By and large, the coordinates for most of the countries fall below the line indicating that targeted disinflation may be costly. Of the seventeen inflation targeters, only six lie above the zero-cost line while the rest are below it. This corroborates Epstein and Yeldan (undated) position that costs of disinflation is not lower for IT than for non-IT countries.

Figure 2.10: Long-run Inflation-Output Trade-off



Data Source: World Development Indicators

2.5 Concluding Remarks

Though developing countries have shared features, their individual characteristics are in many instances different. Hence, while they generally show the prominence of supply-side shocks, the differences in their inflation-output trade-off indicate that IT may actually be optimal for only few of these countries. The inherent high cost of disinflation implies that some inflation targeters may hurt overall macroeconomic growth in their quest for price-stability. Overall, the framework of monetary policy should not be chosen based on the developed-developing countries divide, but rather on the specific features of each economy. For some economies a mix of various frameworks might be optimal, while for others targeting real variables like output or unemployment may be the best option.

3 MONETARY POLICY IN NIGERIA

3.1 Introduction

Throughout its 54 years of existence, the CBN has been tasked with the responsibility of implementing monetary policy in accordance with the macroeconomic policy objectives of the federal government of Nigeria (CBN, 2009b). These objectives, as contained in the various Acts of the CBN, are broadly defined as the maintenance of internal and external balance. Consequently, monetary policy has been designed, over the years, with a view to attaining price, interest rate and exchange rate stability, maintaining a viable balance of payments position, and achieving accelerated growth of the economy (Nnanna, 2001). The policy framework in Nigeria has evolved over time, depending on political regimes and/or international best practices. Currently, the country targets inflation loosely with plans to migrate to a strict version eventually. In this chapter, an overview of the monetary policy in Nigeria is conducted by providing a historical discussion on the conduct of monetary policy, the features of the Nigerian economy and the relationship between the CBN and rest of the economy.

3.2 The Conduct of Monetary Policy: General Overview

With the evolution of the country from a simple traditional economy to a comparatively modern one, the framework for the conduct of monetary policy has been transformed considerably to accommodate the increasing complexity of the economy. Beginning from a regime of exchange rate targeting in 1959 under the Bretton Woods system, the framework changed to that of direct monetary targeting in 1973 and indirect monetary targeting from 1991 to date. In the first two regimes, monetary variables were administratively fixed with markets playing no role except to absorb the determined quantities. During direct monetary targeting, the authorities set the interest rate and issue directives to operating banks on sectoral credit allocation while identifying priority sectors. The indirect regime, however, derived from financial liberalisation and is characterised by the use of market based instruments to manage the level of money stock in the system. Accordingly, the CBN fixes the target for monetary aggregates that are consistent with broad macroeconomic objectives while the market determines the cost and flow of capital. Under the indirect regime, the primary policy instrument is the open market operations (OMO) complemented by discount window operations and reserve requirements.

In order to ensure its efficiency, the conduct of monetary policy requires a conducive socio-political and economic environment. However, the potency of monetary policy in Nigeria has, over time, been weakened by legal, institutional and political factors such as the lack of independence, unrestricted CBN credit to government, and the ill-defined policy objectives (Saxegaard, 2006). At various times monetary policy was conducted jointly by the government and the Bank, while at other times the CBN was subjugated to the federal government in monetary policy decisions (CBN, 2009b). The inability of the CBN to take policy actions without recourse to government inhibited the achievement of the set objectives. This was further enfeebled by the presence of ambiguous and usually conflicting objectives (Batini, 2004; Folawewo and Osinubi, 2006; Saxegaard, *op.cit*). For instance, the goals of reducing inflation while intensifying economic growth, as well as those of expanding credits to priority sectors while lowering the money stock seem inconsistent and create confusion in the working of the monetary system.

Over the decade, the conduct of monetary policy in Nigeria has undergone considerable changes. With the advent of elected government in 1999, the 1958 CBN Act was amended to grant, among other things, instrument autonomy to the Bank. This was based on “the recognition of the need to have an institution that could be relied upon by the government, the private sector [and] the general public to stabilise the economy, through its own independent actions” (CBN, 2009b, p.21). With this development, the CBN gradually shifted its focus from attaining rapid economic growth to ensuring low inflation (Nnanna, 2001). Though OMO remained the major instrument of monetary policy, the use of short-term interest rate gained prominence in liquidity management. The minimum rediscount rate (MRR) served as the nominal anchor for the other interest rates in the economy and was varied in response to economic conditions.

The current approach to monetary policy derives from the notion that inflation is a monetary phenomenon. Consequently, the CBN uses financial programming to estimate monetary targets in tandem with inflation targets – usually defined as a "single-digit" rate of inflation (Okafor, 2009; Uchendu, 2009b). Having established a monetary target, interest rate and the other market instruments are deployed to restrain liquidity surfeit and inflation. This approach is premised on the view that liquidity in excess of target is inflationary, and vice versa. Hence, policy is tightened in the event of excessive monetary expansion with a view to curbing inflationary pressures.

Monetary policy efforts notwithstanding, macroeconomic conditions in Nigeria remained unsatisfactory as the MRR could not anchor the money market interest rates effectively thereby weakening the transmission mechanism (CBN, 2007a). Over time, money market rates seem not to respond significantly to variations in the MRR; thus, monetary policy changes of the MRR had marginal effects on the rest of the economy. In order to ensure effective anchorage of market rates, the CBN announced a new framework in December 2006 (CBN, 2009b). The key element of this framework is the introduction of the monetary policy rate (MPR) as the operating instrument of monetary policy and the withdrawal of MRR as the anchor rate for the interbank and money market. According to the CBN (2009b), in addition to ensuring interest rate stability, the new framework is designed to "achieve efficient liquidity management position and encourage interbank trading of funds in the money market" (p.55). Though the banking system can access the standing (lending and deposit) facilities of the CBN through this framework, the interest rate corridor around the MPR increases the appeal of interbank trading. Thus, an active interbank market would evolve such that the banking system holds zero excess reserves at the CBN. This, therefore, equilibrates the cost of overdraft at the CBN and the opportunity cost of holding surplus reserves (CBN, undated).

Over the years, the CBN has increasingly focused its policies on AD management. Hence, if effective, MPR alterations are transmitted via money market rates; thereby enabling the CBN to affect AD and stabilise prices as desired. The CBN Act of 2007 institutionalised the objective of price-stability by expressly mandating the Bank to pursue monetary and price-stability (FGN, 2007). This is congruent with the current regime of monetary targeting. Though, the Act removed the attainment of rapid economic growth as a principal objective of the bank, it nonetheless retained exchange rate stability. Based on the emergence of price-stability as one of its core mandates, the CBN, in 2007, announced its intention to adopt a full-fledged IT framework within the medium-term. This would imply the announcement of an inflation target to which the Bank is committed over and above all other objectives. The current practice, though described as monetary targeting, is largely an implicit form of IT. In this case, the bank announces its inflation target as 'achieving a "single-digit" inflation rate' while remaining committed to the other macroeconomic objectives.

The responsibility of monetary policy within the Bank is vested in the Monetary Policy Committee (MPC). This committee is mandated by the current Act to meet at least four times a year in order to review economic performance and formulate policies that would ensure price and exchange rate stability. The institutional framework of monetary policy incorporates other sub-committees whose major functions, at different levels, is to evaluate and forecast the amount of liquidity in the system for the consideration of the MPC. Though price-stability is a major goal of monetary policy, the MPC and its various sub-committees do not analyse inflation dynamics directly. Rather these committees base their expectations of inflation evolution on the assumed relationship between inflation and liquidity. Hence, if excess liquidity is forecasted, it is assumed to connote imminent inflation acceleration.

3.3 Cardinal Features of the Nigerian Economy

Beginning in 1956 when oil was discovered in commercial quantities, the structure of the Nigerian economy has changed considerably. From being an agrarian economy, the Nigerian economy has become increasingly oil-driven. The sector became the major foreign exchange earner and the most important source of revenue for government. It accounted for 28.9 per cent of GDP, 76.8 per cent of government revenue, and 94.3 per cent of export earnings during 1985-2011 (see Table 3.1).

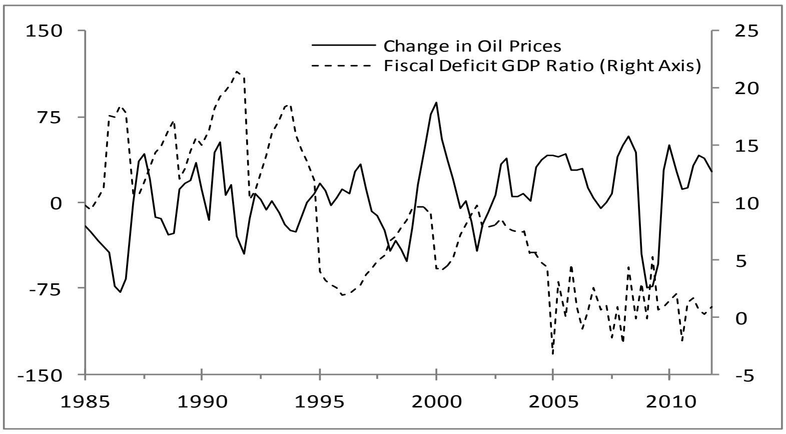
Table 3.1: Contributions of the Oil Sector to the Nigerian Economy

	1985-1990	1991-1998	1999-2011	1985-2011
% GDP	34.5	33.8	23.4	28.9
% Govt Revenue	71.6	77.6	78.7	76.8
% Export	93.2	94.7	94.5	94.3

Data Source: CBN

Consequently, fiscal operations of the federal government have depended on oil revenue and oil price fluctuations. Figure 3.1 below shows an inverse relationship between changes in crude oil price and FD. Changes in the price of oil drive government's fiscal operations; increases in oil prices are associated with decline in FD-GDP ratio and vice versa. The fall in FD following an increase in the price of oil reflects a less proportionate expansion in government expenditure vis-à-vis revenue.

Figure 3.1: Oil Prices and Fiscal Deficit

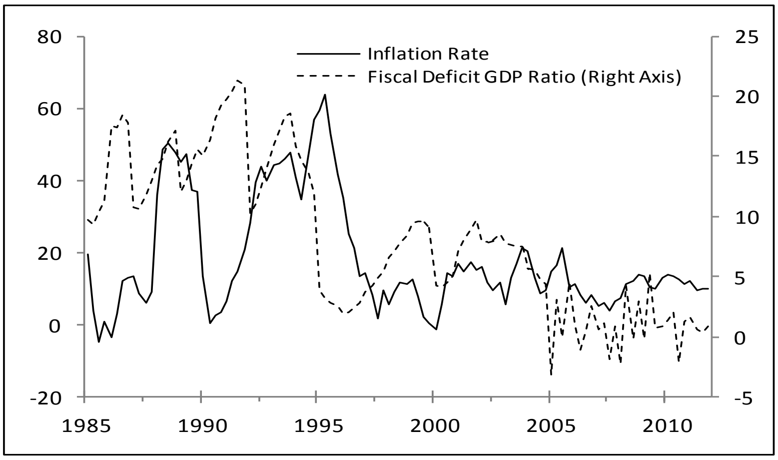


Data Source: CBN

Given the size of government in Nigeria, estimated at about 30.3 per cent of GDP between 1985 and 2011, the impact of oil price changes is directly felt on domestic prices. Rising crude oil prices cause an upsurge in government expenditure which is immediately imparted to AD. Increased fiscal expansion has over the years correlated with rising inflationary pressure. Figure 3.2 (depicting a direct relationship between FD and inflation) shows two distinct episodes in this relationship. Between the mid-1980s and the late-1990s, higher inflation was generally preceded by large FDs. However, beginning from 1997, FD-GDP ratio declined accompanied by periods of relatively lower rates of inflation. The impact of oil on the Nigerian economy is transmitted via the fiscal operations of the government. Naturally, international crude oil market is very volatile; thus, oscillations in the prices of oil are direct sources of instability in the Nigerian economy. These developments are usually outside the control of the domestic policies except when the economy is insulated via sterilisation of oil revenue. However, the 1999 Nigerian constitution mandates the immediate disbursement of oil revenue to all tiers of government; thus making sterilisation impossible. Non-sterilisation of oil revenue and lack of fiscal discipline exposes the economy to the vagaries of the international oil market.

The dependence of the Nigerian economy on oil has further weakened the ability of the government to effectively use fiscal policy for macroeconomic management. As shown in table 3.1 (above), oil contributes over 71.5 per cent of government revenue; highlighting the low tax base of the Nigerian government. This incapacitates the government's ability to effectively impact on private demand through tax policies. Hence, fiscal policy in Nigeria is essentially designed to manage government expenditure based on expected inflow of oil revenue. However, the poor management of public expenditure coupled with fiscal pro-cyclicality has continued to retard development of the Nigerian economy (Katz, 2003; Batini, 2004; Sanusi, 2010).

Figure 3.2: Fiscal Deficit and Inflation Rate



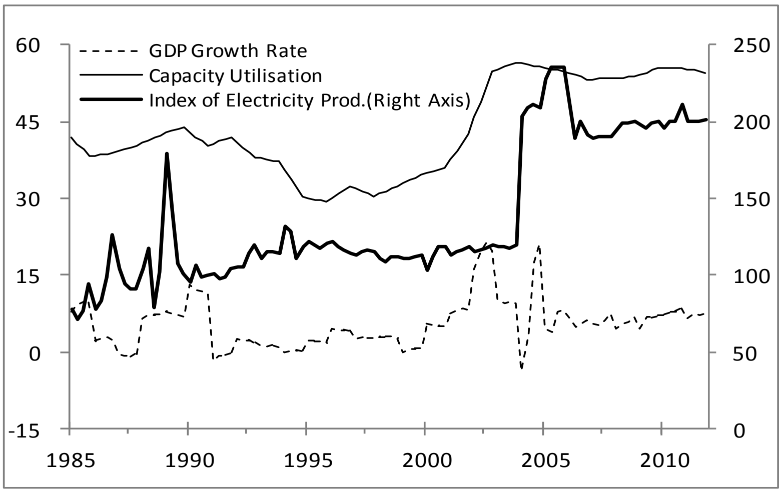
Data Source: CBN

Though oil accounts for most of fiscal revenue, it however, constitutes only about 28.9 per cent of GDP. The other sectors, which account for about 71.1 per cent of GDP, contribute less than a third of government revenue. According to the CBN (2009a), the non-oil sector's contribution to the GDP is essentially driven by the agricultural sector which accounts for about half of GDP growth. The importance of the agricultural sector in the economy is further manifested in the computation of headline consumer price index (CPI) by the National Bureau of Statistics (NBS). Food prices constitute over 63.8 per cent of the overall CPI basket (NBS, 2010a). Hence, variations in the supply of agricultural produce directly impacts on its prices which imminently dictate the direction of headline inflation. In essence, variability of the conditions in the agricultural sector is a key determinant of the volatility in GDP and inflation.

The agricultural sector is the highest employer of labour in Nigeria accounting for about 45 per cent of the active labour force (NBS, 2005). However, the economy is generally characterised by high incidence of unemployment as only about 87.3 per cent of the active labour force are estimated to be in employment between 2004 and

2008 (CBN, 2009a). A good number of this employment is found in the informal sector (Atoloye, 2007). The employment profile of the country is exacerbated by a weak manufacturing sector with an average capacity utilisation circa 50 per cent. The poor performance of the manufacturing sector and low capacity utilisation is attributable to the dismal state of physical infrastructures – especially electricity production (see figure 3.3) – and limited access to cheap (long-term) credit. Credit deprivation is aggravated by large banking system credits to government that inadvertently crowds-out the private sector. Figure 3.3 below compares the trends of electricity production, capacity utilisation and GDP growth rate. Rising electricity production is associated with increasing capacity utilisation which in turn tends to cause GDP growth acceleration.

Figure 3.3: Electricity, Capacity Utilisation and GDP Growth Rate



Data Source: CBN

Nigeria is characterised by a sizeable informal sector which is widely believed to be vibrant and according to CBN/FOS/NISER (2001) to constitute about 37.8 per cent of the GDP (Atoloye, 2007).[21,22] In fact, the sector is commonly acknowledged to play a crucial role in the resilience of the Nigerian economy to various shocks (Otu *et al.*, 2003). Operators of the informal sector are mainly farmers, traders and artisans. Activity in this sector cuts across various economic spheres including the financial markets. For instance, in the credit and the foreign exchange markets, the informal

[21] In Nigeria, the informal sector can be said to constitute all small scale economic units whose activities are unrecorded, unregistered and unregulated, and who do not remit tax to government largely due to non-existing accounts. Given the difficulty in observing, studying and measuring the sector, the statistics for Nigeria are, at best, estimates by the authorities (Atoloye, 2007)

[22] This refers to the tripartite study of the informal sector conducted by the Central Bank of Nigeria (CBN) in collaboration with the erstwhile Federal Office of Statistics (FOS) – now National Bureau of Statistics (NBS) – and the Nigeria Institute of Social and Economic Research (NISER)

sector has been known to play significant roles. In the foreign exchange market, excessive documentation, restrictions and a high spread between the official and the parallel market rates, make small-scale users to source from the informal market. Similarly, the ease and speed of accessing credit explains the continued use of informal sector lenders. Consequently, the CBN (2007b) stated that this sector provides financial services to about 65.0 per cent of the economically active population; while Otu *et al.* (*op.cit*) estimated that it constitutes about 17.0 per cent of the financial sector in Nigeria. Though it provides a veritable source of fund for it members, the low linkage with the formal sector constitutes leakage to monetary policy and macroeconomic management efforts (Sanusi, 2002).

The huge dependence of the Nigerian economy on oil and the agricultural sector is indicative of the prominence of supply-side factors. Oil prices through their impact on government fiscal operations affect inflation and GDP in the country. The sizeable contribution of agriculture to GDP and CPI also has significant impact on inflation outcomes. Agricultural production and crude oil developments are largely outside the control of government. While crude oil development is determined internationally, agricultural output in Nigeria is driven principally by natural factors. The inability of the policies to effectively curb inflation over time can be attributed to the application of demand management techniques on supply-related shocks.

Overall, the Nigerian economy is subjected to enormous volatility, as indicated by the coefficient of variation of GDP growth rate, inflation rate, exchange rate, real monetary expansion, capital market indicators, and oil price (see table 3.2). According to Batini (2004) Nigeria faces relatively more volatility than other emerging market economies like Brazil, Chile, and South Africa. This is essentially due to the transmission of oil price instability to the economy. Between 1985 and 2011, the growth rate of GDP, inflation rate and exchange rate experienced wild swings. Interest rates have remained generally high and have impacted negatively on industrial production thereby retarding economic growth. The low level of development of the financial sector (as shown by the M2-GDP and Capitalisation-GDP ratios) diminishes its ability to effectively transmit monetary policy. Consequently, inflation has remained high – within the *double-digit* range – contrary to the objective of achieving a *single-digit* rate. The largely volatile macroeconomic environment coupled with weak institutions reduces the credibility of macro-policies (Batini, *op.cit*). Hence, general features of the economy which include the prominence of supply-side shocks and the weak financial system, among others, do not seem to support the planned adoption of IT.

Table 3.2: Volatility and Averages of Major Macroeconomic Indicators 1985-2011

	Measures of Volatility									
		Coefficient of Variation				Averages				End
	Standard Deviation	Whole Sample	1985-1990	1991-1998	1999-2011	Whole Sample	1985-1990	1991-1998	1999-2011	Period (2011:Q4)
GDP Growth Rate	4.8	0.9	0.7	0.8	0.7	5.6	6.3	1.9	7.5	7.7
Unemployment Rate	3.8	0.2	0.1	0.2	0.1	17.9	14.2	20.6	18.1	23.9
Capacity Utilisation	9.2	0.2	0.0	0.1	0.2	43.5	40.8	34.4	50.2	54.5
Index of Electricity Prod.	45.2	0.3	0.2	0.1	0.3	137.9	100.9	114.1	169.6	200.9
Index of Manufact. Prod.	12.1	0.1	0.2	0.1	0.0	87.7	77.9	91.9	89.6	96.2
Inflation Rate	21.1	1.0	1.1	0.7	0.5	21.7	22.7	36.9	11.9	10.3
Nominal Exchange Rate	58.3	0.9	0.6	0.2	0.1	67.7	4.5	19.8	126.4	153.7
Real Exchange Rate	2.7	0.4	0.4	0.6	0.2	7.1	6.2	5.9	8.2	5.6
Oil Prices	28.9	0.8	0.3	0.2	0.6	36.5	19.8	18.1	55.5	115.7
FD-GDP Ratio	6.4	0.8	0.2	0.6	1.0	8.0	14.4	10.2	3.8	0.8
Size of Government	6.8	0.2	0.1	0.3	0.2	30.3	34.5	29.0	29.1	28.1
Monetary Policy Rate	4.1	0.3	0.2	0.2	0.3	13.8	12.9	15.6	13.2	12.0
Treasury Bills Rate	5.1	0.4	0.3	0.3	0.5	12.6	11.7	15.2	11.4	14.6
Maximum Lending Rate	5.2	0.2	0.3	0.2	0.2	21.7	17.4	23.2	22.8	23.3
Interbank Rate	7.5	0.5	N/A	0.3	0.6	15.5	N/A	19.6	12.6	13.0
Growth Rate of M2	18.2	0.6	0.9	0.6	0.6	28.7	18.0	34.9	29.0	15.8
Real M2	19.5	2.7	-3.6	17.6	1.0	7.3	-4.5	1.2	15.6	5.0
M2-GDP Ratio	7.0	0.3	0.2	0.3	0.3	24.5	27.2	20.2	26.0	33.1
Market Cap-GDP Ratio	10.1	0.8	0.2	0.3	0.6	11.9	3.8	7.0	18.6	16.3
Credit-GDP Ratio	11.4	0.5	0.3	0.4	0.4	23.2	36.4	22.9	17.4	30.9
All Share Index÷100	33.8	1.2	0.5	0.7	0.6	28.2	0.5	8.1	53.3	48.0
ASI Growth Rate	35.7	1.3	0.5	0.9	2.0	28.3	29.7	44.1	17.9	-18.2

Source: Author's calculations based on data from the CBN.

Note: Rates and ratios are expressed in percentages, indexes are based on 1990=100, exchange rates are in N/$, while oil prices is in $/barrel. Size of government is proxied as the proportion of total government expenditure to GDP.

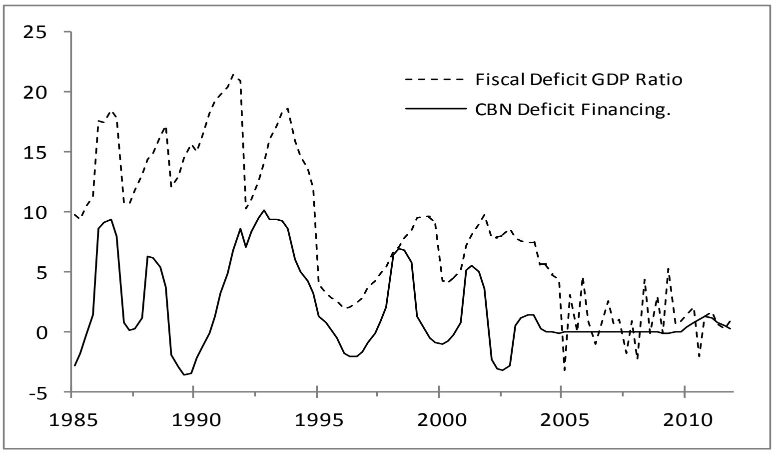
3.4 Features of Monetary Policy in Nigeria

To achieve its monetary policy mandate as specified by its entrusting 1958 Act (amended in 1997, 1998 and replaced by the 2007 Act), the CBN relates with the federal government (FGN), the banking system and the general economy on different fronts. The 1958 and 2007 Acts mandates that the CBN acts as the financial adviser and banker to the FGN, ensure a sound financial system and hence act as the lender of last resort to the banking system, and engage in developmental activities that would further the growth and development of the economy. Consequently, the CBN is expected to interact with and impact every segment of the economy.

3.4.1 CBN Relationship with the Federal Government

The relationship of the CBN with the FGN is as specified in the various CBN Acts the last of which was enacted in 2007. Accordingly, the Bank acts as the financial manager (and adviser) to the government, operates as the banker to the FGN and is, thus, required to provide overdraft facility to it. Though the Act accords some measure of autonomy to the Bank it, nonetheless, failed to remove the characteristic fiscal dominance. The repressive nature of this legislature mandates the CBN to finance FD and provide momentary overdraft facility (Ways and Means advances) to government up to 5.0 per cent of the preceding year's total government revenue. In addition, the Bank is required to underwrite Nigerian Treasury Bills (NTB) for government, thereby taking-up all unallocated bills. This mandate makes it impossible for the CBN to refuse credit to government even if such credit will have pro-cyclical and adverse effect on the economy. Evidently, Ways and Means advances to government and CBN's holding of NTBs have remained historically high. A huge proportion of FD is financed by direct credit from the CBN. Figure 3.4 shows that FD and CBN financing do covary somewhat until about 2005. This has grave implications for the ability of the Bank to conduct monetary policy.

Figure 3.4: CBN Financing of Fiscal Deficit



Data Source: CBN

The CBN-FGN relationship depends critically on the performance of the oil sector and the international price of crude oil. Figures 3.1 (oil price and FD) and figure 3.4 (CBN financing of FD) jointly illustrate this interdependence. As noted earlier, government fiscal operation is contingent on oil price developments. Planned fiscal expenditure is based on the forecasts of oil prices and the expected revenue accruable to the government therefrom. Given the proportion of oil revenue to total government revenue (see table 1), declining oil price causes a shortfalls in FGN total revenue; possibly resulting in increasing FD. Nonetheless, the government in a bid to meet it expenditure obligation resorts to the CBN to finance the deficit. Hence, as seen in figure 3.1, FD tended to vary inversely with changes in oil price so that rising oil prices leads to a decline in the FD-GDP ratio. In figure 3.4, however, FD varied sympathetically with CBN financing. These figures imply that CBN financing of FD relates inversely with oil price so that in periods when oil prices are rising in the international market, the CBN financing of deficits (and provision of Ways and Means advances) decline and vice versa.

Hence, given the dependence of the government on the oil sector, the volatility of the international oil market and the absence of an appropriate fiscal rule have resulted in huge and unpredictable fluctuations in the Ways and Means account of the FGN. Accordingly, these oscillations – via net domestic credits in the monetary survey – continually lead to liquidity surfeit and signifiant instability in the financial system. As Batini (2004) emphasises, liquidity shocks due to the ability of government to borrow from the CBN, debilitated the conduct of monetary policy and has remained a major source of price volatility. Since 2005, however, there has been an increased understanding between the fiscal and monetary arms of government on the need to restrain Ways and Means advances. Thenceforth, direct CBN FD-financing have fallen substantailly. This also followed from the re-introduction of government bonds and increased oil revenue inflow since 2004.

With the inclusion of price-stability as the principal mandate of the Bank, the lack of operational autonomy and the consequent fiscal dominance portend the inability of the CBN to conduct its policy without interference. The failure to legally constrain government’s ability to borrow directly from the banking system continues to pose a treat to the economy. Government and its various agencies find it increasingly attractive to source credit from the banking sector to the detriment of the private sector. Though the proportion of credit to government is on the decline, it has nonetheless remained considerably high averaging 35.7 per cent between 1985 and 2011. As shown in table 3.3, much of the credit to govenment has been provided by the CBN which accounted for over 30.0 per cent of this credit prior to 1999. The banking system holding of government domestic debt instruments – NTBs and Bonds – has also remained siginficantly high accounting for 74.7 per cent of total domestic debt outstanding in 2008 (CBN, 2009a). Since the turn of the millenium, CBN credit to government and holdings of debt instrument have dropped considerably owing mainly to the increased oil inflow and the mutual understanding currently existing between the Bank and the government.

Table 3.3: Banking System Credit Structure

	1985-1990	1991-1998	1999-2011	1985-2011
% Credit to Govt	48.0	40.3	25.1	35.7
% Credit by CBN	30.5	31.3	1.3	18.0
% Credit by DMB	17.4	8.9	23.9	17.7
% Credit to Private Sector	52.0	59.7	74.9	64.3
% Total Credit	100.0	100.0	100.0	100.0

Source: Author's calculations based on data from the CBN

The proportion of public sector deficits financed by the deposit money banks (DMB), however, increased during 1999-2011. This is not surprising since lending to government is deemed less risky vis-à-vis the private sector. Given the size of government, credit flows to the private sector are constrained, thereby , weakening monetary policy effectiveness. Whereas government source credit at relatively cheaper rates (even when it can afford higher rates), the private sector borrowers are confronted with a higher lending rate. Generally, the spread between NTB rate (proxying for government borrowing rate) and the maximum lending rate (which is applied to the average private sector borrower) has remained considerbaly high; standing at 8.7 percentage points in 2011:Q4. The crowding-out of the private sector and its associated high interest rate are effectively transmitted to output and inflation. High interest rate constrains credit demand which subsequently leads to low investment, reduced profitability and low output supply. This repressed supply results in excess demand which eventually drives up prices. Hence, the coexistence of both high interest rate and high inflation rate.

3.4.2 CBN and the Banking System

3.4.2.1 The Nature of the Banking System

In Nigeria, the financial system consists of regulatory bodies and operators that can be classified as money market, foreign exchange market, capital market and specialised development institutions. The money market is further dichotomised into the banking system and non-bank organisations. While the non-bank institutions comprise of 5 discount houses (introduced in 1993), a total of 24 DMBs having 5,134 branches in 2008 constitute the banking sytem with CBN as the regulating authority (CBN, 2009a). Discounts houses are licensed to transact primarily in NTB and commercial instruments like Bankers Acceptances and Commercial Papers on behalf of third-parties. However, DMBs are licensed as universal banks which, in addition to traditional commercial banking functions, can venture into any aspect of the financial market including capital market services, insurances services, and financial consultancy services among others. As at 2008, these DMBs have a total asset base of ₦15.9 trillion, with total loans and advances, and total deposit liabilities standing at ₦7.6 and ₦7.9 trillion, respectively (CBN, *op.cit*). About 0.2 per cent of the credit was advanced to small-scale entreprises as at 2008:Q4, while 6.3 per cent were non-performing (CBN, 2008a; 2009a). On the stock exchange, the banking sector constituted 39.0 per cent of market capitalisation and accounted for 70.0 per cent of the 20 most capitalised stocks in 2008. According to the CBN (2009a) aggregate capital base of the DMBs as at December 2008 stood at ₦2.8 trillion. Nonetheless, 10 banks accounted for about 72.0 per cent of the system's total credit, deposits and capital base as at 2008 (CBN, 2008b)

Given its dominance of the Nigerian financial system, the banking industry is strategically important in the economy both as a conduit of funds to the real (productive) sector and as the nucleus of monetary policy transmission. This requires that the industry as well as individual banks remain healthy and vibrant in order to ensure economic and financial stability. However, the banks in Nigeria have experienced chronic fragility over the years which has continually threatened the fabric of the Nigerian economy and has resulted in the demise of many banks. These weaknesses are broadly attributable to negligence, corruption, ineptitude and slack control both at bank and regulatory levels. In a recent paper, the current CBN governor Sanusi (2010) identified the key causes of banking system fragility as: lack of corporate governance; non-transparency among banks; regulatory gaps/slacks; and macroeconomic volatility.

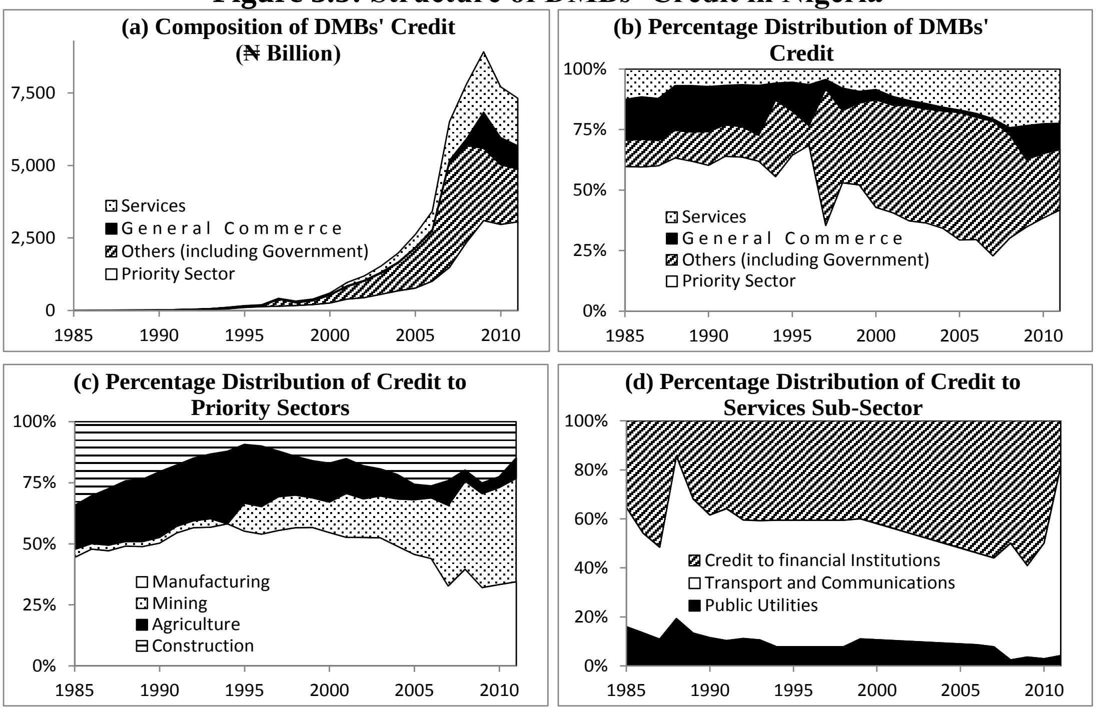
Typically, the health condition of the banks is glimpsed from their balance sheet using their deposits, credits and capital to ensure that banks are not overly exposed.

Important here is the structure of sources and uses of banks' funds. In Nigeria, banks like the rest of the economy are excessively dependent on the oil sector. CBN data indicate that the government accounted for approximately 20 per cent of banks' deposits in 2010 while non-financial (including oil-related) corporations accounted for about 45 per cent. Given the absence of a fiscal rule, oil price volatilities are reflected significantly in banks' deposits and their liquidity conditions (Sanusi, *op.cit*). Thus, rising oil prices cause excess liquidity in the banking sector and increase the availability of loanable funds. According to Sanusi (*op.cit*, p.6) "bank deposits and credit, tracking the price of oil, grew four-fold from 2004-2009 and banking assets grew on average at 76 per cent per annum," highlighting the susceptibility of DMBs to the fortunes of the oil sector. Analysis of DMBs' balance sheet as at mid-2011 also indicated, at 96.6 and 65.3 per cent of deposits and credits, respectively, are short-tenured –i.e. less than one-year maturity (CBN, 2011). This implies that banks' operations are based on unstable liquidity and exhibit high gyration.

Being oil-sector dependent and short-tenured, the structure and nature of banks' deposit (and its implications for liquidity) inhibits DMBs' ability to lend long-term to real sector of the economy. The policy authorities in Nigeria identify four *priority* sectors for bank lending *viz*: agriculture, manufacturing, mining, and construction sectors. Though these sectors generally required long-term finance, banks have favoured short-term lending particularly to government and the service sector. This is depicted in figure 3.5 which shows DMBs' credit structure. Panel (*a*) of the chart shows that DMBs' credit has been rising nominally for all sectors. However, panel (*b*) indicates that the proportion to the priority sectors have been declining while it has been generally rising for services and others (including government) sectors. Among the priority sectors in panel (*c*), credit to agriculture and manufacturing have been declining while rising for mining and construction sectors. Given the rising importance of the services sector, panel (*d*) illustrates the structure of credit in that sector. It indicates that DMBs' are becoming increasingly more exposed to financial institutions as the proportion of credit to that sub-sector has maintained an upward trend since the 1990s. This development reinforced by the dependence on the oil sector posed a major threat to the banking industry and the economy as a whole.

Increased liquidity from oil revenue are not channelled to the productive (priority) sectors but to the services sector in the form of margin lending, to financial institutions, to aid equity trading in the capital market (Sanusi, 2010). This caused market capitalisation to expand more than five-folds between 2004 and 2007 creating a bubble which further increased the DMBs' credit risks. Prior to 2005, Nigerian banks were adjudged weakly capitalised and thus unable to provide long-term finance to the priority sector; hence, the reliance on non-priority lending. However, with the consolidation exercise in 2005 banks were deemed better capitalised. Nonetheless, credit to financial institutions continued to rise whereas within the priority sector only the mining sub-sector recorded increased credit flows (figure 3.5).

Figure 3.5: Structure of DMBs' Credit in Nigeria



Data Source: CBN

Over the years, the increasing exposure of DMBs to the financial sector, particularly in the form of margin-loans (typically secured on the purchased stocks), remain a source of instability and fragility to the banking system. Table 3.4 presents data on DMBs performances and weaknesses since 2000. Pre-consolidation, capital was largely inadequate, as shown by the comparison of the capital-assets ratio with the prescribed threshold of 10 per cent.[23] During that period the ratio of non-performing

[23] 10 per cent threshold is the prescription of the Nigerian authority. The international threshold prescribed by the Bank of International Settlement is 8 per cent.

loans to total loans was also very high vis-à-vis its threshold although the liquidity and loan-deposit ratios did not indicate over-exposure. In order to strengthen the banking industry, the CBN embarked on a consolidation exercise and increased the capital requirements of banks from ₦2bn to ₦25bn effective December 2005; thus, forcing a number of banks to merge and others to exit the industry. This exercise produced 25 so-called mega-banks which were deemed to be adequately capitalised. Post-consolidation, DMBs seemed healthy until 2007 when the liquidity ratio began to decline. Between 2009 and 2010 the chronic weaknesses re-emerged in banks as capital adequacy crashed to 3.2 per cent in 2010 while the proportion of non-performing loans and the loan-deposit ratio –standing at 29.1 and 85.7 per cent, respectively– surpassed their thresholds in 2009 indicating heightened credit risks.

Table 3.4: Banking Industry Assessment Ratios

	Capital-Assets Ratio	Non-performing/ Total Loans	Liquid Reserves-Assets Ratio	Liquidity Ratio	Loan-Deposit Ratio
2000	7.40	22.60	20.00	64.10	51.00
2001	7.50	19.70	22.94	52.90	65.63
2002	10.70	21.40	22.75	52.45	62.78
2003	9.60	20.50	20.66	50.90	61.85
2004	9.90	21.60	17.31	50.48	68.63
2005	12.40	18.10	20.19	50.18	70.80
2006	16.00	8.80	14.07	55.70	63.60
2007	17.00	8.30	9.93	48.75	70.78
2008	18.50	6.30	8.36	44.25	80.93
2009	15.20	29.10	5.12	30.70	85.66
2010	3.20	17.20	5.37	30.43	74.20
2011	9.90	11.60	12.04	25.79	45.35
Average	*11.44*	*17.10*	*14.89*	*46.39*	*66.77*
Threshold	**10.00**	**20.00**	**NA**	**25.00**	**80.00**

Sources: CBN and World Development Indicators

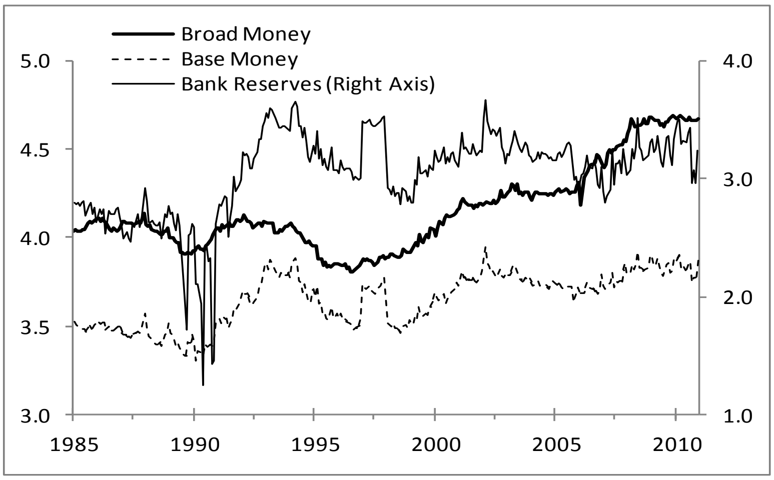
Notes: 1 Liquidity ratio is the ratio of total specified liquid assets to total current liabilities
2 Loan-to-deposit ratio is the ratio of total loans and advances to total deposit liabilities

The performance of the DMBs since 2005 is due to the nature and effect of the consolidation exercise, the effect of the global financial crisis and the over-exposure to margin-loans. For instance, in order to meet the minimum capital requirement during the consolidation exercise, some banks engaged in false accounting, using customers' deposits to create bogus capital-base. Foreign capital inflows during this period also boosted banks liquidity and the availability of loanable funds, which inadvertently encouraged reckless lending particularly for stock-market trading (Sanusi, 2010). In addition, some banks hid loan losses thence by converting non-performing loans to Commercial Papers and Bankers' Acceptances. However, following the global financial crisis in 2007 much of the weaknesses of Nigeria banks were exposed. After the crisis, many Nigerian DMBs experienced significant losses given their over-exposure to margin lending. With the crisis, the Nigerian stock market contracted by over 70 per cent in 2009 causing a considerable fall in the viability of collateral for the margin loans and consequently a huge increase in proportion of non-performing loans. This eventually led the CBN to rescue eight banks in 2009 with about ₦620bn (which is equivalent to the total capital requirement for 25 banks). At the end of 2011, banks' capitalisation remained below the domestic threshold even as liquidity adequacy declined considerably. However, the ratio of non-performing loans to total loans improved to 11.6 per cent in 2011 from 29.1 per cent in 2009 vis-à-vis the threshold of 20 per cent. This decline is nonetheless not due to improved risk management by banks but is rather attributable to the creation on an Asset Management Company (AMCON) by the FGN and the CBN to assume DMBs' non-performing credits.

3.4.2.2 Relationship with Banking System

The relationship between the CBN and the banking system is specified in the various CBN Acts as well as the Bank and Other Financial Institutions Act (BOFIA) of 1991 as amended. Specifically, the CBN Act charges the Bank to maintain monetary stability and to ensure a sound and viable fiancial system. According to the Act, the CBN is also to act as the "banker of last resort" to the banking system. Hence, in addition to conducting monetary policy, the CBN also performs supervisory functions. The monetary policy function is performed using OMO alongside the short-term interest rate to manage liquidity, while in the lender of last resort mandate is accomplished principally via the discount window operations. Liquidity management critically hinges on the relationship between bank reserves and base money, and between base money and money supply, and the overall association of these with inflation. These monetary variables tend to meander sympathetically (see figure 3.6 and 3.7). Hence, actions are taken to directly impact on the bank reserves whenever the CBN evisages liquidity expansion and inflationary treats.

Figure 3.6: Trends in Real Monetary Aggregates (Logarithm)



Data Source: CBN

OMO, the main instrument of liquidity management, is conducted entirely using NTBs which are traded predominantly between the CBN and the DMBs. Currently, the CBN performs OMO in two ways *viz*: direct OMO auctions and the two-way quote trading system. Two-way trading is conducted daily whilst direct OMO auctions are held whenever crude oil proceeds are monetised by the government. During OMO trading, the CBN sells or buys securities in order to affect bank reserves and base money. This inadvertently reduces the ability of the banks to create credit; thus, dampening overall liquidity. The amount of NTBs the CBN auctions at the OMO depends on its liquidity forecasts and expectations.

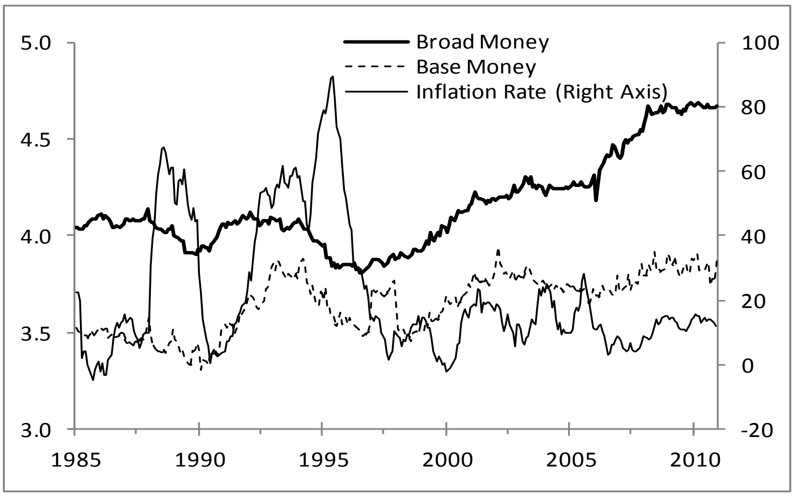
The lender of last resort mandate is performed at the discount window operations. Banks with short-term liquidity needs approach the CBN through this window to finance their deficits. In order to avert unprovoked distress, the CBN is obligated to accommodate these banks by extending overnight lending to them. The loan is secured by the DMB's holding of NTBs or other instruments considered eligible by the CBN. Before December 2006, banks were charged MRR for borrowing at the window. The convenience of borrowing from the CBN undermined the interbank market. Rather than trade reserves among themselves, banks prefer to approach the CBN when confronted with liquidity shortage. The CBN consequently became the lender of first (rather than last) resort for banks.

With the new framework of monetary policy in 2006, the CBN introduced the standing (lending and deposit) facilities. These facilities revolve around the MPR with a band. Banks with excess funds may deposit at the CBN for a rate lower than the MPR and those with deficit can borrow at rates above the MPR. This is with a view to ensuring that deposits and lending become less attractive at the CBN than at the interbank market. The increased trading at the interbank market would deepen the market and ensure that monetary policy actions are better transmitted to the economy. Changes in the policy rate would immediately affect the interbank rate via the standing facility rates and would eventually transmit to the economy through DMBs' deposits and lending rate. The ability of banks to raise funds from the CBN or the interbank and the costs of such funds is a necessary determinant of the amount of credit they create.

The depth of the interbank market notwithstanding, the CBN continually takes measures to affect the overall reserves of the banking system when necessary. In addition to OMO, the reserve requirement is another active money market instrument employed by the CBN. It is applied both for liquidity management and prudential purposes. Hence, in varying banks' reserve requirements, the CBN controls the amount of liquidity available to them, while ensuring the safety and soundness of the system. In Nigeria, the reserve requirements are in two variants: cash reserve ratio (CRR) and the liquidity ratio. These ratios represent the percentage of DMBs' total deposits that must be placed with the CBN and the proportion to be kept in liquid assets, respectively (Nnanna, 2001). As noted by Saxegaard (2006), "the liquidity requirement is satisfied by holding of cash in vault, deposits at the central bank in excess of requirements, treasury bills and CBN certificates and placements in discount houses and the interbank market" (p.18).

Bank reserves in Nigeria have continued to grow over time, even in real terms, and have tended to oscillate sympathetically with the level of base money. Hence, the CBN's ability to control bank reserves effectively could translate to better anchorage of money. While the bank reserves affect base money directly, broad money relates in some way with bank reserves through the money multiplier. A stable money multiplier is a prerequisite for monetary policy under the monetary targeting framework. However, the money multiplier has remained increasingly volatile in Nigeria weakening the ability of the CBN to effectively control inflation (Akanji and Ikoku, 2009; Okafor, 2009; Uchendu, 2009b).

Figure 3.7: Real Monetary Aggregates and Inflation Rate



Data Source: CBN

Monetary aggregates have undoubtedly accommodated inflation dynamics in Nigeria. What is, however, unclear is the direction of causation and the transmission mechanism. The late-1980s until mid-1990s was a period of high instability and accelerating inflation accompanied by large expansions in real money balances (Figure 3.7). The moderation in inflation experienced thereafter coincided with a slower growth of real monetary base while money supply continued to expand in real terms. Consequently, while money may still be important in the dynamics of post-1990s inflation, the association seem quite weakened by the increasing complexity of the Nigerian economy. However, attempts to control inflation via monetary aggregates would be futile given the collapse of the QTM and the fact that monetary growth is outside a CB's control.

3.4.3 Relationship with the Economy

Since its inception, the CBN has been charged with developmental functions in addition to its mandate of promoting economic growth. Though the weight of this function in its overall mandate had declined substantially, the bank is nonetheless required to take actions that would promote the general wellbeing of the economy. One important way through which the CBN relates with the economy is the through the foreign exchange market. The Bank does not interface with the public directly but with their respective DMBs. Being the sole recipient of oil dollar inflows, the CBN provides most of the foreign exchange needed in the official market, supplying about 88.6 per cent in 2008 (CBN, 2009a).

Its prominent supplier status in the market makes interventions inevitable as the Bank strives to maintain exchange rate stability. In order to reduce pressure on the exchange rate, strict allocative mechanisms are put in place. These impose limits to the amount of foreign exchange that individuals can purchase from the official market for personal purposes, while no limit is placed on purchases for commercial purposes. Consequent upon these restrictive measures parallel markets emerged. Nigeria is characterised by multiple foreign exchange markets broadly classified as the official and unofficial markets. The CBN wholesale Dutch auction system (WDAS), the interbank market (IFEM), and the bureaux-de-change constitute the official market, while the black-market represents the unofficial market. On the whole, the spread between these two segments of the market has remained considerably high. While activities at the parallel market are unrecorded, the ease of access to foreign exchange makes the market a haven for millions of individual users who would rather supply to this market at rates higher than those at the official market. Though the parallel market is believed to reflect true market conditions, the CBN does not acknowledge it in designing policies. Exchange rate pass-through is a very significant determinant of inflation and output in Nigeria (Batini, 2004). Hence, the existence of multiple rate and markets impinges the goal of price and exchange rate stability.

Structurally, the financial market in Nigeria is also dichotomised along formal and informal lines. DMBs' inability to perform credit assessment for each micro/small-scale economic unit given their vast number and its potential cost impedes formal credit to them. Hence, these economic units resort to family, friends, money-lenders and shylocks for their financing needs, where interest rates can either be as-low-as zero or exorbitantly high. The informal sector, servicing about 65.0 per cent of the economically active public, accounts for about 17.0 per cent of the overall financial activities in Nigeria (Otu *et al.*, 2003; CBN, 2007b). The continued existence of the informal financial credit and deposit market is largely due to the cash-based nature of the economy. This is reflected in the large amount of currency in circulation and outside the bank system (see table 3.5). Otu *et al.* (*op.cit*) observed that currency outside banks accounted for about 69.9 per cent of credits allocated within the informal sector. In a bid to ensure supervised servicing of this segment of the market, a microfinance policy was introduced in 2005 by the CBN. This was intended to enable the CBN affect the availability and cost of funds within this sector. The microfinance institutions were introduced, by the CBN, mainly to reduce poverty by aiding the economically active poor and low-income group. They were obligated to become an integral part of the community in which they operate, provide simple-*cum*-affordable financial intermediation for low-income groups and lend against character.

Table 3.5: Monetary System Cash Ratios

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
CoB/M2	25.7	24.2	20.8	20.3	20.0	16.2	12.7	9.7	8.6	9.4	9.4
CiC/M2	30.7	29.0	25.3	24.1	22.8	19.3	16.5	12.5	11.0	12.0	11.8
CoB/GDP	7.2	5.6	4.9	4.0	3.9	3.5	3.6	3.7	3.7	3.2	3.3
CiC/GDP	8.5	6.7	5.9	4.8	4.4	4.2	4.7	4.8	4.8	4.1	4.2

Source: Author's calculations based on data from the CBN

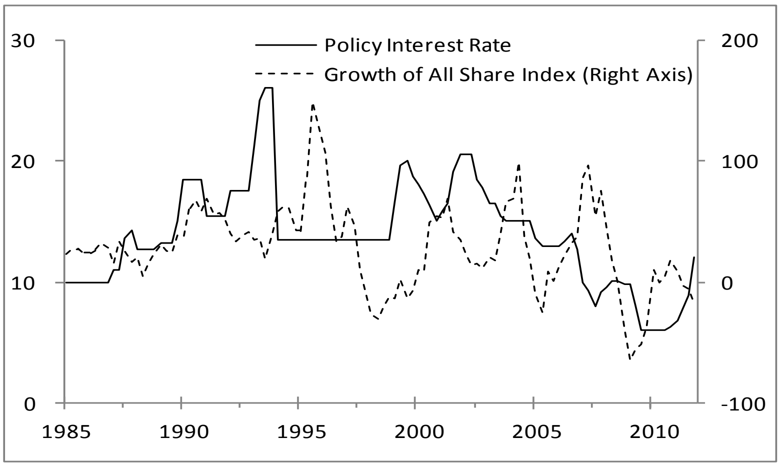
Note: CiC, CoB and M2 are currency in circulation, currency outside banks and broad money supply, respectively.

Other specialised financial institutions established, by the federal government, for developmental purposes also exist in Nigeria. These development finance institutions are funded by the FGN and as such do not source for funds from competitive markets. They are generally mandated to provide loans to specific sectors of the economy at very concessionary rates of interest. Given that these institutions are non-profit oriented, credit decisions are based primarily on their developmental goals. Consequently, liquidity management effort of the CBN does not affect the credit creating ability of these institutions thereby debilitating monetary policy efforts. Though their mandate in some cases requires them to be supportive of monetary policy, their core objectives and *modus operandi* do not support this.

The impact of the CBN on the economy is also expected to be transmitted via the asset price channel. Unlike in advanced countries, the mortgage market is virtually inexistence in Nigeria whilst the bond market is at infancy. Hence, the asset price effect of policy is believed to be entirely through the equity market. On the average, the all share price index (ASI) in Nigeria has tended to vary inversely with changes in the policy rate (figure 3.8). Thus, the capital market may be responsive to policy actions and may be a potential channel for transmitting monetary policy.[24]

[24] This is suggestive of possible correlation between the interest rate and ASI. However, there is no documented evidence that the changes in ASI have an effect on spending decisions, and consequently on GDP in Nigeria.

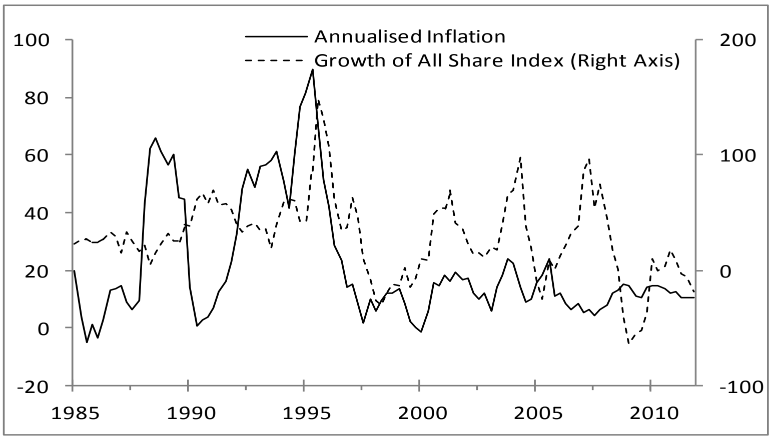
Figure 3.8: Capital Market Impact of Monetary Policy



Data Source: CBN

However, the stock market is largely underdeveloped as suggested by the ratio of market capitalisation to GDP which averaged 18.6 per cent during 1999-2011 compared with 48.4, 100.8 and 198.9 percents for Brazil, Chile and South Africa, respectively.[25] This lack of depth can enfeeble the ability of the monetary policy to effectively affect inflation through the market. A cursory look at figure 3.9 indicates that changes in the share price seem to generally fluctuate with the rate of inflation.

Figure 3.9: Asset Price and Inflation Rate



Data Source: CBN

3.5 Concluding Remarks

Based on its empowering Act of 2007, the CBN is mandated with the monetary policy conduct to broadly achieve both internal and external stability. This requires the Bank to relate with various segment of the economy, curtail inflation and promote economic and financial development. While it interfaces with the banking system as a regulator,

[25] See table 3 and World Development Indicators online at http://data.worldbank.org

the relationship with the general public is via its influence on the prevailing interest rate, the exchange rate, commodity prices and economic condition. So far there is no evidence that the CBN has contributed directly to economic growth and development. On the whole, the Nigerian economy is characterised by dominant fiscal sector with low tax base, low financial deepening, weak linkages between the money and the capital market, and dual financial system. In addition, the economy is largely cash-based, oil dependent and overran with high incidence of unemployment. These characteristics have significant implications for monetary policy. Summing it up, (Batini, 2004) noted that "monetary policy [in Nigeria] has been complicated by...fiscal largesse, lack of operational autonomy of the central bank, insufficient and low quality statistics, a weak transmission mechanisms, and a weak financial system" (p.4).

4 MONETARY POLICY UNDER THE NCM: EXAMINING BANKS' PRICING BEHAVIOUR AND ITS EFFECT ON INTEREST RATE PASS-THROUGH

4.1 Introduction

Monetary policy, as conducted in many countries, has increasingly followed the market oriented approach with the use of the short-term interest rate as primary instrument to influence the economy via market determined interest rates. This is consistent with the tenets of the NCM. Within the NCM framework, decisions of economic agents with regards to credit, investment and consumption are seen as a function of the level of (and changes in) interest rates at the money and/or the retail markets. The effectiveness of monetary policy conducted in this way depends to a large extent on the ability of CBs to influence the decisions of economic agents by affecting the real market and retail interest rates. By implication, the transmission mechanism is such that changes in the policy rate by CBs would first and foremost impact on the interest rates before being conveyed to the final target (say price-stability). This is based on the assumption of a stable relationship between the instrument(s) and final objective(s) of monetary policy (Espinosa-Vega and Rebucci, 2003; Bredin *et al*, 2002; Bain and Howells, 2009,ch.5).

The NCM framework overlooks possible disparities between changes in policy rate vis-à-vis market/retail rates. Thus, analyses are conducted as if changes in these rates relate on a one-to-one basis. As Biefang-Frisancho Mariscal and Howells (2002) pointed out, "all monetary regimes that use interest rates as the operating target must naturally assume a fairly ready link between official and market rates" (p.569). A complete pass-through can thus be viewed as the first prerequisite for policy effectiveness under the NCM. The pattern of pass-through depends on various factors including market power of commercial banks, their risk perception, and the level of financial development, among others.

In many economies, the banking system represents an important conduit of monetary policy impulses. Hence, the extent of pass-through would be directly related to the structure of the banking industry and the pricing behaviour of banks (Heffernan, 2002; Gigineishvili, 2011). Like many other firms, banks determine their prices (interest rates) as a mark-up over costs. However, the banking industry could be considered atypical given that unlike other firms distinction between a bank's input and output are somewhat unclear since a bank can administer both its selling price (lending rate) and buying price (deposit rate) with respect to its customers.[26] In this regard, the selling price would contain a positive mark-up over its average cost of funds (which in this case may be the policy rate) while a negative mark-up (discount) would apply to deposit rate. Given the importance of mark-up in banks' pricing behaviour it becomes apt to understand the determinants of a bank's mark-up and how mark-up relates with pass-through.

Essentially, the purpose of this chapter is to provide theoretical discussion on the nature, determinants and implications of pass-through especially in a developing country. Adequate knowledge of this is important in choosing monetary framework (Gigineishvili, 2011). We show that mark-up is directly related to market power derived from elasticities and the level of competition. In the presence of market power, a bank can change its mark-up (negatively or positively) following a change in the policy rate. Generally, a constant mark-up would be associated with complete pass-through. This implies that by being able to change their mark-up, banks can alter the degree of pass-through so that market power becomes a critical determinant of pass-through (Heffernan, 2002; Fuertes and Heffernan, 2009). Market power, in turn, derives from the liquidity sufficiency of a bank. Banks with adequate liquidity would have the ability to influence prices at the interbank market thereby have an edge over weaker banks. The amount of liquidity would also affect the (a)symmetry in the pattern of pass-through. A bank with insufficient liquidity would tend to raise deposit rates more than lending rates following monetary policy tightening while that with liquidity surfeit will behave conversely.

However, in addition to interbank competition, there may also be competition between the banking sector as a whole and non-bank financial service providers. In this regard, pass-through would depend on the extent to which there are substitutes to banks' products and services and the degree of substitutability. This has direct implication for the pass-through obtainable in developed country compared with that in developing

[26] There is usually the question of whether deposits are inputs and loans are outputs (or vice-versa), which subsequently related to whether banks are regarded as deposit gatherers or loan providers.

countries with the latter having a more inexact coefficient. In essence, pass-through would depend on the level of liquidity, degree of elasticity, availability of substitutes, and the level of financial development.

Completeness or otherwise of the interest rate pass-through has important implication for monetary policy conducted under the NCM. Inexact pass-through diminishes the power of monetary policy and can lead to policy indeterminacy (Kwapil and Scharler, 2006; Hoffman and Mizen, 2004; Ozdemir, 2009; Wang and Lee, 2009). For instance, under the Taylor rule, and the associated Taylor principle, inexact pass-through may lead a CB to adjust the base rate incorrectly thereby exacerbating recession, unemployment and inflation volatility (Liu *et al*., 2008). Overall, the effectiveness of monetary policy under the NCM is undermined by inexact pass-through. This may even be worse in developing countries with underdeveloped financial markets. In these countries, monetary policy under the NCM may not only be ineffective but may be complicated due to possible asymmetric pass-through.

The rest of the chapter is divided into five sections. In section two, conceptual and theoretical discussions of the interest rate pass-through are provided. The section developed practical ideas on the pricing behaviour of banks, the relationship between pass-through and mark-up, and the determinants of market power. Section three reviews the theoretical literature on the determinants of pass-through. Given the idiosyncrasies of developing countries, section three contrasts pass-through in these countries with those in developed countries, while section four expounds the implications of inexact pass-through for monetary policy conducted under the NCM. The chapter is concluded in section six.

4.2 Interest Rate Pass-Through: Conceptual and Theoretical Discussions

Interest rate pass-through generally refers to the degree of changes in policy rate that is transmitted to the markets. A complete pass-through would occur if a 100 per cent change in the policy rate is reflected in the response rates, otherwise the pass-through may be limited or excessive. In addition to the degree of responsiveness, the speed of the response is also immensely important to monetary policy as a quicker pace would reduce the overall response lag of policy. The size and speed of adjustment of market and retail rates by the banking system depend on a number of factors including the market power of firms, competition, elasticity etc which are discussed later.

Banks generally face a wide array of interest rates. While the CB's policy rate (or base rate), interbank rate and deposit rates may be considered as costs, the lending rate is tantamount to a bank's selling price. In addition, the first two may be considered exogenous and outside the immediate control of commercial banks, while the last two could be termed retail rates which are administered by these banks. In setting these retail rates, banks would tend to treat the policy and interbank rates as direct costs. The lending rate (being the *selling* price) would be marked-up while deposit rate (considered as *administered* cost) would be marked-down from the exogenous costs to satisfy profitability. Therefore, changes in these exogenous/direct costs (policy and interbank rates) are expected to reflect directly in banks' retails rates. Nonetheless, the exogenous/direct costs may also interrelate with each other, resulting in a complex network of costs transmission. Changes in the policy rate can also affect the interbank rate thereby having an indirect effect on the retail rates. Hence, changes in monetary policy can have both direct and indirect effect on banks' retail prices.

In this regard, Sander and Kleimeier (2004), Kwapil and Scharler (2006), and Greenwood-Nimmo *et al.* (2010) observed that the approach to studying the interest rate pass-through in literature is dichotomised broadly into the cost of funds approach and the monetary policy approach. While the former considers the interbank (or money market) rate as the cost of bank pricing (de Bondt, 2002; Biefang-Frisancho Mariscal and Howell, 2002; Sander and Kleimeier, 2004), the latter tends to investigate the impact of policy rate on the market and/or retail rates (e.g. Hannan and Berger, 1991; Hoffman and Mizen, 2004; Sander and Kleimeier, 2004; de Bondt, 2005; Amarasekara, 2005). Ultimately, monetary policy pass-through may occur over two stages; first, from policy to market rate and then from market to retail rates (de Bondt, 2002; 2005). In the first stage, policy rate reflects the opportunity cost of funds in the money market since it is the rate at which CBs would avail reserves to the market. In the second stage, the market rate would reflect the average cost at which banks determine the retail rates. Combining these, the policy rate can then reflect the average cost of retail rates (though indirectly). Thus, this broad dichotomy may be relaxed since the policy rate is fundamentally the base rate for all other rates in the economy and can represent the overall cost while retail and market rate can be termed the response rates as they contain some form of mark-up (-down) over the base rate. This corresponds with the view of Borio and Fritz (1995) who observed that

> "...under certain conditions, [the policy rate] can represent the marginal cost of funds for the institution...it can be a convenient reference for the setting of rates, as it reflects changes in objective, general market conditions rather than discretionary decisions on the part of individual institutions...when the money market rates are particularly volatile, [the policy rate] may be a better indicator of their persistent, rather than purely transitory movements" (p.8-9).

Theoretical discussions of the interest rate pass-through in the literature are prevalently based on the marginal cost pricing model. This model relates the retail interest rate as a mark-up of the marginal cost which may be represented by the policy rate (Borio and Fritz, 1995; de Bondt, 2002) and can be expressed as

$$r_t = \mu + \beta i_t \qquad (4.1)$$

where r_t is the retail bank interest rate and i_t is the policy rate, μ represents the mark-up and β the slope which captures the degree of pass-through. A complete pass-through occurs only when $\beta = 1$ otherwise pass-through may be limited ($\beta < 1$) or excessive ($\beta > 1$).[27]

However, equation 4.1 can also be argued to represent an average cost pricing model. This is based on the premise that marginal cost is not only unobservable in many industries but may also be undefined in the banking industry since funds are not traded on a unit-by-unit basis. Important is the fact that the pricing behaviour of banks will reflect a mark-up over cost. How this mark-up is determined is an entirely different matter. A broad range of pricing theory exist which relates price to costs (whether

[27] The mark-up model basically suggests that retail rates are determined as $r_t = (1 + m)i_t$ where $m = \mu/ i_t$ is the mark-up ratio and pass-through is assumed to be complete. However, given the possibility of incomplete pass-through this may be re-expressed as $r_t = (\beta + m)i_t$ so that $r_t = \beta i_t + i_t m = \beta i_t + \mu$ where $\mu = i_t m$ is the level of mark-up.

marginal or average) and which may give very similar equations to 4.1 above. Some aspects of these, nonetheless, do not explicitly consider pricing behaviour of banks. Sawyer (1983) observed that theories of price determination in the literature are akin to theories of firms which are used to predict adjustments of prices and output. In the banking industry, prices and output may not vary as, largely, predicted by these theories. Price does not necessary affect supply in the industry as it would in other industries. One important difference though is that for most firms what counts as inputs and what counts as outputs is clear; for a bank it is less clear – is it deposits or loans or both? Pertaining pass-through, it is also unclear whether a change in the base rate would influence the price of inputs, outputs or both (each of which are administered by banks). Banks are therefore atypical and the quantity (of funds) supplied to the market would depend principally on factors like risk perception, liquidity, and economic conditions rather than prices (i.e. interest rates).

Like other firms, banks are faced with a wide variety of costs some of which are directly related to their core business while others are related indirectly. A bank's total cost can then be seen as the sum of indirect and direct costs. Indirect costs would include implicit costs like opportunity costs (which may subsequently include expected returns/profit), risk premium, overhead cost, rent plus all other costs which we can assume do not vary with a bank's output; hence fixed costs. These would be assumed to have incorporated some provisions for *normal* profit. Correspondingly, direct costs are explicit costs and would include the cost of funds (say at the interbank market), which may vary depending on the bank's liquidity needs.

In this case, a bank may fix price (average revenue) as the sum of averages of indirect (τ) and direct (c) costs

$$p_j = \tau_j + c_j = \left(1 + \frac{\tau_j}{c_j}\right) c_j = \left(1 + m_j\right) c_j \tag{4.2}$$

which shows price $\left(p_j\right)$ as a constant mark-up $\left(m_j\right)$ over average direct costs where the subscript *j* indicates a particular firm in the industry. A change in any of these costs or their elements would directly result in a change in price. The question however is how changes in a particular cost would affect mark-up (and perhaps pass-through) if all other costs are held constant. This would depend on a number of factors which are illustrated later in this section.

For many firms, pricing behaviour and mark-up determination would depend on the firm's objective. The objective of many banks is essentially to maximise profits for their shareholders, in the short-term. According to Sawyer (1983), "...profits are linked to the ability of firms to achieve a mark-up of price over costs and thereby extract a surplus" (p.15). Hence, banks are expected to charge a mark-up over there relevant cost. Under the assumption of a profit maximising firm, Sawyer showed that the mark-up would be determined by elasticity of demand, the degree of concentration, and the interdependence of firms, subject to the kind of industry. Generally, this may then imply a price-setting behaviour as follows

$$p_j = \left(1 + \frac{1}{(e_j - \xi_j D - 1)}\right) c_j = (1 + m) c_j \quad (4.3)$$

where e_j is firm *j*'s own elasticity of demand, ξ_j is cross elasticity of demand between firm *j*'s output and the prices charged by other firms within the industry, and *D* is the degree of interdependence (captured by the proportionate change in other firm's prices following a change in *j*'s price and hence competition).

While theories of price determination are unanimous in stating price as a mark-up of cost, they however differ in the determinants of mark-up in the model as seen in equations 4.2 (the full average cost pricing approach) and 4.3 (the profit maximisation approach). Given the nature of the banking industry relative to other kinds of industries both approaches can be relevant for banks. While the relationship in equation 4.2 would describe the determinants of the *level* of mark-up, that in 4.3 captured the determinants of the *rate* of mark-up. Mark-up may be defined in absolute term (μ) or in relative term (m). In the case of banks, μ would be measured in percentage points as the difference between the cost of funds (i) and the bank's retail rate (r) while m would be measured as the proportion of μ to i at a point in time. This can be applied to equations 4.2 and 4.3 to yield

$$r_j = \mu_j + i_j = \left(1 + \frac{\mu_j}{i_j}\right) i_j = (1 + m_j) i_j \quad (4.2`)$$

and

$$r_j = \left(1 + \frac{1}{(e_j - \xi_j D - 1)}\right) i_j = (1 + m_j) i_j \qquad (4.3`)$$

after substituting $p = r$; $\tau = \mu$; $c = i$ in the equations. Expectedly, a bank would change the level of mark-up (μ_j) if the indirect costs changes while changes in direct cost ought not to affect the level of mark-up but can alter the mark-up rate (m_j). In reality however banks may alter their mark-up even when direct rather than indirect cost changes. The ability of banks to do this depends on a number of factors derived by equating equations 4.2` and 4.3` as

$$(1 + m_j) i_j = \left(1 + \frac{\mu_j}{i_j}\right) i_j = \left(1 + \frac{1}{(e_j - \xi_j D - 1)}\right) i_j \qquad (4.4)$$

which implies

$$\frac{\mu_j}{i_j} = \frac{1}{(e_j - \xi_j D - 1)} = \frac{1}{\epsilon} \qquad (4.5)$$

where $\epsilon = e_j - \xi_j D - 1$ captures elasticity and the extent of market power, which are inversely related. If we hold the influence of i_j exogenous to the bank, then the level of mark-up is easily seen to depend on ϵ since 4.5 can be re-arranged as

$$\mu_j = \frac{i_j}{\epsilon} \qquad (4.6)$$

Then the ability of a bank to change its absolute mark-up level thus depends on elasticity and market power. Lower ϵ implies that bank j would incur minimal loss of business if it increases its price since its clients and/or competitors are dependent on it. Hence, the balance of power in the industry rests with bank j. So alterations in indirect (implicit) costs are fully reflected in the price. If the banks have limited power, where ϵ is large, then its level of mark-up would be low. Essentially, therefore, while the level of mark-up would reflect some cost, the ability to change it reflects market power.

Normally, from equation 4.2` we see that $r_j = \mu_j + i_j$ which indicates that a bank's level of mark-up is not affected by its direct cost of fund. If this is so, then the changes in i_j is fully reflected in r_j and pass-through is complete ($\beta = 1$). However, following changes in i_j a bank may be able to adjust μ_j by probably altering the expected profit component of implicit cost, depending on its level of market power. If this is so, then the level of mark-up may be seen as a function of direct cost $\mu_j = \mu(i)$. Hence from 4.2` we have

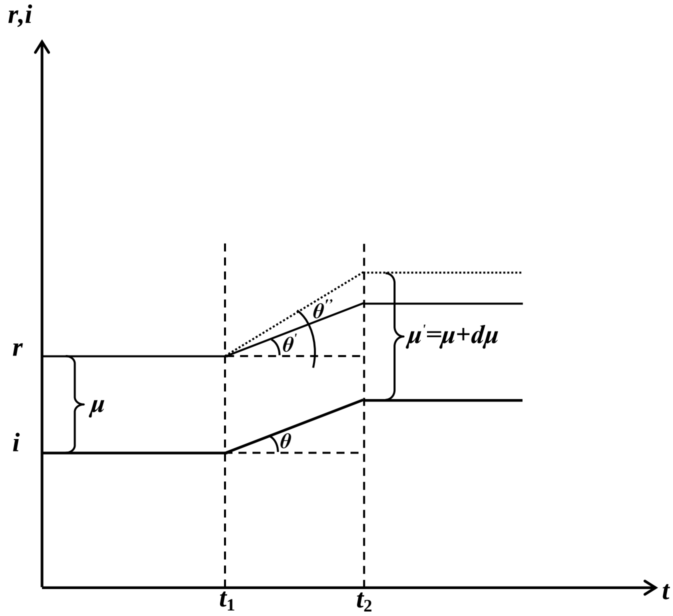
$$r_j = \left(1 + \frac{\mu(i)}{i_j}\right) i_j \qquad (4.2``)$$

So that pass-through is given by the total derivative as

$$\frac{dr_j}{di_j} = 1 + \frac{d\mu_j}{di_j} = \beta_j \qquad (4.7)$$

Ability of a bank to alter its level of mark-up would be reflected in its interest rate pass-through. The required conditions would be that if $\mu'(i) = 0$ then $\beta = 1$, complete pass-through; if $\mu'(i) < 0$ then $\beta < 1$, incomplete pass-through; while $\mu'(i) > 0$ implies $\beta > 1$, and indicates overshooting. The relationship between pass-through and the level of mark-up is depicted in figure 4.1 below. At the initial period, the bank's price is $r = \mu + i$. If at time t_1 the cost (i) is changed by a degree of θ, then pass-through would be complete if the bank adjusts its price by the same degree.

Figure 4.1: Relationship between Interest Rate Mark-up and Pass-through



Hence, if r is adjusted by θ' degree and $\theta' = \theta$ then pass-through is complete (since $\beta' = \theta'/\theta = 1$) and the level of mark-up would remain unchanged at μ. If for instance there is a pass-through overshoot, then the bank's price would be adjusted by a larger degree than the change in cost so that $\beta'' = \theta''/\theta > 1$ would hold and the mark-up would increase to $\mu' = \mu + d\mu$ where $d\mu$ is positive. For an incomplete pass-through, price would be adjusted by a lower degree than cost and the level of mark-up would be reduced since $d\mu < 0$. Hence, the extent of a bank's power as reflected in the pass-through is seen in its ability to alter the level of mark-up following a change in direct costs. The reasons why a bank may or may not have power over its mark-up are discussed later in the chapter. From the foregoing it becomes evident that factors which affect pass-through may affect mark-up while changes in mark-up would not necessary affect the pass-through.

Generally, pricing theories can be separated according to those that treat firms as price-takers and those where firms are assumed to have some degree of power over there prices. The former consist of the neo-classical theory of perfect competition, the basis of which is that a firm's action is incapable of affecting its prices so that equilibrium is achieved where price equals costs (marginal and average) and the firm makes only normal profit. In the latter, firms have the power to determine and administer their own prices; relevant here are the theories of monopoly, oligopoly and monopolistic competition. In both cases, the relationship between individual bank's behaviour vis-à-vis the industry is of utmost relevance for the final outcome.

To understand the pricing behaviour of banks we begin with the theory of perfect competition. According to this theory if the banking industry is perfectly competitive banks will operate where price equals costs (average and marginal). In line with the discussions above, this would be equal to average cost and the banks would only make normal profit (equal to opportunity costs). The theory further suggests an infinite number of banks in the industry, freedom of entry and exist and a purely homogenous product across the industry. Furthermore, banks would face an infinitely elastic demand and would lack market power to influence their prices as "they are atomistic players in the market" (Espinosa-Vega and Rebucci, 2003, p.3). From equations 4.5 and 4.6 we see that infinite elasticity implies low ability to change mark-up and prices unilaterally. Banks would, thus, be price-takers and only control quantity. Under these assumptions, therefore, the level of mark-up would be low and invariant to direct cost while the pass-through would be complete (and symmetric) for all firms (Hannan and Berger, 1991; de Bondt, 2002; 2005; Wang and Lee, 2009). However, from the models above, perfect competition can be considered as the limiting case when number of firms approaches infinity.

Practically, banks do not typically operate under perfect competition and the interest rate adjustment have been found to be sticky, sluggish and in some cases asymmetry. Hoffman and Mizen (2004) argued that banks have some degree of monopoly power and at best may be considered as operating under monopolistic competition while Hannan and Berger (1991), and Borio and Fritz (1995) viewed the industry as highly concentrated and oligopolistic. Whether under monopolistic or oligopolistic structure, imperfect competition in the banking industry confers on individual banks some measure of power to determine their prices. In this case, prices can be seen as administered rather than market determined so that customers are faced with prices as set by the firms and have no influence over it, indicating that firms have some measure of power over the clients (at least with respect to price).

More realistically, the banking system can be described as oligopolistic given the finite number of firms at any point in time in the industry. This would in turn affect the size and speed of interest rate pass-through and the effectiveness of monetary policy. It also raises question of how prices are set in an oligopolistic situation. The terms of entry into the banking industry is immensely relevant in oligopolistic pricing given the licensing prerequisite for operation; in effect creating barriers to entry. Sawyer (1983, 1985) and Stead *et al*. (1996) observed the existence of competing theories for an oligopolistic industry. Notably however are theories of the kinked model and the market leader model. In the kinked demand model, firms would be quick to reduce the price than to raise it with a view to attracting clients away from their competitors. The leadership model is based on the premise that firms do not bear equal weight in the industry so that the firm with the highest industrial weight dictates the pace (and has market power over clients and competitors).

The reality may vary from country to country and from region to region. In many cases, rather than one bank, there may be a group of market leaders who direct the pace. Hence, this group may represent those with sufficient liquidity while a group of followers may be seen as those with liquidity dearth. From equation 4.3, this categorisation would depend on the $\xi_j D$ term where D is expected to be large for the followers' group. It is expected that the price charged by one bank would depend on that charged by others, and price decisions would take into account the perceived reactions of other banks. In the context of an oligopolistic banking industry, it may be argued that the expectations have built up that each bank will respond to a change in the policy rate (direct cost) but to a varying degree. Thus, while the group of followers would be less willing to raise prices and more willing to reduce them, the converse may be true for the group of market leaders. This implies that between these groups, kinked demand model can be applied differently. For the followers it would be in the form described by theory (negative asymmetry) while for the leaders it would kink outward showing positive asymmetry. The industrial demand curve would depend on the weight of the leaders' group relative to the followers' group and may have a positive, negative or zero kink, as the case may be. This generally indicates that banks have some measure of power at administering their own price so that they can change the level of their mark-up to meet their immediate objective. If banks possess market power over their customers then $d\mu \neq 0$ and $\beta \neq 1$ would hold.

The industries' pricing behaviour implied by equation 4.1 can be derived from combining 4.2` with 4.7 and calculating the weighted average for the industry

$$r = \mu + \beta i \equiv \sum \omega_j \, r_j = \sum \omega_j \left(\mu_j + \beta_j i_j\right) \qquad (4.1`)$$

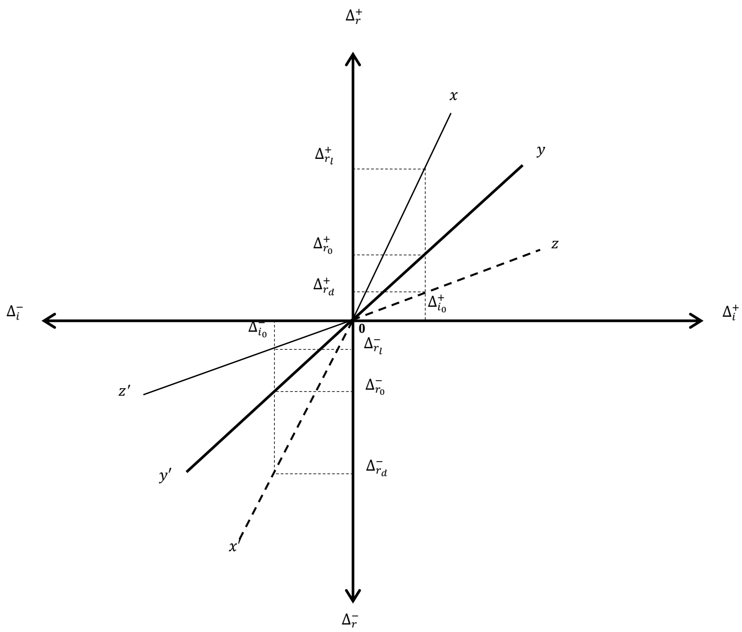
where ω_j is bank j's industrial weight. The mark-up parameter contains essential information on the market power of the firms in the industry as larger values would indicate ability to usurp profit even if $\beta = 1$. The ability of a bank (or the banking industry) to raise its margin depends on its ability to influence relative prices in the market without suffering adverse consequences. For the entire industry, this would to a large extent further depend on the availability of substitute and the degree of substitutability (with other non-bank financial products). The more highly differentiated the products are perceived the higher the ability of banks to change mark-up. By implication the degree of competition varies inversely with the spread between retail interest rates and cost of fund (Bredin *et al.*, 2002). Biefang-Frisancho

Mariscal and Howells (2002) argued that the spread (μ) may be a more important parameter in the analysis of the interest rate pass-through as it reflects relative prices in the market. Though, this is true when comparing interest rates across different segments of the market, considering the effect of μ in isolation may obscure the picture of how banks react to interest changes given the unidirectional relationship between pass-through and mark-up mentioned earlier.

Generally, market power would portend a bank's ability to affect both its mark-up and the pass-through parameter. This is reflected on the extent to which substitutes are available to the banks product, the elasticity of demand and the extent of symmetry of the bank's response to changes in policy rate. Asymmetric response to monetary policy changes is indicative of market power (Hannan and Berger 1991; Espinosa-Vega and Rebucci, 2003). This asymmetry may be with respect to product (segment of the market) or direction (sign) of change or both. Product asymmetry would occur when bank react differently with respect to deposit and lending rate while directional asymmetry would occur when the reaction differs depending on whether the change is positive or whether it is negative. Provided that banks have market power, both kinds of asymmetry may come into play concurrently. For instance, Hannan and Berger (1991) indicated that following a positive change in the base rate, all things being equal, banks may increase lending rate faster and to a higher degree than they would raise deposit rate. Biefang-Frisancho Mariscal and Howells (2002) associated this asymmetry to the potency of monetary policy. According to them, "...monetary policy would be stronger if it could be made to operate upon the loan-deposit spread, rather than upon both individual rates equally" (p.574).

Asymmetry would occur only in the case of inexact pass-through coefficient (i.e. where $\beta \gtrless 1$). This condition though necessary does not connote that all inexact pass-through are asymmetric. However, it suggests that if pass-through is complete then any asymmetry disappears. By implication, assumption of complete pass-through simultaneously connotes symmetry. Figure 4.2 below depict (a)symmetry in the pass-through in retail rates. The 45^0 line $y0y'$ shows the case of complete (and symmetric) pass-through where a change in policy rate ($\Delta_{i_0}^{+}$ or $\Delta_{i_0}^{-}$) results in a commensurate (positive/negative) change in retail rates. Lines $x0x'$ (and $z0z'$) on the other hand illustrates symmetric but overshot (incomplete) pass-through. In the presence of market power, as discussed above, banks may change retail rates to varying degree depending on whether the impulse is positive or negative. However, it is practically possible that pass-through to retail rate is incomplete, yet unequal for lending and deposit rate; and also possible that asymmetry occurs in event of overall overshoot.

Figure 4.2: Asymmetry in Pass-through



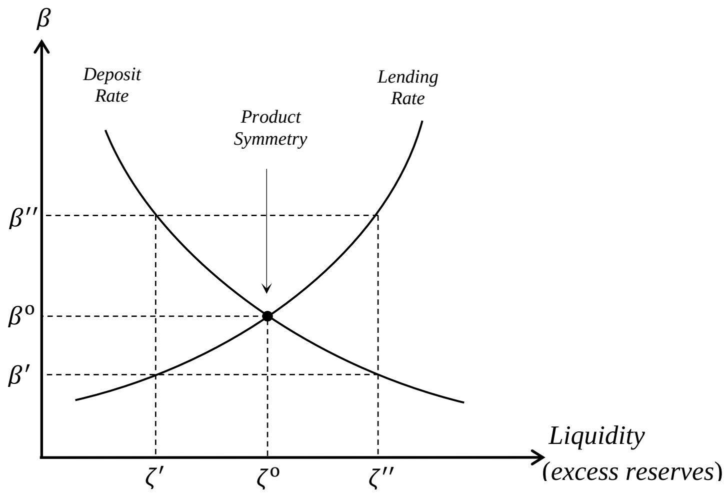
The chart in 4.2 nonetheless illustrates a scenario where banks may be more willing to raise lending than deposit rate following monetary tightening and less willing to reduce lending rate during policy ease vis-à-vis deposit rate. Hence, under asymmetric pass-through and in the presence of market power, the solid line $x0z'$ would represent a bank's adjustment to lending rate in response to changes in policy rate. The broken line $z0x'$ captures deposit rate adjustments under this scenario. The kink in both lines is indicative of asymmetry around a zero threshold. Thus, if banks are able to utilise their market power to increase their profit then a tight policy change equivalent to $\Delta_{i_0}^+$ would induce an increase in lending rate of $\Delta_{r_l}^+$ but only raise deposit rate by $\Delta_{r_d}^+$ where $\Delta_{r_l}^+ > \Delta_{i_0}^+ > \Delta_{r_d}^+$ shows the asymetry. For a negative change $\Delta_{r_l}^- < \Delta_{i_0}^- < \Delta_{r_d}^-$ would hold instead. Hence, when pass-through is asymmetric with respect to product, the change in policy rate would lie between the change in lending and deposit rate. The case of directional asymmetry would require that equal but opposite impulse in policy rate induces unequal responses in opposite direction. Thus, a change of $\Delta_{i_0} = \Delta_{i_0}^+ = \Delta_{i_0}^-$ in policy rate would cause lending rate to change by $\Delta_{r_l}^+$ and $\Delta_{r_l}^-$, respectively; where $\Delta^{+}_{r_l} > \Delta_{i_0} > \Delta^{-}_{r_l}$ holds absolutely. Conversely, for deposit rate the condition would be such that $\Delta^{+}_{r_d} < \Delta_{i_0} < \Delta^{-}_{r_d}$ holds in absolute terms.

For banks, market power and hence the ability to administer prices (on a take or leave it basis) would be closely related to their ability to supply loanable funds. In this regard, both internal factors (like liquidity) and external factors (like profitability) are critical. While liquidity would depend on the bank's ability to generate needed funds and availability of such funds, profitability entails issues of risk perception and expected returns from a particular credit. Ordinarily therefore, a bank would make loan if it has loanable funds (or access to them), if the risk is low and if the expected returns are reasonable. As noted earlier, the level of liquidity a bank has is directly related to its market power and would include a bank's reserves (i.e. vault cash *plus* deposit with the CB) and holdings of government (or other eligible) securities. Banks can source liquidity from depositors, the interbank market or the CB with deposits as the first resort and the CB as the last resort. Hence, banks with adequate liquidity would have more power at the interbank market vis-à-vis those with shortages and would dictate the prices at the market. Inadequate liquidity may also mean that such banks have insufficient holdings of government securities with which to borrow reserves from the CB. Consequently, institutions with liquidity dearth would, as a first resort, attempt to attract liquidity by making the interest rates on deposits more attractive and would therefore raise those rates. This narrows the loan-deposit spread and profit margin. By implication, market power (in the form of sufficient liquidity) enables a bank to maintain an ample profit margin; conversely for liquidity deficit.

The level of liquidity, by affecting market power, would affect the pass-through in interest rates. This is illustrated in figure 4.3 which depicts pass-through to lending (deposit) rate as a positive (negative) function of liquidity. This implies that the negative relationship between pass-through and liquidity reported in the literature (for instance by Sørensen and Werner, 2006; and Gigineishvili, 2011) may in fact reflect the behaviour of interest earning instruments which would include savings or term deposits and government securities. As argued above, as a bank's liquidity reduces it would raise deposit rates to attract more deposit in an attempt to maintain its market share. Consequently, following monetary tightening such banks would be more willing to raise deposit rate than lending rates thereby reducing profitability.

Conversely, those with liquidity surfeit, owing to their market power, would increase their profitability by raising lending rates more than deposit rates. Without the influence of other outside forces, deposits would move from those with excess liquidity to those with shortage until equilibrium is established. However, depositors perceive bank's with adequate liquidity as more solvent and healthier than those without. This would thus culminate in depositors keeping faith with the healthier banks where they are confident that their money (or life's savings as the case may be) is safer. It can then be argued that depositors would rather accept low deposit rates rather than confront the risk of losing their entire (or part of their) savings.

Figure 4.3: Pass-through and Liquidity



According to the chart above, product asymmetry between deposit and lending rates can be attributed to a bank's liquidity profile. At liquidity level ζ', a bank would experience shortage and pass-through would be higher for deposit than lending rates. As liquidity position improves towards level ζ^{o}, the asymmetry begins to disappear. Banks operating at level ζ'' have liquidity surfeit and would be prone to raise lending rates by a greater proportion than deposit rates. Liquidity at level ζ^{o} in this case would represent the industrial weighted average so that banks operating at that level would have the tendency to maintain their profit margin and raise both deposit and lending rates equi-proportionally. If all banks cluster around the industrial average so that there is no clear market leader overall pass-through would be symmetric between lending and deposit rates in the banking system. Product (a)symmetry on an industrial scale would depend on the weight of market leaders (with sufficient liquidity) vis-à-vis followers. From figure 4.3 this weight can be reflected by the distance of followers (i.e. at point ζ') and leaders (at ζ'') from the industrial average. The farther is ζ' or ζ'' from ζ^o the larger would be the respective weights of the followers' and leaders' groups in the industry. If the followers' group outweighs the leaders then the asymmetry would be such that deposit rates would respond more than lending rates, while converse would hold if the leaders outweigh the followers. Pass-through in the banking system would be symmetric if both groups have equal weights in the industry. The behaviour of market leaders with sufficient liquidity can thus be represented by the solid line $x0z'$ in figure 4.2 while for those with shortages pricing behaviour would be consistent with the broken line $z0x'$ above.

4.3 Determinants of Pass-Through: A Review of Theoretical Literature

Given the role of market power in the analysis of pass-through and its significance for monetary policy it is apt to understand its determinants. While Biefang-Frisancho Mariscal and Howells (2002); Espinosa-Vega and Rebucci (2003) emphasised the availability of alternative instrument (i.e. substitutes) as key the determinant of banks' pricing behaviour, Greenwood-Nimmo *et al*. (2010) and de Bondt (2002, 2005) noted the role of elasticity in the pass-through process. These factors, however, are mutually reinforcing given that they are offshoots of imperfect competition in the industry. The existence of substitutes directly affects the demand elasticity of a product and this elasticity increases with the degree of substitutability. Hence, the availability of substitutes increases elasticity and competition while reducing banks' market power. This line of argument would suggest that the pass-through would depend on the extent to which the financial industry is diversified and depth of the market. Hannan and Berger (1991) argued that a lack of market contestability and a high degree of financial market underdevelopment limit the substitute for money and credit thereby affecting their respective elasticities and the overall monetary policy pass-through. The substitutes for money would include the securities, bonds, stocks and financial derivative products at the capital and money market. As argued above, contestability and competition within the industry would also depend on the liquidity and reserve position of individual institutions. Higher liquidity and reserve adequacy boost a bank's power both at the interbank and the retail market. Hence, those institutions that are relatively well-off would tend to have more power than those that are deprived in usurping profits (and/or market share which in turn begets more power).

Market power may not adequately explain the interest rate adjustment behaviour of banks. The ability of these banks to transmit base rates changes to their customers depends to a large extent on the opportunity cost of making those adjustments. Hofmann and Mizen (2004) separate these costs into pecuniary costs and non-pecuniary costs. The former include those shoe leather costs, which are incurred directly during information search; and menu costs of adjusting prices, which may include costs of labour, computing and notification (Hannan and Berger, 1991; Kwapil and Scharler, 2006). The latter includes switching cost of losing clients after adjustment of rates and asymmetric information costs which heralds the problems of adverse selection and moral hazard (de Bondt, 2005).[28] In this case, a bank would only transmit the changes to its customers if the associated opportunity cost is less than the gain, otherwise the bank would absorb such changes. Hence, the existence of opportunity costs would increase the stickiness of banks' retail rates. While pecuniary costs are explicit costs (that are displayed in banks' profit and loss accounts) with short- to medium-term consequences, the non-pecuniary costs are implicit and may have medium- to long-term effects on banks' profitability.

According to Berger and Udell (1992) and Allen and Gale (2004), high switching costs would result in limited pass-through occasioned by "implicit contract between the bank and its customers, which arises as a consequence of long-term relationships" (Kwapil and Scharler, 2006, p.27). In order retain patronage, therefore, banks may be willing to protect their customers from adverse interest rate changes and from volatility that would arise from frequent adjustments of rate (Hofmann and Mizen, 2004). In this case, banks absorb the shock and most of the related costs. These costs are termed switching costs and would be high if the bank and the customer have enjoyed long-term relationship, if the customer is considered a high net-worth client and if such customer conducts large or repeated transactions (de Bondt, 2004; Hannan and Berger, 1991; Kim *et al*. 2003; Sharpe, 1997). This cost is also expected to relate inversely with the proportion of new customers and directly with the proportion of

[28] Switching cost and asymmetric information costs can seem to be pecuniary costs as well since they may lead to loss of income/profits, even if these are difficult to compute. However, these are costs arising due to potential income foregone and are at best implicit costs. Hence, by pecuniary costs we mean explicit costs while non-pecuniary costs are implicit costs.

prime customers. Loss of prime customers may affect banks' profitability. Therefore, banks would rather shield such customers and bear the extra cost.[29]

Costs arising from information asymmetry reflect the existence of risk and basically affect the setting of lending rate by banks. This typically is associated with the problems of adverse selection and moral hazard. Following a positive change in the base rate, banks may encounter these problems if they raise the lending rate. Stiglitz and Weiss (1981) and de Bondt (2002, 2005) noted that with increases in lending rate, banks may attract riskier clients and/or clients may opt for riskier ventures; thereby presenting the problems of adverse selection and moral hazard, respectively. By implication, increases in lending rate may result in higher likelihood of default and lower expected earnings on loans (de Bondt, *op.cit*; Borio and Fritz, 1995).

To avert these problems and minimise their exposure to risks, Stiglitz and Weiss (*op.cit*) argued that banks would set their interest rate below equilibrium (i.e. the level of interest rate if pass-through was complete) and ration credit so that lending rate would be sticky upward and the interest rate pass-through would be incomplete. However, according to Sander and Kleimeier (2004) when high risk is perceived, rather than ration credit, banks may compensate for this by raising lending rate more than proportionately (overshoot the pass-through so that $\beta > 1$). In doing so, banks may partition borrowers according to their perceived riskiness so that a premium is charged on risk-prone borrowers. Hence, the spread between the loan rate charged to prime customers and that charged to riskier borrowers may be an indication of the degree of risk perception in the two segments of the market. While prime customers may be protected from frequent rate changes, the costs arising thereof from may be transferred to other customers. Thus, the effect of switching cost may not be fully borne by banks.

Another related factor that may affect monetary policy pass-through is the general risk perception of the banks (Borio and Fritz, 1995). This is slightly different from those

[29] It can be argued that since cost change affects all banks (and if banks believe that others are in a similar situation as themselves, then they would expect one another to behave alike so that each bank changes its interest rates and) relative prices would change very little. However, it can be counter-argued that while banks may behave alike with respect to the ordinary customers, thereby leaving relative prices unchanged, they may be more willing to offer concessionary rates to high net-worth customers in order to retain their services or attract them away from their current banker. In this case, individual banks would be willing to bear the switching cost rather than raise their rate and lose the custom to a competitor. If all banks behave in this way, we can assume that the banking system would bear some switching cost.

associated with asymmetric information. Gropp *et al*. (2007) categorised this into *credit risk* – reflecting the risk of loan default; *interest rate risk* – arising from the mismatch of the demand for long-term loan and supply of short-term deposit; and *liquidity risk* – due to inadequate capacity to fulfil deposit withdrawal. Accordingly, the higher these risks the lower the pass-through and the larger the spread between lending and base rates (Gropp *et al.*, *op.cit*).

The degree of anticipated persistence of changes to the base rate also affects the adjustment of retail rates (Borio and Fritz, 1995; Hoffman and Mizen, 2004; Wang and Lee, 2009). Anticipated persistence and expectations generally mute the pass-through of monetary policy. First, owing to the various costs of adjustment, if banks perceive that a change in the base rate is a one-off occurrence, they may absorb the impact and protect their (prime) customers. Banks would only have the incentive to adjust their prices if they anticipate successive changes in the same direction. Such adjustment may be made with a view to minimising cost "by pre-empting the full increase or by catching-up with the official rate after the event" (Hoffman and Mizen, 2004, p.101). Anticipatory increase in this way assumes that banks have adequate information regarding the conduct of monetary policy. Thus, in the presence of rational expectations, banks may under-adjust their rates since base rate changes may have been built into their prices already (Wang and Lee, 2009, Bredin *et al*., 2002).

Other factors that affect the pass-through process include structure of the market and the level of financial development (Hannan and Berger, 1991; Borio and Fritz, 1995; Ozdemir, 2009; Gigineishvili, 2011), and cyclical factors (Borio and Fritz, 1995; Bredin *et al*., 2002). According to Hannan and Berger (1991) and Ozdemir (2009), more developed markets are expected to have a variety of financial products and derivatives so that there is increased substitutability and higher competition among various sources and/or uses of funds. Invariably, the degree of financial development should relate directly with the degree of pass-through. Sander and Kleimeier (2004) affirmed that low levels of financial development reduce the size of pass-through in the economy while Gropp *et al.* (2007) argued that financial innovation increases the speed of pass-through. However, Gropp's perspective on financial innovation may be seen by some as counter-intuitive. Arguably, innovations would be expected to further the degree of product differentiation while reducing substitutability and cross-elasticity of product. Thus, innovation can be seen to foster market power which inadvertently would then retard the pass-through process or lead to asymmetric pass-through. Nonetheless, and in fact, innovation can intensify competition in the industry (if every institution continues to develop attractive product and/or innovation is systemic). In this case financial innovation would expand alternatives and increase substitutability thereby supporting Gropp's argument. In reality, banks financial innovation tends to occur on a systemic basis so that the industry becomes increasingly sophisticated and developed. On the issue of cyclical factors, Borio and Fritz (*op.cit*) and Bredin *et al.* (*op.cit*) stated that banks may be less willing to transmit interest rate changes during economic recession vis-à-vis boom. Indeed, Gropp *et al.* (*op.cit*) found that business cycle have an asymmetric effect on pass-through.

The importance of all these factors may differ between individual banks and the entire industry. Market power would be important both for individual banks and the industry. Based on the models of oligopolistic pricing discussed earlier, pass-through would be affected by the structure of the banking industry – number of banks, degree of collusion between them, etc. This would affect how banks compete within the industry. The banking industry would also be seen to compete with other non-bank financial institutions so that market power, both intra- and inter-industry, would be important for the process of pass-through. As a result, opportunity costs like the switching cost may affect the banking industry as a whole given the possible competition from the non-bank institutions. Other costs like information asymmetry costs and the associated risks would apply on a micro level; the impact of which may cancel out and become insignificant for the industry as a whole. Degree of anticipated persistence of the change, expectations, financial development and the cyclical factors would be expected to affect the banking system as a whole and as such would affect the average pass-through of the policy rate.

4.4 The Atypical Case of Developing Countries

Pass-through is expected to vary across countries and regions depending on the level of financial and/or economic development of a country (Masih and Hamda, 2008). As observed in chapter two, institutional arrangements and country idiosyncrasies have a significant effect on policy effectiveness. All other things assumed equal therefore, the degree and pattern of monetary policy pass-through would be higher in advanced countries (with more developed/sophisticated financial market and are characterised by regular tranches of systemic financial innovations) than in less developed countries with weak and largely rudimentary financial markets (Weeks, 2009; 2010). In developed market, contestability and substitutability is higher between bank and non-bank financial instruments than in less developed ones (Gigineishvili, 2011). This has implication for (average) pass-through in the entire banking industry. To demonstrate this, we begin by re-writing equation 4.1` to depict the average (banking system) interest rate as

$$r_f = \sum \omega_j(\mu_j + \beta_j i_j) = \left(1 + \frac{1}{(e_f - \xi_f D - 1)}\right) i \equiv \left(1 + \frac{1}{\epsilon_f}\right) i \qquad (4.1``)$$

where e_f and $\xi_f D$ represent banking system's own (average) elasticity and cross elasticity vis-à-vis non-bank financial products. In advanced countries with developed market, elasticities and interdependence (ϵ_f) are expected to be higher than in developing market due to a dearth of alternatives in the latter. This connotes low substitutability in developing countries, so that the banking system may have more power over clients than in advanced countries. Thus, the effectiveness of monetary policy would depend on both inter- and intra-industry competition as well as on the viability of the market for securities.

The argument can be elucidated by allowing the mark-up component of equation 4.1`` to vary with the base rate (consistent with discussions preceding equation 4.2``). Accordingly, equation 4.1`` can be expressed as

$$r_f = \left(1 + \frac{1}{\epsilon_f(i)}\right) i \qquad (4.1```)$$

which yields the banking system average pass-through as

$$\frac{dr_f}{di} = 1 + \frac{1}{\epsilon_f(i)} - \frac{d\epsilon_f}{di} \cdot \frac{i}{(\epsilon_f(i))^2} = \beta_f \qquad (4.8)$$

Combining this with 4.7 and re-arranging after applying the relevant weights implies that

$$\frac{du_f}{di} = \frac{1}{\epsilon_f(i)} - \frac{d\epsilon_f}{di} \cdot \frac{i}{(\epsilon_f(i))^2} \qquad (4.9)$$

and

$$\frac{du_f}{di} = \frac{1}{\epsilon_f(i)}\left(1 - \frac{d\epsilon_f}{di} \cdot \frac{i}{\epsilon_f(i)}\right) \tag{4.10}$$

The term $\left(d\epsilon_f/di\right) \cdot \left(i/\epsilon_f(i)\right)$ is an elasticity measure which captures the responsiveness of banks' market power to policy rate. Hence, the ability of the banking system to adjust its mark-up following a change in the policy rate depends on the dynamics of own- and cross-elasticity. In developed countries, interdependence between banks and non-bank financial institutions is expected to be high so that with stiff competition the banking system does not gain market power. Elasticity would in this case be high and may even be increasing. Therefore, we can expect that the condition $d\epsilon_f \geq 0$ be satisfied among developed countries. In countries with underdeveloped financial market, we would expect that the inability of non-bank institutions to compete with the banking system in the market increases the power of banks generally. Hence, $d\epsilon_f < 0$ would be expected to hold in developing countries. This would lead to a further reduction in the value of ϵ_f and as bank products become less elastic the market power of banks continues to rise. Lack of inter-industry competition may be due to the institutional features of a country especially with regards to licensing, legislation and the mandate of the financial institutions. For instance, in Nigeria while banks are licensed to venture into any type of financial business (under the universal banking law), other financial institutions are restricted on the kind of business they can venture into. Hence, the banking industry would always have the competitive edge over other providers of financial services. This then increase their power over both competitors and customers.

In many developing countries like those of sub-Saharan Africa, the dearth of viable and/or admissible instruments/securities further compounds this problem. This is reflected in the excessive dominance of the market for government securities. For instance, in Nigeria, FGN bond accounts for 94.8 per cent share of the bond market, while corporate bonds accounts for a paltry 0.48 per cent (VETIVA, 2010). This does not only limit the functioning of the financial market it also expands the power of banks in another direction. Banks may have other avenues to earn profit (returns) rather than from lending. Particularly in developing countries, these banks may prefer negligible risk to higher returns and ration credit in a way which is unrelated to the problem of adverse selection. Even when lending portends low risks banks may opt for risk-free income in the form of government securities. Thus, given the viability of the market for government securities and its risk-free nature, banks in developing countries are rather more willing to hold government securities even at low yield than to lend to the private sector at a higher rate (Weeks, 2009; 2010). Since FGN bonds may not respond to policy in the same measure as corporate bonds, owing partly to market underdevelopment, the pass-through process would be impeded. Due to the dominance of a segment of the financial market by some operators, therefore, imperfect competition would also affect the pass-through process. In the Nigerian banking sector, twenty four DMBs (commercial banks) account for over 95 per cent of entire financial market, while only ten banks account for over 70 per cent of the banking sector (CBN, 2008b). This oligopolistic structure has considerable implication for the entire monetary policy process. As banks become more powerful vis-à-vis the customers, the elasticities for loans and deposits declines and banks can alter the level of mark-up without deterring profitability.

4.5 Quantitative Estimates of Pass-through

The preceding sections generally imply that the pattern of interest rate pass-through in any economy depends on the structure and nature of that country's financial system over time. In many developing countries, like Nigeria, the banking system dominates the financial system – engaging in both core intermediation and non-core financial services (Gigineishvili, 2011). However, Heffernan (2002), IMF (2008), and Fuertes and Heffernan (2009) indicate that non-bank financial institutions play key roles in developed countries, as banks withdraw from core intermediation activities and increasingly engage in market financing. The resultant imperfectly competitive financial system accords firms some market power in determining their price. Studying the UK, Heffernan (*op.cit*), provided evidence of significantly high administrative cost – i.e. mark-up – in a monopolistically competitive financial system where pricing behaviour is product dependent, and non-identical for lending and deposit rates. The extent of market competition (and the associated market power), as we discussed earlier, have implications for the size and symmetry of pass-through across products, markets or countries/regions.

Quantitative evidence of the effect of competition on pass-through is provided by Heffernan (*op.cit*) and van Leuvensteijn *et al.* (2008).[30] Investigating eight Euro-area countries, van Leuvensteijn *et al.* (*op.cit*) estimated retail market pass-through within the range 0.06-1.34 and found that competition increases the lending rates pass-through coefficient by about 0.05 points but lowers the deposit rates pass-through by approximately 0.2 points. Comparably, Heffernan (*op.cit*) showed that declining competiveness between 1989 and 1998 reduced the UK mortgage market pass-through by about 0.1 points to a range of 0.71-0.85. UK savings deposits, however, recorded an increase of about 0.14 points to a range of 0.63-0.70 indicating better market contestability for reserves and liquidity. In a cross-country study, Gigineishvili (2011) showed that improved liquidity position lowers lending rate pass-through by 0.32 points. Generally, while the degree of competition and market power affects banks' pricing behaviour, the size of the estimated pass-through varies across countries and study. A survey of these estimates (in table 4.1) generally indicates heterogeneity of interest rate pass-through among countries; and a considerable difference between advanced and developing countries.

For developed countries, Borio and Fritz (1995), Greenwood-nimmo *et al.* (2010), IMF (2008) and Kaufmann and Scharler (2006) investigated the heterogeneity of pass-through between the USA and Europe and recorded higher coefficients for the USA. For instance, Kaufmann and Scharler (*op.cit*) provided estimates of lending rate pass-through for nine Euro-area countries and the USA ranging from 0.23 (for Portugal) to 0.92 (for the USA) with a Euro-area pass-through of 0.48. Similarly, Greenwood-nimmo *et al.* (2010) estimated long-run pass-through within 0.29-0.62 for Germany and 0.60-1.64 for USA. The heterogeneity in the pass-through between the USA and the Euro-area was attributed to the dissimilarities in the financial structure of both groups – where a vibrant capital market deepens competition in the USA but the bank dominated European financial system is less competitive. The findings in IMF (2008) did not only confirm the heterogeneity between the USA and the Euro-area, but indicated that the pass-through coefficient has weakened over the years (especially in the USA) – thus, undermining the transmission of monetary policy less certain. This is due mainly to the financial crisis reinforced by the changing structure of financial

[30] Detailed discussion of empirically issues in pass-through is provided in chapter 5.

system given the rising importance of "near-bank" financial institutions in financial intermediation and increased focus of banks on non-core (and less reliable) market financing – away from core deposit mobilisation (IMF, *op.cit*).

Table 4.1: Summary of the Empirical Estimates of Pass-through

Authors	Country/ Region	Deposit Rate		Lending rate		Pass-through Complete		Asymmetric Pass-through
		Short-run	Long-run	Short-run	Long-run	Short-run	Long-run	
Advanced Economies								
Borio and Fritz (1995)	USA; EU;	-	-	0.11-1.03	0.70-1.27	NO	YES	NO
Kaufmann and Scharler (2006)	USA; Euro-area	-	-	0.23-0.92	-	NO	-	YES
IMF (2008)	USA; Euro-area	0.06-0.21	0.97-1.66	0.09-0.51	0.24-2.35	NO	YES	YES
Greenwood-Nimmo *et al*. (2010)	USA; Germany	-	-	-	0.29-1.64	-	-	YES
Aggelis (2005)	Euro-area	0.07-0.12	0.67-1.01	0.13-0.48	0.39-1.02	NO	YES	-
de Bondt (2002)	Euro-area	0.01-0.47	0.18-0.76	0.08-0.55	0.61-1.04	NO	YES	-
de Bondt (2005)	Euro-area	0.02-0.35	0.35-0.98	0.13-0.54	0.92-1.53	NO	YES	YES
Sander and Kleimeier (2004)	Euro-area	0.10-0.45	0.25-0.80	0.25-0.45	0.65-0.75	NO	NO	-
van Leuvensteijn *et al.* (2008)	Euro-area	-	0.06-0.99	-	0.41-1.34	-	-	-
Liu *et al*. (2008)	New Zealand	0.43	0.83-0.91	0.19-0.93	0.15-1.12	YES	YES	NO
Burgstaller and Scharler (2010)	UK	-	-	0.22-0.36	0.80-0.85	NO	YES	-
Heffernan (1997)	UK	0.21-0.53	0.48-0.97	0.17-0.53	0.93-1.02	NO	YES	-
Hoffman and Mizen (2004)	UK	0.15-0.78	1.00	0.13-0.25	0.81-0.91	NO	YES	YES
Espinosa-Vega and Rebucci (2003)	OECD	0.27-1.13	0.60-1.00	0.18-0.86	0.24-1.00	NO	YES	-
Emerging/Developing Economies								
Égert et al (2007)	CEE	-	0.01-0.95	-	0.07-1.28	-	NO	-
Cas *et al.* (2011)	CLA	-	-	0.05-0.80	0.22-1.19	NO	NO	-
Espinosa-Vega and Rebucci (2003)	Chile	0.19-0.68	0.39-0.68	0.18-0.63	0.45-0.88	NO	YES	-
Kovanen (2011)	Ghana	0.06-0.31	0.71-1.09	0.08-0.31	0.64-1.16	NO	NO	-
Zulkhibri (2012)	Malaysia	0.02-0.29	0.33-1.12	0.01-0.09	0.17-1.00	NO	NO	YES
Aziakpono and Wilson (2010)	South Africa	0.01-0.81	0.49-1.03	0.40-1.00	0.93-1.04	NO	YES	YES
Amarasekara (2005)	Sri Lanka	0.01-0.05	0.06-0.37	0.51	0.76-0.81	NO	NO	-
Ozdemir (2009)	Turkey	0.23-0.45	1.05	0.26-0.74	1.19	NO	YES	NO

Notes: (1) CLA represents Central and Latin America.
(2) CEE is Central and Eastern European Countries

This heterogeneity is not only between the Euro-area and USA but also among Euro-area countries and between products. For instance, Bernhofer and van Treeck (2011) estimated lower pass-through coefficients of 0.11-1.06 for deposit rates vis-à-vis 0.18-1.57 for lending rates, which ranged from 0.11 in Spain to 1.57 in Finland. For the UK, Burgstaller and Scharler (2010), Hoffman and Mizen (2004), and Heffernan (1997), respectively, documented the lending rate pass-through as 0.22-0.36, 0.13-0.25 and 0.17-0.53 in the short-run but 0.80-0.85, 0.81-0.91 and 0.48-1.02 in the long-run. Their estimates were usually larger for lending rates than deposit rates.

Comparing Chile with a group of advanced economies, Espinosa-Vega and Rebucci (2003) documented homogeneity in the estimated coefficients. However, in a cross-country analysis, Gigineishvili (2011) showed that pass-through was about 0.12 points lower for developing countries vis-à-vis advanced countries. Some country specific studies also indicated lower pass-through. For instance, in Sri Lanka, Amarasekara (2005) found sluggish and incomplete pass-through ranging from 0.01-0.51 in the short-run to 0.06-0.81 in the long-run. Kovanen (2011) estimated pass-through in Ghana and found incomplete coefficients both in the short- and long-run as 0.06-0.31 and 0.64-1.19, respectively. The observed sluggishness and incomplete pass-through in developing countries were attributed mainly to a non-competitive financial system and inelasticity of demand for banking products.

4.6 Implications of Inexact Pass-Through for Monetary Policy

Under the NCM, monetary policy is conducted with the notion that pass-through is complete. Hence, the momentum of a change in policy rate would be maintained in the retail/market rates until it impacts on real economic variables. Inexactness in this momentum during transmission may result to a missed target. Thus, the degree of interest rate pass-through has important implications for the economy. While excessive pass-through would expose the economy to increased volatility, limited pass-through can be seen to shield the economy from volatile interest rates and interest rate shocks (Kwapil and Scharler, 2006; Hoffman and Mizen, 2004). In the case of limited pass-through, if banks protect their long-standing clients from frequent interest changes, the effects of financial market shocks on economic agents are moderated.

However, in situations where loan interest rates are variable and fully based on the policy rate, volatilities (or changes) in policy are fully reflected in the lending rate so that pass-through is complete. According to Kwapil and Scharler (*op.cit*) this argument may be more applicable in bank-based economics vis-à-vis market-based ones. This is because in bank-based economies, the retail interest rate (which may have some elements of prime customers' protection) would bear a substantially high weight in the economy while in market-based economy money (and capital) market returns would be considered more important. However, inexact pass-through diminishes the power of monetary policy since the effects of policy-induced adjustments in the base rate on the real economy are either muted (for incomplete) or exaggerated (for overshoot) (Kwapil and Scharler, *op.cit*; Hoffman and Mizen, *op.cit*; Ozdemir, 2009; Wang and Lee, 2009). Hence, inexact pass-through poses a significant threat to the determinacy of optimal policy actions.

Any monetary policy (or policy rule) which seeks to use interest rates to influence level of demand, rate of inflation or asset prices would face this problem of indeterminacy. For instance, under the Taylor rule, given a CB's reaction function and the associated Taylor principle, limited pass-through or inadequate knowledge of it may lead the CB to adjust base rate incorrectly.[31] The Taylor rule is built on the assumption that the pass-through from policy to retail rates is complete. If this assumption is violated (and pass-through is for instance incomplete) then the CB may have to increase the policy rate by even more than proportionately to have any effect on the real economy (Kwapil and Scharler, *op.cit*). There is, however, the risk that this more than proportionate change may lead to indeterminate equilibrium and economic instability. For instance, an excessive tighten of monetary conditions aimed at combating inflation may put pressure on the real sector thereby exacerbating recession, unemployment and inflation volatility (Liu et al., 2008). Hence, by altering the Taylor principle, incomplete pass-through affects the trade-off between inflation and output in an economy. This may derail the stabilising role of monetary policy while making it to be more accommodating to inflation (Kwapil and Scharler, *op.cit*). The converse can also be argued for pass-through overshoot. In this case, an inadequate tightening of policy may end up not having the desired effect on AD and inflation thus rendering the policy ineffective. Further tightening in an attempt to correct this may exert undue pressure on the economy tipping it into recession.

Rather than assume complete pass-through, adequate knowledge of it is essential for an NCM-type monetary policy to effectively combat inflation. If pass-through is known to be complete for any particular economy, then *ceteris paribus*, the NCM may

[31] The Taylor principle states policy rate should rise by more than one-to-one in response to inflationary pressure. In other words, following a one percentage point rise in inflation rate CBs should raise the short-term nominal interest rate by more than one percentage point in order to ensure a stable equilibrium.

have the desired effect depending also on other features of that economy. Inexact pass-through (or the inadequate knowledge of it) does not only affect the size of impact but may also affect the relationship between inflation and economic growth; hence, the cost of disinflation. Given that under the NCM the CB's primary objective is price-stability (and output growth is considered secondary), policy would always focus on the expected effect on inflation with less consideration for the real economy. When pass-through is limited, the CB may change the policy rate more than proportionate to the Taylor principle, thereby reducing output by more than commensurate with inflation. If on the other hand pass-through is excessive, policy rate may be changed in line with the Taylor principle but the overshoot means that output would still fall by more than is necessary. It is important to note that the relationship between output and inflation is nonlinear (though the NCM representations suggests linearity) so that the cost of disinflation would depend on the current level of economic growth and amount by which it is changed. Sizeable pressures on output which can emanate from inexact pass-through, given the aforementioned nonlinearity, would increase the cost of disinflation.

The existence of asymmetry in the pass-through process also would have implication for policy. As noted earlier, asymmetry may be in terms of product or policy stance. In the presence of asymmetry, CBs may need to change policy rate by a different amount depending on whether policy is easing or tightening. This implies that the Taylor principle would again be violated in one or both policy stances. Besides, considering that some economies may be savings-driven while others are credit-driven, product asymmetry may lead to wrong outcomes of policy targets. Assuming that the tenets of the NCM with regards to inflation being an AD phenomenon is correct, then the ability of a CB to control inflation would be hinged on its influence on consumption and investment decisions of economic agents. In credit-driven economies, it would be the case that a large proportion of agents maintain bank credit either for consumption or investment purposes so that changes in lending rates affect AD significantly. In savings-led economies, economic agents (especially households) consume from savings rather than from credits. Consequently, changes in deposit rate would determine inter-temporal consumption behaviour and AD. Thus, widening of the loan-deposit rate spread, following a change in base rate, might make policy more effective if the economy is relatively credit-driven but would worsen outcome if the economy was savings-driven. Narrowing of the spread may be more relevant for savings-led economies.

4.7 Conclusion

The effectiveness of monetary policy under the NCM would at the first instance depend on the degree of interest rate pass-through. This subsequently depends on liquidity and elasticities as well as competition within the banking sector and that between the sector and entire financial industry. Inexact pass-through (and adequate knowledge of it) automatically undermines the effectiveness of monetary policy. In many developing countries with weak and rudimentary financial market, pass-through would be far from complete and may even be asymmetric. Thus, in these countries, monetary policy under the NCM may not only be ineffective and complicated but may also result to an increasing cost of disinflation. Again, product asymmetry may be important depending on whether the economy is credit- or savings-driven. For a credit-based economy, asymmetry which widens the loan-deposit rate spread, following monetary policy tightening, would make policy more effective while for a savings-led economy policy would be effective if the spread is narrowed.

5 INTEREST RATE CHANNEL OF MONETARY POLICY: ANALYSIS OF THE PASS-THROUGH IN NIGERIA

5.1 Introduction

The transmission of monetary policy to the final objective occurs in different stages and over various channels. Key among these channels is the interest rate channel which "transmits changes in policy rates to [retail] rates via the money markets" (Gigineishvili, 2011, p.4). Hence, the interest rate channel can be broken down with respect to the link between policy and market (or interbank) rate, on the one hand and between market and retail rates on the other hand. At each stage, the pass-through in these interest rates is usually assumed to be complete; thus, implying that 100 per cent of the changes in policy rate is reflected in the response rates. Effectiveness of the interest rate channel requires that pass-through is not only complete but relatively fast, as a quicker response rate reduces the overall response lag of monetary policy. This channel is believed to be dominant in countries with advanced and sophisticated financial market vis-à-vis those with underdeveloped markets (Gigineishvili, *op.cit*). Thus, for developing countries with weak and rudimentary financial markets monetary policy, via this channel, may be less effective (Weeks, 2009; 2010).

In Nigeria, the interbank market is considered focal in the monetary policy process. The CBN regularly monitors the interest rates in this market to surmise developments in the retail market and the economy. Hence, efforts are continually made by the CBN to anchor the interbank rate to the policy rate. For instance, the reform of the monetary policy framework in December 2006 was undertaken in this respect. An offshoot of this reform was the creation of lending and deposit facilities at the CBN which bounded the policy rate from above and below, respectively, with a view to making the interbank market more attractive to banks. A necessary condition for monetary policy effectiveness, therefore, is an adequate link between policy and retail rates via the interbank. The dynamics of pass-through in the short- and long-run and the associated response lags also have implications for monetary policy effectiveness.

Under the interest rate channel, the pass-through from policy rate may differ over time, between rates, markets, maturities and depend on the direction of the policy change.

The size and speed of pass-through may vary inter-temporally so that at some points in time, monetary policy may be more effective than at others. Hence, the purpose of this chapter is to investigate the pattern of pass-through in Nigeria starting from policy-to-market (*cum* policy-to-retail) and subsequently market-to-retail rates. The methodologies adopted include the autoregressive distrusted lag models (ARDL) and the state-space analysis which allowed the concurrent determination of the size, speed, and time-path of the interest rate pass-through in the short- and long-run. The ARDL is used, in line with the standard literature, to investigate the linearity and nonlinearity in the pass-through process both in the short- and the long-run. However, unlike other studies in the literature which rely solely on structural dummies to examine the possible changes in pass-through over time, this study uses the state-space modelling approach to estimate the course of pass-through over the sample period. Empirical investigation is conducted to capture the practicalities of monetary policy in Nigeria using monthly data, which at the longest covered the period 1985:M1 to 2011:M1 for all interest rates except for the interbank rate which spanned the period 1996:M1-2011:M1. Eleven interest rates variables are mostly utilised, including the policy rate, the interbank rate, two lending rates, and seven different deposit rates. A proxy to capture financial (under)development is also included in the analysis.

In general, the results suggest that the link between interbank and retail rates is weak (given the low pass-through) while pass-through from policy rate is higher, thereby supporting the findings of Sanders and Kleimeier (2004). Short-run pass-through is also found to be more sluggish than its long-run counterpart, which was consistent with the findings of Mojon (2000), de Bondt (2002, 2005) and Gropp *et al.* (2007) among others. In addition, we find downward structural shifts in the long-run pass-through and a persistent decline in the short-run pass-through over time. In fact, the introduction of the interbank market, in 1996, heralded a decline in pass-through thereby suggesting that transmission of monetary policy had been debilitated. The declining size of pass-through indicated reducing potency of policy both in size and in response lag (determined by the means adjustment lag) and can be attributable to financial underdevelopment and the considerable market power of commercial banks. Significant market power can be deduced from the asymmetry found between lending and deposit rate, and between positive and negative changes. The results show that not only is pass-through higher for lending rates vis-à-vis deposit rates, they also exhibit positive long-run asymmetry in lending while deposit rates respond symmetrically. Thus, banks are more willing to raise lending rates following monetary policy tightening and less willing to lower them when rates fall thereby ensuring non-reducible profit mark-up.

These findings may imply ineffectiveness in the conduct of monetary policy given that the CBN attempts to influence retail rates via the interbank market in the short-term. Nonetheless, while the inability of the interbank to anchor retail rates may weaken the transmission mechanism, the considerable adverse effects of the market power of commercial banks in price determination may deteriorate it further. This may be reflective of the inadvertent exclusion of non-bank private sector from the money market and the dearth of viable securities and instruments in the market. In essence, given the weak market-to-retail (vis-à-vis policy-to-retail) pass-through, the CBN may need to de-emphasise the focus on the interbank market as it is more-or-less redundant in the monetary policy transmission process and focus directly on the retail rates. There is also the need to reduce market power by ensuring enhanced depth of financial markets (so that all players and agents have considerable access to the market) and that there is a wide array of instruments and securities to choose from.

The chapter is divided into six sections. Following this introduction, section two reviews the empirical literature with respect to issues, methodologies and findings. Data and stylised facts about the relevant interest rates, in Nigeria, are presented in section three. Section four specifies the empirical model to be analysed and expounds our methodology as well as econometric framework. In section five, empirical analysis of the results are conducted, presented and discussed while section six contains the conclusion.

5.2 Empirical Literature

Monetary policy changes can be transmitted to retail rate over two phases: first is the policy-to-market; then the market-to-retail pass-through (de Bondt, 2005). Investigations of the patterns of interest pass-through in the literature have tended to concentrate on either one or both of these phases. Hannan and Berger (1991), Hoffman and Mizen (2004), Biefang-Frisancho Mariscal and Howells (2002, 2010), Aggelis (2005), Amarasekara (2009), Greenwood- Nimmo *et al.* (2010), and

Aziakpono and Wilson (2010) examined pass-through directly from policy rate to money market and retail rates of various maturities. However, de Bondt (2002), Bredin *et al*. (2002), Espinosa-Vega and Rebucci (2003), Kwapil and Scharler (2006), Sørensen and Werner (2006), Liu *et al*. (2008), and Wang and Lee (2009) focused on the pass-through from money market to retail rate. Borio and Fritz (1995), Sander and Kleimeier (2004), and de Bondt (2005) estimated and compared the pass-through in both phases of the process. While many of these studies documented enormous evidences of interest rate stickiness, the findings nonetheless indicated considerable heterogeneity with regards to maturity structure, market segment, country etc. Comparing both phases in the Euro area, Sander and Kleimeier (*op.cit*) found that pass-through from policy rate was generally higher than that from market rates. For Sri Lanka, Amarasekara (*op.cit*) documented a fast and near complete pass-through from policy rate to money market rate. A similar result was derived for the Euro area by de Bondt (2005) who found significantly high (in some cases complete) pass-through from policy to retail rates via short-term money market rate while the pass-through from long-term money market rate was somewhat lower. This, he stated, indicated that monetary policy fully controls the short-end of the yield curve

A comparable study on interest rates of various maturities in New Zealand was conducted by Liu *et al*. (2008) in which they found faster and higher degree of pass-through to short-term rates than for long-term rates. In contrast, Kwapil and Scharler (2006) found short-term sluggishness in deposit rates across the Euro area vis-à-vis long-term rates. This result has implications for monetary policy. Monetary policy is usually designed to affects both ends of the market; it is nonetheless assumed to impact quickly on the short-end of the market while it affects the long-end more slowly. Whereas household decisions are expected to be influenced by instruments of short-term maturities investments are largely determined by long-term rates. Biefang-Frisancho Mariscal and Howells (2002) argued that for monetary policy to be effective it should affect the relative prices of money, loan and bonds which eventually influence savings, consumption and investment. They found that increases in the official rate widened the spread between short-term lending and bonds rates but had no significant effect on the spread between bond and deposit rate.

The speed and size of pass-through may vary between the short-run and the long-run. The lag in the impact of policy changes is a function of the rate at which these changes are conveyed to the money and financial markets. Monetary policy would be more effective if it had huge and immediate effect on the retail interest rates. More importantly even if pass-through is not complete in the short-run (i.e. immediate pass-through), effectiveness requires that it be fast and complete in the long-run. Empirical studies in the literature provide diverse results on the rate of pass-through in the short- and long-run. For instance, while Mojon (2000), Gropp *et al*. (2007) and Aggelis (2005) found short-run stickiness, Sander and Kleimeier (2004) using both the monetary policy and the cost of funds approach documented long-run rigidity vis-à-vis the short-run though pass-through was limited in both horizons. Other studies including Biefang-Frisancho Mariscal and Howells (2002), de Bondt (2002, 2005), Aggelis (2005), Ozdemir (2009), Greenwood-Nimmo *et al*. (2010), and Aziakpono and Wilson (2010) are almost unanimous in their finding of higher pass-through in the long-run compared to the short-run. According to Kwapil and Scharler (2006), this implies "that the adjustment of retail rates to changes in [base] rate does need some time and does not occur instantaneously" (p.30). This notwithstanding, long-run pass-through was scarcely found to be complete in these studies suggesting that banks may indeed be insulating their clients from interest rate volatility.

Whether in the short- or long-run, monetary policy may have different effects on the cost of borrowing vis-à-vis money's own rate so that pass-through would differ in retail market between deposit and lending rates. Biefang-Frisancho Mariscal and Howells (2002) studied the ability of policy to alter relative prices in the form of loan-deposit spread. They found that following an interest rate hike, the spread between lending and deposit rate widened indicating that lending rate responded more than deposit rate. This is comparable to the findings of Hoffman and Mizen (2004), de Bondt (2005), Sørensen and Werner (2006), Gropp *et al*. (2007), Ozdemir (2009), and Aziakpono and Wilson (2010) who also found evidence of higher pass-through to lending rate compared to deposit rate. This may be indicative of market power as banks are able to increase their profit by raising the mark-up of loan-deposit rate. The contrast may be the case in Malaysia as Zulkhibri (2012) found higher stickiness of the lending rate vis-à-vis deposit rate, though pass-through was limited for all retail rates.

A strand of the theoretical literature suggested that in order not to lose their patronage, banks would insulate elite customers from interest volatility while passing the cost to ordinary and lower-grade clients. Yet another bloc argued that, owing to risk perception, banks may prefer not to raise lending rate so as to prevent the problems of adverse selection and moral hazard. Empirical evidence from Bredin *et al*. (2000) and Amarasekara (2009) indicated that for Ireland and Sri Lanka, respectively, pass-through was higher for prime lending rates than for all other retail rates. Similarly, Kwapil and Scharler (2006) showed that for the Euro-area the lending rate to businesses was adjusted more than the interest rate on household loans. Thus, banks may actually increase their expected earnings by raising the interest rate on less risky and better secured loans to credit worthy customers while rationing loans to households and non-premium customers.

Monetary policy may have different effects on the retail rates depending on whether the policy rate was adjusted upward (contractionary) or downward (expansionary). Asymmetric response had been studied in the literature in terms of size of adjustment (Greenwood-Nimmo *et al*., 2010), probability of adjustment (Hannan and Berger, 1991) and speed of adjustment (Borio and Fritz, 1995; Hoffman and Mizen, 2004; Espinosa-Vega and Rebucci, 2003; Sander and Kleimeier, 2004; and Liu *et al*., 2008). Expectedly banks would be more likely to raise lending rate faster than deposit rates following monetary tightening and behave conversely during monetary ease; thus, widening the loan-deposit rate spread. While this is intuitively plausible, studies like Borio and Fritz (1995), Espinosa-Vega and Rebucci (2003), Liu *et al*. (2008), Amarasekara (2009), and Ozdemir (2009) found no statistically significant evidence of asymmetry in the speed of adjustment in retail rates following a change in the base rate. Comparing the USA with nine Asian countries, Wang and Lee (2009), however, reported asymmetry in eight countries including the USA.

Other studies that found asymmetry in speed of adjustment included Hoffman and Mizen (2004) who found evidence that pass-through is faster for retail rates when the spread with policy rate is wide but sluggish when the spread is small. In a study of South Africa, Aziakpono and Wilson (2010) found asymmetry in the form of upward rigidity in both lending and deposit rates. According to them, this showed increased competition and insulation of customers to changes in lending rates but simultaneously indicated collusive behaviour in the setting of deposit rates. Zulkhibri (2012) also documented significant asymmetry as they found that all retail rates adjust more sluggishly during monetary tightening than during ease in Malaysia, thereby leaving the loan-deposit spread unaltered. However, Biefang-Frisancho Mariscal and Howells (2010) provided evidence to the contrary showing that for the UK, monetary tightening narrows the spread while it is widened by monetary ease. This provides confirmation that while retail rates may be rigid, the extent and/or direction of stickiness would differ between deposit and lending rates. For instance, Hannan and Berger (1991) found that deposit rates were upwardly rigid during monetary tightening. In addition to upward rigidity in deposit rates, Sander and Kleimeier (2004), Gropp *et al*. (2007), and Wang and Lee (2009) found that lending rate were sticky downward.

While the preceding studies investigated asymmetry in the long-run adjustment of various response rates to the base rate, Greenwood-Nimmo *et al*. (2010) studied the size of asymmetric response both in the short- and long-run. They found that loan and bonds rates of long-maturities are downwardly rigid in the short-run (positive asymmetry) but upwardly rigid in the long-run (negative asymmetry).[32] This indicated that following monetary tightening banks would increase lending rate more than they would do for monetary ease in the short-run but in the long-run they may be more willing to retain their "well-informed and foot-loose" customers. Another kind of asymmetry found in the literature was institutional, according to Zulkhibri (2012), who found that finance companies adjusted deposit rates faster than commercial banks following changes in the base rate. This may imply, firstly, that commercial banks have more market power than finance companies and, secondly, may be more willing to shield their patrons from interest rate volatility.

The patterns of pass-through are affected by various exogenous factors as discussed in the preceding chapter. Besides market power, structural and regime changes in the conduct of monetary policy can also have considerable effect on the sign and speed of

[32] Greenwood-Nimmo *et al*. (2009) defined positive asymmetry as a situation where interest rate responded more to increases in policy rate than to decreases while negative asymmetry occurred when the response to monetary ease exceeded that of monetary tightening. They interpreted their finding of positive short-run asymmetry as up-holding "the view that monetary policy is like a string that can be pulled but not pushed" while the negative long-run asymmetry was reflective of financial innovations as well as lower inflation expectation due to globalisation and financial liberalisation (p.3).

pass-through. In Ireland, New Zealand and the Euro area for instance, Bredin *et al*. (2002), Liu *et al*. (2008), and Sander and Kleimeier (2004), respectively, found that structural changes had a significant positive effect on the pass-through process. Correspondingly, de Bondt (2002, 2005) found that the speed of pass-through had improved significantly since the introduction of the Euro. Espinosa-Vega and Rebucci (2003), however, found that structural factors like changes in monetary policy regime had no effect on the pass-through in Chile while factors like the Asian crisis had a significant negative impact. Similarly, Gropp *et al*. (2007) provided empirical evidence suggesting that the level of bank soundness, credit risk and interest rate risk limits pass-through considerably. This can be construed as supporting the findings of Espinosa-Vega and Rebucci (*op.cit*) that financial crisis increases interest rate rigidity. Biefang-Frisancho Mariscal and Howells (2010) analysed the impact of the 2008 financial crisis on the pass-through in the UK. They found that although the crisis failed to change the spread for most retail rates, pass-through was higher for deposit rates than for loan rates after the crisis.

Financial crisis may affect pass-through directly or indirectly through the business cycle. Fluctuations in the business cycle may determine how banks adjust their prices during economic boom vis-à-vis recession. Conducting a cross-country analysis, Borio and Fritz (1995) could, however, not find evidence to support this hypothesis. Instead, the effect of other exogenous factors such as market power, competition and financial innovation were found to be substantial (Gropp *et al*., 2007; Borio and Fritz, *op.cit*). Similarly, Hannan and Berger (1991) documented evidence which indicated that interest rates would be more rigid in markets characterised by higher degrees of concentration. Imperfect competition and a high degree of market concentration may be typified by information asymmetry which may subsequently lead to some measure of interest rate volatility. Empirical evidence from Wang and Lee (2009) indicated that such volatility (from information asymmetry) diminished pass-through.

Country specific factors and heterogeneity are important in the determining the size and speed of pass-through and the effectiveness of monetary policy. All the empirical literature discussed above examined pass-through for different countries (or regions) and in some cases conducted cross-country analyses. Investigating the pass-through process in the USA and Germany, Greenwood-Nimmo *et al*. (2010) noted that pass-through may depend on whether a country is market-based (like the USA) or bank-based (like Germany and the Euro area). The higher pass-through usually found in the USA vis-à-vis the Euro area and other countries may be attributed to this kind of distinction. Wang and Lee (2009) examined interest rate adjustments in the USA and nine Asian countries and found complete pass-through only for the USA. Conversely, Espinosa-Vega and Rebucci (2003) found incomplete pass-through for the countries they surveyed (including the USA) but faster adjustment in the USA and Chile than the other countries. In a cross-country comparative study, Borio and Fritz (1995) observed that the size and speed of pass-through varies considerably across the surveyed countries. While it was full and immediate in the short- and long-run for the UK and the Netherlands it was not for others. Sørensen and Werner (2006), Kwapil and Scharler (2006) equally documented a high degree of heterogeneity in the pattern of pass-through among Euro area countries. Thus, Aggelis (2005) concluded that stickiness of pass-through depends on the institutional idiosyncrasies of individual countries.

The heterogeneity of empirical findings is attributable to the kind of data utilised, the sample period or the methodology adopted. In order to derive estimates of the speed and size of pass-through as well as make comparison between the short- and long-run, most of the studies conducted cointegration and error correction analyses in different forms either using single equations or vector approaches. Generally, a single equation based technique is attractive given the advantage of economically interpretable coefficients while a vector based method provides super-consistent estimates and is desirable since it does not impose inappropriate cointegrating relations (de Bondt, 2005). Popular methodologies in the literature included Johansen's vector error correction method (VECM) and ARDL. The estimated models also differed in the degree of linearity assumed and the type of asymmetry considered. For instance, in order to model the *size* of short- and long-run asymmetry coherently, Greenwood-Nimmo *et al*. (2010) estimated a nonlinear-ARDL model which decomposed policy adjustments into positive and negative changes. However, other models of nonlinear-ARDL in the literature captured asymmetry in the *speed* of adjustment via asymmetric mean adjustment lag which decomposes the error correction mechanism according to positive or negative policy change.

A fairly common trend in these empirical studies is the observation that pass-through may vary inter-temporally due to a collection of factors. A number of these studies including de Bondt (2002), Biefang-Frisancho Mariscal and Howells (2002) and Greenwood-Nimmo *et al*. (2010) estimated the coefficient over the entire sample as well as shorter sample periods with a view to comparing their outcomes. Others like Bredin *et al*. (2002), Hoffman and Mizen, 2004), Liu *et al*. (2008) identified possible periods of structural breaks and included various dummies to determine the effects on the slope and intercept of the models. However, as Sander and Kleimeier (2004) noted, the documented structural breaks and/or changes in the coefficients may not coincide with the exogenously imposed break-points and may occur much earlier or much later. They therefore endogenously determined the appropriateness of structural break via a rolling search of its occurrence and timing.[33]

These studies point to the fact that the estimated parameter may be time-varying so that the eventual coefficient estimated either for the entire model or for the sub-periods may be misleading. Though, Sander and Kleimeier (2004) attempted an endogenous search of break-points, their efforts still required exogenous impositions of potential breaks used in the Chow-test. A modelling framework which endogenously determines the time path of the parameter over the entire sample would be a superior and more appropriate alternative. Accordingly, this chapter attempts to fill this gap. Thus, besides an ARDL approach, nonlinearity in pass-through is determined via a state-space modelling framework which allows the estimation of time-varying parameters. Hence, rather than compare coefficients over two or three sub-samples, comparison is made over the entire sample (relating estimated parameters to possible structural factors).

5.3 Data and Stylised Considerations

5.3.1 Data

The dataset used in this chapter is of monthly frequency. At the longest, the data covered the 1985:M1-2011:M1 period except for the interbank interest rate which spanned 1996:M1-2011:M1. This is because the interbank market officially began in Nigeria circa mid-1990s. The entire dataset was sourced directly from the CBN.

[33] To estimate breaks they conducted *supremum F*-test using Chow-tests for various exogenously identified potential break-points. The *sup-F* is the largest *F*-statistic from these Chow-tests.

Twelve different interest rate variables, predominantly of short-term nature, were included in the sample. These comprise various deposit rates (savings, 7-day, 1-month, 3-month, 6-month, 12-month, and over 12-month), lending rates (prime and maximum), interbank rate and official rates (Treasury Bills and monetary policy rates).

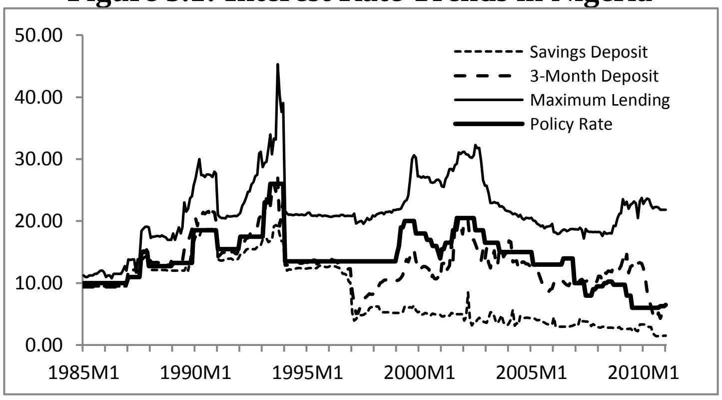
The monetary policy rate is here regarded as base rate for the analysis. Though the use of frequently changing "official rates" is widespread in the literature, the policy rate is preferred as the base rate in this chapter. This is informed by our underlying objective of deducing market reaction to changes in the CBN policy stance – following intermittent base rate adjustments. Furthermore, this is supported by the arguments of Borio and Fritz (1995) who pointed out that "revisions in infrequently changed rates on official standing facilities generally speed up the adjustment of loan rates" (p.7). Under oligopolistic market conditions or money market volatility, they opined that the policy rate becomes a better indicator of policy objective "as it reflects changes in...general market conditions rather than discretionary decisions...of individual institutions" (p.9).

All the interest rates analysed were reported as monthly averages. The base rate is the minimum rediscount rate (MRR) before December 2006 and monetary policy rate (MPR) thereafter. Both the (erstwhile) MRR and MPR represented, *albeit* to some extent, the rate at which the CBN provides reserves to banks. Hence, for the purpose of this study the CBN interest rate is generically referred to as the MPR. Wherever used, the Treasury Bills rate (TBR) is the average monthly rate on 91-day T-Bills of the Nigerian government. The interbank rate (IBR) is the overnight call rate at the Nigeria interbank offer (NIBOR) market. Retail rates are those obtainable from commercial banks. Deposit rates (DR) consist of the savings (SDR) and term-deposit (TDR) interest rates as shown above. Lending rates (LR) constitute maximum lending rate (MLR) and prime lending rate (PLR) – charged, respectively, to ordinary and high net-worth customers. Over the years, the number of commercial banks in Nigeria had fluctuated reaching 90 in 2001 before dropping to 24 in 2007 (due to the 2005 consolidation exercise). The universal banking system introduced in 2001 saw transformation of all the merchant banks to commercial banks. The deposit and lending rates thus used were the weighted average rate on existing and licensed commercial banks for the various years.

5.3.2 Stylised Analysis

Prior to the mid-1980s the interest rates in Nigeria were administratively fixed. The CBN determined both the MRR and retail rates. Then, the spreads between these rates were kept as low as possible. Following the reforms and financial liberalisation of the mid-1980s, retail rates were decoupled from official rates. Both MRR and the retail rates ascended continuously, *albeit* at different speeds, for about a decade. Theoretically, it is expected that, in a free market condition, MPR would lie between LR and DR. This would allow the CB to be the "lender of last resort" rather than "lender of first resort" to commercial banks. As shown in figure 5.1, this pattern was, however, indiscernible in the first decade of financial liberalisation as TDR was between MPR and MLR in a number of cases during this period. Additional reforms and the introduction of the interbank market in 1996 heralded further decoupling so that MPR began to look more like a penal rate as desired. The trends in figure 5.1 show that while SDR declined in the late-1990s, MLR initially rose and maintained a widened spread for about five years but declined gradually, thereafter. Though usually high and around 20 per cent, MLR fluctuate more sympathetically with MPR than SDR but less-so vis-à-vis TDR. Hence, savings-deposit may be less elastic to policy changes than term-deposits. This is intuitive as customers maintain savings account primarily as a safeguard mechanism (given the flexible drawdown) while term-deposits are kept to earn interest on funds not required immediately.

Figure 5.1: Interest Rate Trends in Nigeria

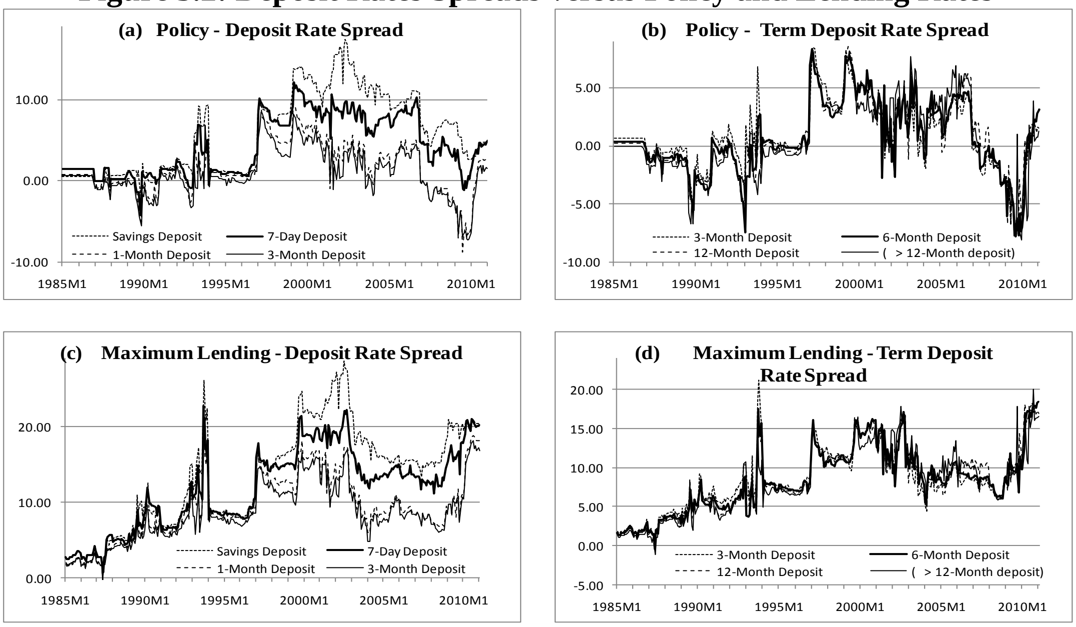


Data Source: CBN

With the MPR reform in 2006, the inter-relationship changed somewhat. TDR thence surpassed MPR while the MLR-MPR spread widened. This may be connected to the deposit and lending facilities introduced during the reform. With these facilities banks with excess reserves at the CBN receive interest payment (equivalent to a mark-down of the MPR) while those with liquidity deficit are charged a mark-up on the MPR. Though the band was intended to promote interbank trading, it nonetheless seemed to encourage banks with excess reserves to seek risk-free returns from the CBN; thus, creating liquidity dearth at the interbank market. Concurrently, banks with reserve shortages would raise DR higher in order to attract deposits.

Biefang-Frisancho Mariscal and Howells (2002) argued that monetary policy effectiveness depends on its ability to influence the LR-DR spread. Nonetheless, these spreads are continually changing; fluctuations that may not always be attributable to monetary policy. Figures 5.2 and 5.3 depict the spreads between various interest rates in the dataset. Panels (*a*) and (*b*) of figure 5.2 show the MPR-DR spreads. Prior the mid-1990s, the MPR-SDR spread moved almost in tandem with those of other deposit rates. Thenceforth, as shown in panel (*a*), these trends were uncoupled and the size of spread tended to diminish with maturity; MPR-SDR spread being highest. Nonetheless, apart from the 7-day maturity, most TDRs showed fairly similar attributes regarding the trend and size of their spread with the policy rate.

Figure 5.2: Deposit Rates Spreads versus Policy and Lending Rates



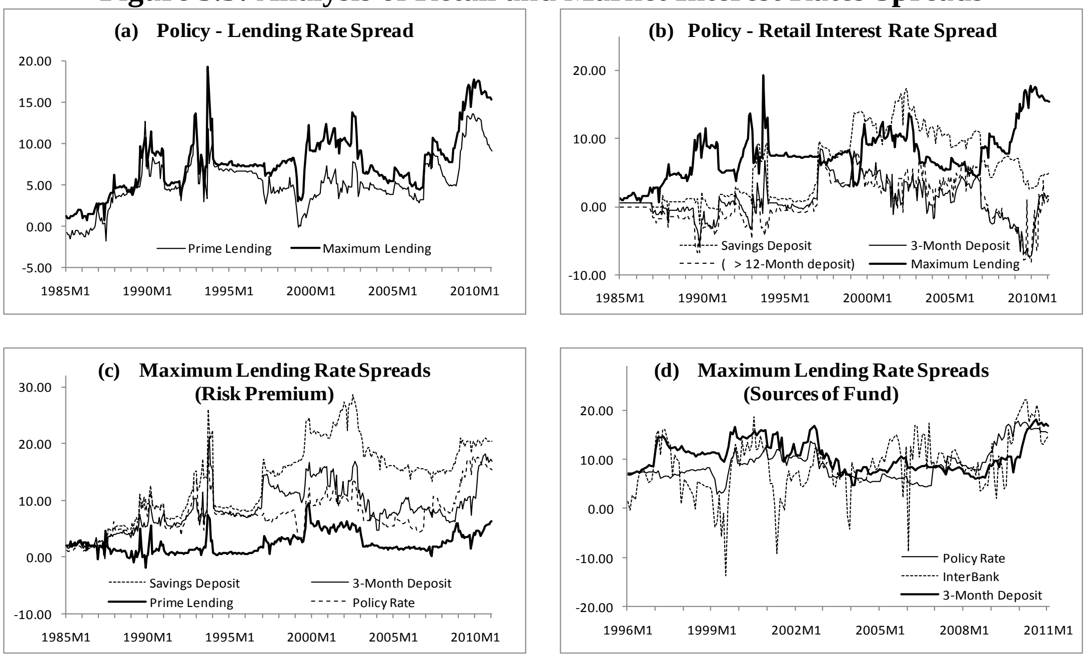
Data Source: CBN

Panels (*c*) and (*d*) of figure 5.2 present the MLR-DR spreads. These are generally characterised by an upward long-run trend. As in the previous case, the traverses of MLR-SDR and MLR-TDR spreads were comparable before mid-1990s but divergent afterwards. These were nonetheless high – with MLR-SDR spread reaching 28.69

percentage points in 2002 – and were usually about 10 percentage points above the MPR-DR spread. The widening of the LR-DR spread is indicative of increasing market power of the commercial banks that are able to increase their profitability in the process of financial intermediation.

Comparing the mark-up (mark-down) over MPR, MLR-MPR spread was larger vis-à-vis other rates (see figure 5.3). In addition to denoting commercial banks' market power, it may also be an indication of their risk perception. The MLR-DR and MLR-PLR spreads can each represent risk perception. *Ceteris paribus*, banks would raise the LR-DR spread in order to accommodate perceived risk. However, a better measure of risk perception may be the MLR-PLR spread which shows the difference between rates on loans that are presumably safe and those that are risky. MLR is charged on the riskiest loans while PLR applies to the least risky credits. In Nigeria, the LR-DR spread considerably surpasses the MLR-PLR margin indicating that profitability rather than risk perception is the main driver of commercial bank price-setting behaviour.

Figure 5.3: Analysis of Retail and Market Interest Rates Spreads



Data Source: CBN

Banks can usually source liquidity from depositors, the CB or the interbank market while lending same to borrowers for a margin. The interbank market being the most competitive source, IBR oscillates with larger amplitudes than MPR and DR (see panel (*d*) above). Consequently, the MLR-IBR spread fluctuated more than other MLR spreads and was on average lower than the MLR-MPR margin. This implies larger uncertainty in the profitability of funds from the interbank market which captures market conditions and the true costs of funds as allocated by the market.

Monetary policy is designed to influence inflation and output via its influence on market and retail rates. The first point of impact of monetary policy is expected to be the money market before it is transmitted to the retail rates. This drives the implementation of monetary policy in Nigeria where MPR adjustments are expected to impact initially on IBR and the retail rates thereafter. The interbank represents an important reference market in the Nigerian policy arena and money market activities are conducted along this line. The first indication of the effectiveness of monetary policy is the analysis of the correlation between policy rate, interbank rate and the retail rates. Table 5.1 presents the dynamic correlation of these rates over a six-period horizon of lags and leads. This is performed to capture the effects of both forward and backward expectations.

The first half of the table shows the dynamic correlation of policy rate with the other rates in the dataset. Importantly, all the correlation coefficients are positively signed as expected. High contemporaneous correlation of 0.94 observed between MPR and TBR reflects the official nature of both rates. With the exception of SDR with 0.44, the contemporaneous coefficients of other rates exceeded 0.60. Average-LR, at 0.75, displayed higher correlation than IBR (0.67), average-DR (0.68), and average-TDR (0.72).[34] The low MPR-IBR correlation is attributable to the large fluctuations in the interbank market. This may provide justification for Borio and Fritz (1995) arguments that policy rate may impact more directly on retail rates when markets are volatile.

More interestingly however, the dynamic correlations showed that over comparable distances the coefficients are on average larger for leads than lags except for LR. This may indicate that expected changes have more impact than past changes and implies that banks look more with foresight than hindsight when adjusting DR but conversely for LR. Nonetheless, contemporaneous correlations are generally higher than inter-temporal ones, suggesting that actual policy changes have more impact than expected changes. This is at variance with Hoffman and Mizen (2004) who suggested that expected changes are a more significant driver of pass-through than actual changes.

[34] SDR is included in the computation of average-DR but excluded from average-TDR.

Table 5.1: Dynamic Correlation of Policy Rate and the Interbank Rate with other Interest Rates (1985:M1-2011:M1)

	Correlation of Policy Rate at time (*t*+*k*) with other Interest Rate												
	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6
Policy Rate	0.78	0.82	0.86	0.90	0.94	0.97	1.00	0.97	0.93	0.90	0.86	0.82	0.78
Treasury Bill	0.74	0.78	0.81	0.85	0.88	0.91	0.94	0.92	0.90	0.88	0.86	0.83	0.80
Interbank	0.52	0.55	0.59	0.61	0.64	0.66	0.67	0.68	0.69	0.69	0.69	0.68	0.67
Deposit Rate	**0.52**	**0.55**	**0.58**	**0.61**	**0.64**	**0.66**	**0.68**	**0.66**	**0.65**	**0.62**	**0.59**	**0.56**	**0.53**
Savings	0.31	0.34	0.36	0.38	0.40	0.42	0.44	0.43	0.43	0.42	0.41	0.40	0.39
7-Day	0.51	0.54	0.56	0.59	0.61	0.63	0.65	0.63	0.62	0.60	0.58	0.56	0.54
1-Month	0.54	0.57	0.61	0.64	0.67	0.69	0.70	0.68	0.66	0.62	0.59	0.55	0.50
3-Month	0.56	0.60	0.64	0.67	0.70	0.73	0.75	0.73	0.71	0.70	0.66	0.62	0.58
6-Month	0.56	0.60	0.63	0.67	0.70	0.73	0.75	0.74	0.72	0.70	0.66	0.63	0.59
12-Month	0.57	0.61	0.64	0.68	0.71	0.73	0.75	0.74	0.72	0.69	0.66	0.63	0.59
> 12-Month	0.55	0.59	0.62	0.65	0.68	0.70	0.72	0.69	0.67	0.63	0.60	0.57	0.53
Term-Deposits	**0.55**	**0.58**	**0.62**	**0.65**	**0.68**	**0.70**	**0.72**	**0.70**	**0.68**	**0.66**	**0.63**	**0.59**	**0.55**
Lending Rate	**0.64**	**0.67**	**0.69**	**0.71**	**0.73**	**0.74**	**0.75**	**0.72**	**0.69**	**0.66**	**0.62**	**0.59**	**0.57**
Prime	0.67	0.69	0.71	0.73	0.75	0.76	0.77	0.74	0.71	0.68	0.64	0.62	0.59
Maximum	0.61	0.64	0.67	0.69	0.71	0.72	0.73	0.70	0.67	0.64	0.59	0.57	0.55

	Correlation of Interbank Rate at time (*t*+*k*) with other Interest Rate												
	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6
Policy Rate	0.67	0.68	0.69	0.69	0.69	0.68	0.67	0.66	0.65	0.62	0.59	0.56	0.52
Treasury Bill	0.66	0.68	0.69	0.71	0.73	0.74	0.72	0.69	0.66	0.61	0.58	0.56	0.55
Interbank	0.54	0.60	0.65	0.71	0.77	0.80	1.00	0.80	0.77	0.71	0.65	0.60	0.54
Deposit Rate	**0.64**	**0.66**	**0.67**	**0.67**	**0.65**	**0.63**	**0.59**	**0.54**	**0.49**	**0.44**	**0.38**	**0.32**	**0.27**
Savings	0.36	0.35	0.36	0.37	0.35	0.33	0.33	0.29	0.26	0.23	0.18	0.16	0.13
7-Day	0.74	0.76	0.77	0.75	0.73	0.71	0.67	0.62	0.56	0.50	0.43	0.37	0.32
1-Month	0.62	0.66	0.67	0.67	0.65	0.64	0.57	0.51	0.46	0.39	0.31	0.24	0.18
3-Month	0.69	0.72	0.73	0.74	0.71	0.68	0.63	0.57	0.52	0.46	0.39	0.32	0.26
6-Month	0.69	0.71	0.72	0.73	0.71	0.69	0.65	0.60	0.54	0.50	0.44	0.37	0.30
12-Month	0.71	0.72	0.74	0.74	0.73	0.68	0.66	0.60	0.55	0.50	0.45	0.39	0.32
> 12-Month	0.67	0.71	0.71	0.70	0.70	0.66	0.66	0.57	0.53	0.49	0.43	0.39	0.36
Term-Deposits	**0.69**	**0.72**	**0.72**	**0.72**	**0.70**	**0.67**	**0.64**	**0.58**	**0.53**	**0.47**	**0.41**	**0.35**	**0.29**
Lending Rate	**0.71**	**0.71**	**0.70**	**0.69**	**0.67**	**0.64**	**0.61**	**0.58**	**0.55**	**0.51**	**0.48**	**0.44**	**0.42**
Prime	0.73	0.73	0.71	0.70	0.68	0.66	0.63	0.60	0.55	0.51	0.46	0.42	0.39
Maximum	0.69	0.68	0.68	0.67	0.66	0.63	0.59	0.57	0.54	0.51	0.49	0.47	0.45

Source: Author's computations based on data from the CBN

Note: Given that the interbank data series starts from January 1996, the correlation coefficients between the interbank rate and all other rates are computed for sample period 1996:M1-2011:M1.

In the second half of the table, the correlations of IBR with the other rates are presented. The highest contemporaneous correlation is with the TBR (0.72) while the lowest is with the SDR (0.33). Average-TDR exhibited a slightly higher correlation (0.64) than average-LR (0.61). This is congruous with the view that high IBR drives reserve deficient banks to raise DR so as to attract liquidity. Dynamic analyses show that, contrary to the first half, coefficients are higher for lags than contemporaneous and lead correlations. Thus, banks would adjust their prices based on the historical trends in the interbank market.

Over the two halves of the table, PLR showed higher correlation coefficient than the MLR. This tended to contradict the argument that banks would protect their prime customers from market volatility more than they would shield other customers. Comparing both halves of the table, contemporaneous correlations are higher in the upper half than in the lower one. This may suggest that pass-through from policy rate to retail rates are higher than that from interbank (money market) rate to retail market rates. Thus, banks probably adjust their rates following policy pronouncements more than they respond to changes in the money market. If this is so, then the money market may not be an effective conduit of monetary policy decisions to the economy.

5.4 Methodology and Econometric Framework

Monetary policy may have both short- and long-run implications for an economy.[35] Hence, it is desirable to utilize a modelling framework that provides information for both horizons. For simplicity, we begin by assuming a linear econometric relationship. From equation 4.1 in the preceding chapter, the long-run model relating retail and base rates is

$$r_t = \mu + \beta i_t + u_t \tag{5.1}$$

where u_t is the stochastic error term, r_t is the retail interest rate, i_t is the policy rate, μ represents the mark-up and β reflects the size of pass-through. A complete pass-through requires that $\beta = 1$ holds otherwise pass-through may be deemed incomplete ($\beta < 1$) or overshot ($\beta > 1$). The subscript t indicates that the variables are stochastic processes observed inter-temporally; hence, time-series. The characteristics of β are empirically investigated using both ARDL and state-space models.

5.4.1 The ARDL Model

A fundamental issue in time-series analysis relates to the concept of stationarity which supposes that the means and variances of variables are time independent. Variables that satisfy this condition are stationary and therefore integrated of order zero, $I(0)$, otherwise they are integrated of a higher order d, $I(d)$. Where $d = 1,2,\cdots$ denotes the number of times such variables need to be differenced to become stationary. Empirical

[35] This derives from the discussions in chapter one on the non-neutrality of monetary policy based on the possible impact of policy on the potential output and /or the existence of an oblique long-run Phillips curve.

evidence from the literature suggests that the interest rate variables are usually non-stationary and are $I(1)$.[36] When variables are non-stationary any analysis conducted with them would be economically meaningless. Hence, to avoid the problem of spurious regression, equation 5.1 may be re-expressed in first differences as

$$\Delta r_t = \varphi_0 + \varphi_1 \Delta i_t + e_t \tag{5.2}$$

where φ_0 and φ_1 are short-run parameters, e_t is an error term and Δ is the difference operator. While this circumvents spuriousness in the relationship it is nonetheless devoid of long-run information and captures only short-run dynamics. Analysis of the long-run relationship requires that the variables be cointegrated so that, even if they are individually integrated, their linear combination ($u_t = r_t - \mu - \beta i_t$) is stationary. Incorporating this into equation 5.2, a simple error correction model is derived as

$$\Delta r_t = \varphi_0 + \varphi_1 \Delta i_t + \alpha(r_{t-1} - \mu - \beta i_{t-1}) + \varepsilon_t \tag{5.3}$$

where α is the error correction parameter, which captures the speed of adjustment to the long-run equilibrium after a shock and satisfies $-1 < \alpha < 0$, and ε_t is an error term which is assumedly $iid(0, \sigma_\varepsilon^2)$. The error correction term is expected to be negatively signed which would indicate that the system is mean-reverting.

Hoffman and Mizen (2004) provided substantial evidence of the time dynamics on the pass-through process with respect to forward and backward expectations. This reinforces the notion that in time-series analysis, regressors may influence regressands with a lag while contemporaneous values of the regressand may correlate with its past values. Hence, lag effects may exist in the relationship between policy and retail rates. Given these consideration, the specifications may be augmented with lags so that the baseline equation thus becomes an autoregressive distributed lag (ARDL(p,q)) model as follows

$$\phi(L) r_t = \mu + \theta(L) i_t + \eta_t \tag{5.4}$$

with

$$\phi(L) = 1 - \sum_{j=1}^{p} \phi_j L^j \tag{5.5}$$

$$\theta(L) = \beta + \sum_{j=1}^{q} \theta_j L^j \tag{5.6}$$

[36] See for instance Hoffman and Mizen (2004), Sander and Kleimeier (2004) and Liu *et al.* (2008)

where $\phi(L)$ and $\theta(L)$ are lag polynomials in the regressand and regressors, respectively, and η_t is an error term. Pesaran and Shin (1998), showed that by simple iterative process equation 5.4 can be transformed into an unrestricted ARDL error correction model of the form

$$\Delta r_t = \Phi + \alpha r_{t-1} + \delta i_{t-1} + \sum_{j=1}^{p-1} \psi_j \Delta r_{t-j} + \sum_{j=0}^{q-1} \gamma_j \Delta i_{t-j} + \eta_t \qquad (5.7)$$

where Φ is the intercept, α is the error correction parameter earlier defined. The term δ nests the long-run parameter (β), while γ_j are short-run dynamic parameters that capture the extent of pass-through at the j^{th} lag. Hence, γ_0 is the impact parameter indicating immediate pass-through within the contemporaneous month (and thus defines our short-run pass-through). Inertial effects are measured by the dynamic adjustment parameters (ψ_j). Given the error correction parameter, α, and the impact parameter, γ_0, the mean adjustment lag (*M.A.L*) are derived, following Hendry (1995), to indicate the number of months required for complete adjustments to long-run equilibrium. This is computed as

$$M.A.L = \frac{1-\gamma_0}{-\alpha} \qquad (5.8)$$

If the rates are cointegrated the long-run pass-through parameter (β) can be retrieved directly from equation 5.7 as $\beta = {}^{\delta}/_{-\alpha}$.[37] Complete pass-through exists when $\beta = 1$. This restriction is investigated via the *Wald*-test with the null hypothesis of complete pass-through.

Whether pass-through is complete or not, Pesaran and Shin (*op.cit*) stated that estimator of the cointegrating parameter thus derived is both Gaussian and efficient. However, to forestall the problem of autocorrelation it is essential to choose the correct number of lags using appropriate criteria such as the Akaike information criterion (AIC). As a single equation error correction model, the ARDL has the desirable benefit of economically interpretable coefficients. Furthermore, the estimators of long-run parameters has the limiting normal distribution and are super-consistent which makes them computationally equivalent to a vector based approach.

[37] From equation 5.3 the long-run component is $\alpha(r_{t-1} - \mu - \beta i_{t-1}) = \alpha r_{t-1} - \alpha\mu - \alpha\beta i_{t-1}$. The error correction model can, thus, be expressed as $\Delta r_t = \varphi_0 + \varphi_1 \Delta i_t + \alpha r_{t-1} - \alpha\mu - \alpha\beta i_{t-1} + \varepsilon_t$ which implies $\Delta r_t = (\varphi_0 - \alpha\mu) + \varphi_1 \Delta i_t + \alpha r_{t-1} - \alpha\beta i_{t-1} + \varepsilon_t$. Parameters of equation 5.3 and 5.7 are, therefore, trivially equivalent since $\delta = -\alpha\beta; \Phi = \varphi_0 - \alpha\mu$

Moreover, even in the presence of non-stationarity of variables, estimators of the short-run parameters in the ARDL are consistent.

Test of cointegration in the ARDL is conducted using the PSS bounds-testing approach advanced by Pesaran *et al*. (2001).[38] The test is applicable regardless of whether the variables are stationary or not and irrespective of their order of integration. Assuming an unrestricted intercept, the test of long-run relationship using the PSS approach is performed, under the (joint) null of no cointegration as

$$H_0 : \alpha = \delta = 0 \tag{5.9}$$

The test is conducted using standard *F*-test. Pesaran *et al*. (*op.cit*), however, observed the existence of non-standard asymptotic distribution of the *F*-statistic regardless of the order of integration of the variables. They therefore provided two sets of asymptotic critical values with which the calculated *F*-statistic are compared. The first set of critical value assumes that all variables are non-stationary while the second set assumes stationarity of all variables. As long as the computed statistic lies outside the critical value bounds a conclusive inference can be drawn otherwise inference would be inconclusive and tests of stationarity for individual variables become necessary.

Given the possible asymmetry in the relationship between retail rate and policy rate the assumption of linearity can be relaxed. Hence, following Greenwood-Nimmo *et al*. (2010), an asymmetric ARDL proposed by Shin *et al*. (2009) is derived by splitting MPR into positive and negative changes so that the long-run equation is written as

$$r_t = \mu + \beta^+ i_t^+ + \beta^- i_t^- + u_t \tag{5.10}$$

where r_t and i_t may be *I*(1) variables and i_t is partitioned as

$$i_t = i_0 + i_t^+ + i_t^- \tag{5.11}$$

where i_t^+ and i_t^- constitute the partial sum processes of the positive and negative changes in i_t derived as

$$i_t^+ = \sum_{h=1}^{t} \Delta i_h^+ = \sum_{h=1}^{t} \max(\Delta i_h, 0), \quad i_t^- = \sum_{h=1}^{t} \Delta i_h^- = \sum_{h=1}^{t} \min(\Delta i_h, 0) \tag{5.12}$$

[38] This is the approach developed in the study by Pesaran, Shin and Smith (2001) which has been commonly termed the PSS approach in econometric literature.

β^{+} and β^{-} are asymmetric parameters of the long-run pass-through. Accordingly, equation 5.10 can be integrated with 5.7 to obtain the nonlinear-ARDL model as follows

$$\Delta r_t = \Phi + \alpha r_{t-1} + \delta^{+} i_{t-1}^{+} + \delta^{-} i_{t-1}^{-} + \cdots$$
$$\cdots + \sum_{j=1}^{p-1} \psi_j \Delta r_{t-j} + \sum_{j=0}^{q-1} \left(\gamma_j^{+} \Delta i_{t-j}^{+} + \gamma_j^{-} \Delta i_{t-j}^{-} \right) + \eta_t \qquad (5.13)$$

Short-run asymmetric parameters are γ_j^{+} and γ_j^{-} while the long-run asymmetric parameters are obtained as $\beta^{+} = \delta^{+}/-\alpha$ and $\beta^{-} = \delta^{-}/-\alpha$. In addition to testing for completeness, the *Wald*-test for $\beta^{+} = \beta^{-}$ is used to investigate asymmetry in response. Asymmetric *M.A.L* for positive and negative changes are derived, respectively, as

$$M.A.L^{+} = \frac{1 - \gamma_0^{+}}{-\alpha} \;; \quad M.A.L^{-} = \frac{1 - \gamma_0^{-}}{-\alpha} \qquad (5.14)$$

These reflect the asymmetry in the speed of adjustment obtained directly from the asymmetry in the size of the impact multiplier.

A test of long-run relationships can be performed, on equation 5.13 (after adjusting equation 5.9 for asymmetry) as $H_0\!: \alpha = \delta^{+} = \delta^{-} = 0$, using a standard *F*-test compared against the asymptotic critical values from the PSS bounds test.

The effects of exogenous variables in the pass-through process are recognised in the literature. These, if incorporated into the model, may provide more appropriate estimates of pass-through. Hence, the linear and nonlinear-ARDL models in equations 5.7 and 5.13 can be re-written, respectively, to incorporate exogenous factors as follows

$$\Delta r_t = \Phi + \alpha r_{t-1} + \delta i_{t-1} + \sum_{j=1}^{p-1} \psi_j \Delta r_{t-j} + \sum_{j=0}^{q-1} \gamma_j \Delta i_{t-j} + \boldsymbol{\Xi}' \boldsymbol{Z}_t + \eta_t \qquad (5.15)$$

and

$$\Delta r_t = \Phi + \alpha r_{t-1} + \Pi i_{t-1}^{*} + \sum_{j=1}^{p-1} \psi_j \Delta r_{t-j} + \sum_{j=0}^{q-1} \Gamma \Delta i_{t-j}^{*} + \boldsymbol{\Xi}' \boldsymbol{Z}_t + \eta_t \qquad (5.16)$$

where $\boldsymbol{\Xi}'$ is a $1 \times k$ vector of exogenous parameters and $\boldsymbol{Z}_t$ is a $k \times 1$ vector of exogenous variables. For convenience, the short- and long-run asymmetric relations are compacted to

$$\Pi i_{t-1}^{*} = \delta^{+} i_{t-1}^{+} + \delta^{-} i_{t-1}^{-} \quad ;$$

$$\sum_{j=0}^{q-1} \Gamma \Delta i_{t-j}^{*} = \sum_{j=0}^{q-1} \gamma_j^{+} \Delta i_{t-j}^{+} + \sum_{j=0}^{q-1} \gamma_j^{-} \Delta i_{t-j}^{-} \qquad (5.17)$$

The parameters in equations 5.15 and 5.16 can be estimated consistently with the ordinary least squares (OLS) technique. We expect that i_t be orthogonal to the error term to ensure consistency. Nonetheless, violation of this assumption may not invalidate ARDL estimates. Given that financial time-series such as interest rates are volatile and may be path-dependent, OLS estimation may be confronted with the problems of autocorrelation and heteroskedasticity. Adequate lag augmentation should eliminate any endogeneity bias and autocorrelation that are inherent in the data (Pesaran and Shin, 1998). Nonetheless, we obtain robust OLS estimates using the Newey-West method. This provides heteroskedastic and autocorrelation consistent (HAC) standard errors which allow for valid inferences even in the presence of the classical problems. Our preferential choice between the linear (equation 5.15) and nonlinear (equation 5.16) models is broadly based on the AIC. For instance, from among a class of models with the same dependent variable, the one with the least AIC is preferred.

5.4.2 The State-Space Model

As observed in the various empirical literatures, the pattern of pass-through may be changing over time. In the conduct of monetary policy, the changing perspective of policymakers and the continuing evolution of their relationship with economic agents and financial market have implication for policy outcome. Citing McNees (1986), Kim and Nelson (1999) observed that "...a policy reaction function is likely to be a fragile creature. Over time...the importance attached to the conflicting objectives may change, [policymakers'] views on the structure of the economy may change" (p.45). This argument is relevant from the perspective of both the policymaker and economic agent, so that reactions (or its size) may change over time. Hence, the pass-through parameter may be time-varying. To understand the time path of the parameter, equations 5.15 and 5.16 can be modelled in state-space form, estimated via a maximum likelihood method and analysed using the Kalman filter recursive algorithm. The key advantage of specifying dynamic systems or relationships in a state-space form is that it permits the inclusion and concurrent estimation of both unobserved (state) and observed variables in a model. In state-space models, therefore, the dynamics of the system is represented by a series of state variables e.g. $\{a_t\}$ related to a series of observations e.g. $\{\Delta r_t\}$ for $t = 1,2,\cdots,T$. According to Durbin and Koopman (2001), the relationship between $\{a_t\}$ and $\{\Delta r_t\}$ is equivalent to a linear regression of $\{\Delta r_t\}$ on $\{x_t\}$ where $\{a_t\}$ is the time-varying vector of coefficients consistent with a Gaussian first-order vector autoregression. The state-space model, thus allows us to infer the important properties of $\{a_t\}$ based on knowledge of $\{\Delta r_t\}$ where the behaviour of $\{\Delta r_t\}$ is captured in the signal equation and the evolution of $\{a_t\}$ is modelled in a state equation.

For simplicity, only the symmetric pass-through is modelled in this study (although it can also be applied to the asymmetric case). In a simple state-space form, the ARDL of equation 5.15 is expressed as

$$\Delta r_t = \varPhi + \alpha_t r_{t-1} + \delta_t i_{t-1} + \psi_{j,t} \sum_{j=1}^{p-1} \Delta r_{t-j} + \gamma_{j,t} \sum_{j=0}^{q-1} \Delta i_{t-j} + \boldsymbol{\varXi}' \boldsymbol{Z}_t + \eta_t \qquad (5.18)$$

where the subscript t attached to the parameters indicate that these are time-varying. Equation 5.18 is the signal (or observation) equation. In order to show the associated state (or transition) equations, we formalised equation 5.18 in matrix form as

$$\Delta r_t = \varPhi + \begin{bmatrix} r_{t-1} & i_{t-1} & \sum_{j=1}^{p-1} \Delta r_{t-j} & \sum_{j=0}^{q-1} \Delta i_{t-j} \end{bmatrix} \begin{bmatrix} \alpha_t \\ \delta_t \\ \psi_{j,t} \\ \gamma_{j,t} \end{bmatrix} + \boldsymbol{\varXi}' \boldsymbol{Z}_t + \eta_t \qquad (5.19)$$

and rationalised it into a state-space model as

$$\Delta r_t = \varPhi + \boldsymbol{x}_t \boldsymbol{a}_t + \boldsymbol{\varXi}' \boldsymbol{Z}_t + \eta_t \; ; \qquad \eta_t \sim iidN(0, \boldsymbol{R}) \qquad (5.20)$$

$$\boldsymbol{a}_{t+1} = c_t + \varLambda_t \boldsymbol{a}_t + v_t \; ; \qquad v_t \sim iidN(0, \boldsymbol{H}) \qquad (5.21)$$

This specification allows us to estimate the time path of both long- and short-run pass-through. Equations 5.20 and 5.21 are the signal and state equations, respectively. Associated with these equations are random disturbance vectors η_t and v_t which are assumed to be serially orthogonal; hence, white noise. The parameter $\boldsymbol{R}$ is the variance of the signal disturbance and $\boldsymbol{H}$ is a symmetric variance matrix of the state disturbances with dimension $(m+3)$ where $m = (p-1, q-1)$ is the order of ARDL. The variance structure of the model is therefore represented as

$$\boldsymbol{\Psi} = var\begin{bmatrix} \eta_t \\ v_t \end{bmatrix} = \begin{bmatrix} \boldsymbol{R} & \boldsymbol{Q} \\ \boldsymbol{Q}' & \boldsymbol{H} \end{bmatrix} \tag{5.22}$$

where $\boldsymbol{Q}$ is a matrix of covariances which can be restricted to zero. In state-space modelling, estimation and inferences about $\{a_t\}$ conditional on available information at time t is usually made under the assumption of a complete knowledge of all the hyperparameters (c_t, Λ_t, $\boldsymbol{R}$, and $\boldsymbol{H}$) of the model. If some of these are unknown they are estimated (by maximum likelihood) before making inferences (see appendix 5.1).

In estimating time-varying coefficients of the state-space model, the Kalman filter enhances the understanding of how rational economic agents update their inferences when new information becomes available following uncertainties connected with regime shifts (Kim and Nelson, 1999). Uncertainty about the regression coefficient leads to changing outcomes of the conditional variance which is adequately captured by prediction error variance $\left(\tilde{F}_t\right)$. The structure of the variance matrix $(\boldsymbol{\Psi})$ of the disturbance term and its underlying assumptions play an important role. For the state-space equations (5.20-5.21) a number of addition assumptions or restrictions are made. First, $E(\eta_t v_t) = 0$ is assumed. This implies imposing zero values on the covariance matrix so that $\boldsymbol{Q} = 0$. Second, the $\boldsymbol{H}$ matrix of state disturbances is assumed diagonal, thereby restricting all covariances to zero. Following Kim and Nelson (1999) and Commandeur and Koopman (2007) the state equations may be specified as a random walk so that the vector of intercepts is null $(c_t = 0)$ and the $k \times k$ parameter matrix is an identity $(\Lambda_t = I_k)$. However, we assume that the long-run components of the state equations ($\{\alpha_t\}$ and $\{\delta_t\}$) are stochastic processes while short-run components ($\{\gamma_t\}$ and $\{\psi_t\}$) are recursive. This is because short-run reaction can be predicted from past values with negligible errors while long-run reaction would contain some random errors. The model is evaluated via standard coefficient tests on the predicted errors.

5.5 Empirical Analysis and Discussions

Although the empirical literature on the interest rate pass-through suggest that time-series data on interest rates are commonly $I(1)$, empirical analyses in this section, nonetheless, begin by investigating the time-series properties of the various interest rate. The augmented Dickey-Fuller (ADF) and the Kwaitkowski-Phillips-Schmidt-Shin (KPSS) tests of stationarity are conducted. The ADF is performed under the null of unit root while the KPSS test had a null of stationarity. Visual inspection of the series revealed no obvious trends, hence, the tests are conducted with intercept but no trend. The results, presented in table 5.2 below, indicated that all the interest rates in the analyses, except lending rates, are $I(1)$ as suggested by the literature. PLR and MLR are however $I(0)$, indicating stationarity. Nonetheless, these results pose no inconvenience for the estimation of long-run pass-through since the ARDL and the PSS-test are valid irrespective of whether the variables are $I(0)$, $I(1)$ or mutually cointegrated. It would also not affect the estimation of dynamic pass-through because, according to Commandeur and Koopman (2007), "[in] state-space methods, stationarity of the time-series is not required" since the model allows for concurrent decomposition and diagnosis of the dynamics of time-series data (p.134).

Table 5.2: Tests of Stationarity of Time-Series Variables

	ADF			KPSS		
	Levels	1st-Diff.	Characteristic	Levels	1st-Diff.	Characteristic
Policy rate	-1.96	- 6.12***	$I(1)$	0.44*	0.13	$I(1)$
Interbank	-2.56	-20.79***	$I(1)$	0.70**	0.04	$I(1)$
Savings	-0.96	-17.25***	$I(1)$	1.57***	0.11	$I(1)$
7-Day	-1.17	-16.75***	$I(1)$	1.22***	0.12	$I(1)$
1-Month	-2.26	-19.03***	$I(1)$	0.43*	0.10	$I(1)$
3-Month	-2.07	-20.91***	$I(1)$	0.39*	0.10	$I(1)$
6-Month	-2.25	-20.31***	$I(1)$	0.51**	0.11	$I(1)$
12-Month	-2.17	-19.12***	$I(1)$	0.58**	0.12	$I(1)$
>12-Month	-2.45	-21.63***	$I(1)$	0.66**	0.08	$I(1)$
Prime	-2.89**	-20.01***	$I(0)$	0.27	0.12	$I(0)$
Maximum	-2.97**	-10.03***	$I(0)$	0.34	0.08	$I(0)$

Source: Author's computations based on data from the CBN.

Note: ***,**,* indicate significance at the 1%, 5%, and 10% levels, respectively. The ADF-test was conducted under the null hypothesis of a unit root with MacKinnon critical values, respectively, at -3.45, -2.87, and -2.57 for the 1%, 5% and 10% significance levels, while the KPSS-test was performed under the null of stationarity with corresponding asymptotic critical values of 0.73, 0.46, and 0.34.

5.5.1 The Linear Model

Sequel to earlier discussions, empirical investigation is conducted in two phases. In the first phase the policy-to-interbank and policy-to-retail pass-through are examined while the second phase estimates interbank-to-retail pass-through. This is because, in Nigeria, policy rate changes are expected to transmit to the retail rates via the interbank rate while retail rates can also respond directly to the policy rate. Estimations are conducted by initially over-parameterising the model with twelve lags of Δr_t and Δi_t . A parsimonious model is obtained by sequentially removing insignificant coefficients, complemented with the AIC. Among a class of possible parsimonious options, the model with the least AIC value is preferred. Analysis in this section is largely focused on the error correction parameter (α), the long-run pass-through (β), and the immediate (or short-run) pass-through (γ_0). Where reported, inertial effect is $\sum_{j=1}^{12} \psi_j$; $\forall\ \psi_j \ncong 0$. Similarly, overall short-run pass-through is $\sum_{j=0}^{12} \gamma_j$; $\forall\ \gamma_j \ncong 0$ (although we focus on γ_0 – the immediate pass-through). All restriction and model evaluation tests are conducted at the 5 per cent level of significance.

5.5.1.1 Results of Symmetric Policy-to-Market and Policy-to-Retail Pass-through

Tables 5.3–5.5 present results of three variants of the ARDL model (exclusive and inclusive of exogenous variables). Result without exogenous variables is reported in table 5.3. Pass-through is investigated for ten interest rates types including IBR, seven DRs, and two LRs. All coefficients in the table are found to be correctly signed as the intercept, short- and long-run pass-through and inertial coefficients bear positive signs and the error correction term is negatively signed. In addition, the variables of interest $(\alpha, \beta, \gamma_0)$ are predominantly rightly sized and lied (in absolute terms) between one and zero as expected. For IBR all variables are statistically significant except the intercept term. The table indicated a complete pass-through in the long-run while immediate pass-through is approximately 61 per cent. The error correction term indicated an adjustment speed of about 37 per cent monthly per disequilibrium. These jointly show an *M.A.L* of one month for full adjustment.[39]

The results for deposit rates are somewhat different. While there are no significant long-run pass-through to SDR and 7-day-TDR, the immediate multipliers are significant. The low *cum* insignificant speed of adjustment meant an *M.A.L* of 2–7 years for SDR and 7-day-TDR. Other TDRs (1-month up to over-12-month) showed remarkably better results. All coefficients in this group are statistically significant, the pass-through coefficient ranged 38–61 per cent and 61–74 per cent for short-run and long-run, respectively. Though the error correction term showed a low speed of adjustment of between 7–12 per cent monthly, the *M.A.L* is modest vis-à-vis SDR and 7-day-TDR and ranging between 3–9 months. The LRs showed statistically significant and higher pass-through both in the short- and long-run than DRs. Again, the error correction term is low; although, at approximately 3 months, the *M.A.L* showed faster adjustment time than most DRs. The *Wald*-test of complete long-run pass-through is

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[39] See appendix 5.2

statistically significant for all the interest rate except for SDR, 7-day, and 3-month rates. The performance of the models is evaluated using the adjusted R-squared ($\bar{R}^2$) and the PSS F-test. The $\bar{R}^2$ is generally low for all models ranging from 12–35 per cent while the PSS-test could only confirm cointegration for IBR and over-12-month rate.

Table 5.3: Linear-ARDL Results for Policy Rate Pass-through (Excluding Exogenous Variables)

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	> 1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	0.12 (0.86)	0.09 (0.10)	0.02 (0.19)	0.18 (0.27)	0.49 (0.37)	0.23 (0.28)	0.32 (0.27)	0.40 (0.32)	0.67** (0.31)	0.80** (0.39)
$\boldsymbol{\alpha}$	-0.37*** (0.08)	-0.01 (0.00)	-0.05** (0.01)	-0.07*** (0.03)	-0.11*** (0.04)	-0.08** (0.03)	-0.09*** (0.03)	-0.12*** (0.03)	-0.08*** (0.02)	-0.07** (0.03)
$\boldsymbol{\beta}$	1.00*** (0.16)	0.15 (0.76)	0.61 (0.42)	0.70*** (0.24)	0.61*** (0.19)	0.74*** (0.23)	0.68*** (0.19)	0.72*** (0.16)	0.84*** (0.20)	0.82*** (0.33)
$\boldsymbol{\gamma_0}$	0.61* (0.36)	0.25*** (0.06)	0.35*** (0.11)	0.38*** (0.14)	0.51*** (0.16)	0.45*** (0.12)	0.47*** (0.12)	0.60*** (0.15)	0.69*** (0.21)	0.79*** (0.26)
$\bar{\boldsymbol{R}}^2$	0.21	0.12	0.19	0.15	0.21	0.15	0.16	0.22	0.34	0.31
$\boldsymbol{F\text{-}Test}_{(PSS)}$	9.48**	1.16	2.09	4.30	3.68	2.92	4.46	6.56**	4.61	3.06
$\boldsymbol{\beta = 1}$	YES	NO	NO	YES	NO	YES	YES	YES	YES	YES

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. F-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for β = 1 (YES connotes complete pass-through).

Albeit marginally, IBR outperformed most retail rates regarding the size and speed of pass-through and general model evaluations. Intuitively, these results may not be comparable given that the interbank series started much later than the others and the introduction of the interbank market could have impacted on the pattern of pass through. Hence, to allow for comparability and also capture the impact of the interbank system (introduced in 1996), a dummy variable is included in the model. This takes the value of zero pre-1996:M1 and unity thenceforth. Both intercept and slope dummies are used; to capture regime shifts and changing patterns, respectively.

Results of the re-estimated model are reported in table 5.4 which indicated that the inclusion of the 1996-dummies had a significant effect on the models. While all slope-dummies are significant at the 5 per cent level, only SDR intercept-dummy is significant at that level. Intercept-dummies for 7-day and 1-month rates are significant only at 10 per cent while those on other retail rates are statistically insignificant. Overall, although the coefficients are higher than those in the preceding model, analyses suggest that the introduction of the interbank reduced the size and speed pass-through.[40] However, all relevant parameter estimates are statistically significant. For SDR the long-run pass-through is about 54 per cent while the immediate pass-through is only 35 per cent. The error correction term indicated an adjustment speed of about 43 per cent while the *M.A.L* is 1.5 months. For TDRs, pass-through increased with the term of maturity. The estimates ranged 49–86 per cent and 81–106 per cent (7-day: lowest and over-12-month: highest) for the short-run and long-run, respectively. Adjustments speeds are within 48–79 per cent monthly, with *M.A.L* of 0.2–1.1 months.

Table 5.4: Linear-ARDL Results for Policy Rate Pass-through Including 1996-Dummies

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	0.12 (0.86)	2.31** (0.96)	0.85 (0.55)	1.08 (0.67)	1.37 (0.97)	0.33 (0.88)	0.59 (0.83)	0.50 (0.72)	-0.50 (0.68)	-1.12 (0.80)
$\boldsymbol{\alpha}$	-0.37*** (0.08)	-0.43*** (0.16)	-0.47*** (0.12)	-0.65*** (0.11)	-0.61*** (0.11)	-0.66*** (0.15)	-0.65*** (0.10)	-0.78*** (0.08)	-0.27*** (0.07)	-0.40*** (0.09)
$\boldsymbol{\beta}$	1.00*** (0.16)	0.54*** (0.13)	0.80*** (0.07)	0.88*** (0.07)	0.87*** (0.10)	1.03*** (0.09)	1.02*** (0.08)	1.06*** (0.05)	1.46*** (0.16)	1.59*** (0.11)
$\boldsymbol{\gamma_0}$	0.61* (0.36)	0.35*** (0.06)	0.49*** (0.09)	0.63*** (0.09)	0.71*** (0.10)	0.81*** (0.08)	0.79*** (0.07)	0.85*** (0.73)	0.85*** (0.21)	1.02*** (0.22)
Φ-Dummy		-2.27** (0.96)	-0.95* (0.55)	-1.09* (0.66)	-1.25 (0.88)	-0.31 (0.91)	-0.69 (0.85)	-0.65 (0.75)	-0.08 (0.72)	0.81 (0.86)
α-Dummy		0.44*** (0.16)	0.50*** (0.12)	0.66*** (0.10)	0.63*** (0.10)	0.68*** (0.10)	0.70*** (0.09)	0.83*** (0.07)	0.31*** (0.07)	0.43*** (0.09)
δ-Dummy		-0.24** (0.11)	-0.39*** (0.10)	-0.58*** (0.11)	-0.55*** (0.11)	-0.70*** (0.15)	-0.70*** (0.13)	-0.86*** (0.10)	-0.41*** (0.11)	-0.67*** (0.16)
$\bar{R}^2$	0.21	0.44	0.52	0.62	0.59	0.64	0.65	0.80	0.44	0.50
***F-Test**(PSS)*	9.48**	3.60	7.36**	15.78**	15.00**	16.34**	19.84***	42.02**	6.23**	9.95**
$\boldsymbol{\beta = 1}$	YES	NO	NO	YES	YES	YES	YES	YES	NO	NO

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through).

Again, as in the previous case, LRs are less rigid than DRs both in the long- and short-run and have (approximately) complete short-run pass-through but significant long-run overshoot. Pass-through is higher for MLR than PLR. While the speed coefficients are modest, the *M.A.L* indicated swift adjustment periods -0.1 and 0.5 months, respectively. The negative coefficient for MLR could reflect pre-emptive changes ahead of a change in the policy rate. Further analyses indicated that besides the

[40] While it may be intuitive to interpret positive coefficients as indicating increases, it is nonetheless converse for coefficients whose *a priori* sign expectations are negative. The coefficient of the speed variable is expected to be negative so that an increase requires it to be more negative. The slope dummy for the speed being positive reduces the size of the negative, thus, reduces the speed.

overshoot in LR, pass-through to SDR and 7-day rate are incomplete, while those for other TDRs are statistically unity. The $\bar{R}^2$ showed considerable improvement vis-à-vis the previous table and was within 45–80 per cent. In addition, the reduced values of AIC suggested that models with dummies are superior to those without. The PSS-test also showed improvement, confirming cointegration at 5 per cent for all variables except SDR.

Given the broad objectives of this thesis, one of which is to ascertain the effectiveness of monetary policy in a developing country, a proxy for financial development is included in the analysis. We expect that increased developments and innovations in the financial market would enhance pass-through. The variable is introduced directly in order to control for its impact on the level and speed of pass-through. The results presented in table 5.5, showed that the proxy for financial development is statistically significant in the analysis *albeit* weakly in some cases. It is, however, not significant for over-12-month rate.

While financial development reduced the margin on retail rates it nonetheless had a positive impact on the interbank mark-up. The coefficients of pass-through were generally moderated for retail rates, in the short- and long-run relative to the previous models, though it increased slightly (in the short-run) for LR. Pass-through to IBR increased substantially, indicating long-run overshoot with an instantaneous pass-through of 79 per cent. The error correction term also showed further improvement while the *M.A.L* was generally below 2 months though remaining negative for MLR. The $\bar{R}^2$ indicate increased explanatory power of the model while the AIC suggested superiority over the preceding model. Furthermore, the PSS-test confirmed cointegration for the models; although at 10 per cent for SDR. The *Wald*-test indicated incomplete pass-through for SDR, 7-day and 1-month rates; overshoot for LRs and IBR; and complete for the rest.

Overall, the model suggested that the introduction of the interbank market and the level of financial development helped to explain the pattern of pass-through in Nigeria. Changes in MPR are significantly passed-through to retail and market rates. In the short-run, pass-through is incomplete for all rates except MLR. However, long-run pass-through is either complete or overshot except for SDR, 7-day, and 1-month rates.

IBR has the highest long-run pass-through while SDR has the lowest. Hence, we can deduce that changes in market rates are not entirely transmitted to retail rates. Furthermore, pass-through is higher for LRs than DRs. This could indicate banks' use of market power to influence their mark-up profit. The general finding of higher pass-through to MLR vis-à-vis PLR could mean that banks protected esteemed customers from volatility more than ordinary customers.

Table 5.5: Linear-ARDL Results for Policy Rate Pass-through Including 1996-Dummies and M2/GDP

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	-6.33**	3.00***	1.61**	2.09**	2.46**	1.39	1.59	1.37	0.52	0.62
	(3.05)	(0.85)	(0.55)	(0.82)	(1.10)	(1.14)	(1.07)	(1.01)	(0.82)	(0.90)
$\boldsymbol{\alpha}$	-0.43***	-0.45***	-0.50***	-0.65***	-0.63***	-0.64***	-0.65***	-0.78***	-0.29***	-0.44***
	(0.09)	(0.14)	(0.11)	(0.11)	(0.10)	(0.12)	(0.10)	(0.08)	(0.07)	(0.08)
$\boldsymbol{\beta}$	1.52***	0.53***	0.77***	0.84***	0.84***	0.99***	0.99***	1.03***	1.42***	1.51***
	(0.23)	(0.10)	(0.06)	(0.06)	(0.09)	(0.09)	(0.08)	(0.05)	(0.12)	(0.10)
$\boldsymbol{\gamma_0}$	0.78*	0.35***	0.48***	0.65***	0.73***	0.81***	0.77***	0.84***	0.86***	1.02***
	(0.45)	(0.06)	(0.09)	(0.09)	(0.09)	(0.09)	(0.07)	(0.08)	(0.18)	(0.20)
Φ-Dummy		-2.14**	-0.97*	-1.12*	-1.14	-0.33	-0.54	-0.59	-0.36	0.07
		(0.88)	(0.54)	(0.58)	(0.78)	(080)	(0.73)	(0.67)	(0.84)	(0.88)
α-Dummy		0.43***	0.53***	0.71***	0.68***	0.71***	0.73***	0.85***	0.41***	0.55***
		(0.14)	(0.11)	(010)	(0.09)	(0.10)	(0.08)	(0.06)	(0.08)	(0.08)
δ-Dummy		-0.26***	-0.42***	-0.62***	-0.61***	-0.73***	-0.74***	-0.88***	-0.53***	-0.84***
		(0.09)	(0.09)	(0.09)	(0.09)	(0.14)	(0.11)	(0.09)	(0.11)	(0.15)
M2/GDP	13.99**	-1.79**	-1.67**	-2.62*	-3.12**	-2.94*	-2.96*	-2.41	-3.96***	-5.32***
	(6.55)	(0.72)	(0.81)	(1.47)	(1.50)	(1.61)	(1.59)	(1.69)	(1.50)	(1.39)
$\boldsymbol{\bar{R}^2}$	0.23	0.44	0.54	0.63	0.61	0.65	0.67	0.80	0.45	0.53
F-Test $_{(PSS)}$	11.19**	5.58*	9.82**	18.82**	18.41**	16.31**	23.78**	52.26**	9.18**	17.44**
$\boldsymbol{\beta = 1}$	NO	NO	NO	NO	YES	YES	YES	YES	NO	NO

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *F*-test$_{(PSS)}$ is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through).

5.5.1.2 Results of Symmetric Interbank-to-Retail Pass-through

The results of the pass-through from interbank-to-retail rates are contained in tables 5.6–5.7 below. Table 5.6 presents the results of the models without exogenous variables. Parameters in the SDR equation are statistically significant, at least, at 10 per cent except the intercept term. Long-run pass-through to SDR is approximately 13 per cent with an adjustment speed of 9 per cent monthly. Instantaneous pass-through is 3 per cent, thus, indicating an *M.A.L* of 11 months. The 7-day and the 1-month rates, however, indicated no significant pass-through in the short-run, while long-run pass-through, at 31 and 45 per cent, respectively, are significant. With adjustment speed of about 17 per cent, in both cases, the *M.A.L* is approximately 6 months apiece.

Other TDRs showed comparable results and had statistically significant coefficients. Long-run pass-through is within 34–42 per cent (with 3-month rate having the highest coefficient). Immediate pass-through and the adjustment speed, respectively, ranged 4–12 per cent and 16–35 per cent (the highest values being over-12-month rate). The *M.A.L* spanned approximately 3–6 months (lowest: over-12-month and highest: 3-month). Thus, for TDRs, long-run pass-through decayed with maturity while the impact multiplier and the adjustment speed increased with maturity analysis.

Table 5.6: Linear-ARDL Results for Interbank Rate Pass-through (Excluding Exogenous Variables)

	Deposits							Lending	
	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\Phi}$	0.19 (0.16)	0.42** (0.19)	0.73** (0.34)	0.97*** (0.30)	1.39*** (0.49)	1.18*** (0.38)	2.33*** (0.68)	1.17** (0.49)	1.25*** (0.38)
$\boldsymbol{\alpha}$	-0.09** (0.04)	-0.18*** (0.051	-0.16*** (0.04)	-0.17*** (0.04)	-0.23*** (0.06)	-0.20*** (0.04)	-0.35*** (0.08)	-0.09*** (0.03)	-0.08*** (0.03)
$\boldsymbol{\beta}$	0.13* (0.07)	0.31*** (0.05)	0.45*** (0.08)	0.42*** (0.07)	0.40*** (0.06)	0.39*** (0.06)	0.34*** (0.06)	0.39*** (0.09)	0.54*** (0.13)
$\boldsymbol{\gamma_0}$	0.03** (0.01)	0.01 (0.01)	0.01 (0.03)	0.04* (0.02)	0.04* (0.02)	0.05** (0.02)	0.12*** (0.04)	0.02* (0.01)	0.01 (0.01)
$\boldsymbol{\bar{R}^2}$	0.09	0.16	0.14	0.16	0.15	0.16	0.26	0.08	0.12
F-Test*(PSS)*	2.66	8.89**	6.97**	11.29**	6.83**	10.35**	10.55**	8.11**	5.20*
$\boldsymbol{\beta = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. F-test$_{(PSS)}$ is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through).

IBR pass-through to LR is also low. Short-run pass-through is found to be either weakly significant (at 10 per cent for PLR) or insignificant (for MLR). However, at 40 and 54 per cent, long-run pass-through to PLR and MLR are, respectively, statistically significant. Again, these results may indicate protection of prime customers from market volatility. With the error correction at about 8 per cent monthly, the *M.A.L* is approximately twelve months each. Compared with the DR, pattern of pass-through is considerably different for MLR but marginally dissimilar for PLR. As expected, MLR displayed higher pass-through in the long-run than DR indicating changing profit spreads and relative prices. Model evaluations suggest poor market-to-retail pass-through. Generally, the $\bar{R}^2$ is low for all rates ranging from 9–26 per cent. The *Wald*-test rejected the null (of $\beta = 1$) indicating incomplete interbank-to-retail pass-through. The PSS-test, however, could not reject the null for SDR but confirmed long-run relationship for other rates.

The role of financial development in the pass-through process is again investigated by including a proxy in the model. This had marginal effects and is statistically significant in the SDR, 7-day and MLR equations but insignificant for other rates. While it varied inversely with SDR and 7-day rates, it varied directly with the rest. As in the previous model, low and incomplete pass-through is recorded; *albeit* higher for LR than for most DRs. Adjustment lags ranged about 2–12 months (highest for PLR). Again, the PSS-test confirmed cointegration for all rates except SDR while the $\bar{R}^2$ is generally less than 30 per cent. The AIC, however, suggested that the proxy cannot be discarded across all the models. Specifically, equations with statistically significant proxy have lower AIC than counterparts in the preceding table. Hence, the models for SDR, 7-day and MLR are preferred with the inclusion of proxy while those for other rates are better without it. The impact of financial development on interbank pass-through cannot therefore be generalised for all retail rates.

Table 5.7: Linear-ARDL Results for Interbank Rate Pass-through Including M2/GDP

	Deposits							Lending	
	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\Phi}$	0.64* (0.38)	0.73*** (0.23)	0.60 (0.39)	0.88** (0.38)	1.32*** (0.49)	1.13** (0.48)	2.03*** (0.65)	1.05** (0.48)	0.99** (0.41)
$\boldsymbol{\alpha}$	-0.12* (0.06)	-0.19*** (0.05)	-0.16*** (0.05)	-0.17*** (0.04)	-0.24*** (0.07)	-0.21*** (0.05)	-0.35*** (0.08)	-0.09*** (0.03)	-0.09*** (0.03)
$\boldsymbol{\beta}$	0.10* (0.06)	0.29*** (0.04)	0.44*** (0.08)	0.42*** (0.08)	0.40*** (0.06)	0.40*** (0.07)	0.35*** (0.05)	0.41*** (0.10)	0.57*** (0.11)
$\boldsymbol{\gamma_0}$	0.03* (0.01)	0.01 (0.01)	0.01 (0.02)	0.04* (0.02)	0.04* (0.02)	0.06** (0.02)	0.12*** (0.04)	0.02* (0.01)	0.02* (0.01)
M2/GDP	-1.27* (0.71)	-0.95** (0.47	0.62 (1.22)	0.34 (0.96)	0.27 (1.41)	0.18 (1.25)	1.16 (1.69)	0.36 (0.48)	1.52*** (0.49)
$\bar{\boldsymbol{R}}^2$	0.10	0.16	0.14	0.16	0.15	0.16	0.26	0.08	0.14
$\boldsymbol{F\text{-}Test_{(PSS)}}$	2.20	8.50**	8.61**	11.18**	6.50**	9.55**	9.87**	8.04**	7.69**
$\boldsymbol{\beta = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. F-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through).

5.5.1.3 Stylised Deductions from the Linear Models

The analyses revealed a number of outcomes. Most of these are related to the size and speed of pass-through across transmission phases and interest categories. Some of these are congruous with the stylised analyses conducted in section 5.3. From the analyses in the foregoing (sub-)sections, the findings from linear pass-through models are enumerated as follows.

(1) *Higher pass-through from policy rate*. First and foremost, pass-through is generally complete and higher for policy-to-market/retail than market-to-retail phase. This can imply a possible weakening of monetary policy transmission as the CBN attempt to influence the retail interest rates via the interbank market. However, retail rates adjust directly to policy changes suggesting that policy may nevertheless be effective. In Nigeria with the pronouncement of policy changes in the interest rate, banks may adjust their retail rates since customers may already be aware of the policy changes. The higher policy-to-retail pass-through (vis-à-vis market-to-retail) reflects the frequent (sometimes daily) fluctuation of IBR while retail rates are infrequently adjusted given the associated opportunity costs. Furthermore, banks may prefer to restrain market volatility from their customers. The seldom fine-tuned retail rates would thus covary prominently with the policy rate which also changes infrequently. This is consistent with Borio and Fristz (1995), who opined that in the face of a volatile money market the policy rate would anchor retail rates better, since it reflects stable rather than momentary adjustments. So the two phases of money policy may not be statistically relevant to the Nigerian case, and there may just be one phase.

(2) *Lower pass-through since 1996.* Results in tables 5.3–5.5 suggest that pass-through was affected by the introduction of the interbank market. Pass-through is generally lower in table 5.3 than in 5.4 and 5.5. The inclusion of 1996 dummies in the latter tables indicated that pass-through was considerable higher pre-1996 and reduced afterwards. In fact, linear addition of the coefficient of slope dummies in these tables indicated that pass-through was closer to those of table 5.3 (without dummies). This finding can be supported by the graphical presentations in section 5.3 which showed close movements of rates before mid-1990s and a decoupling thereafter. The reduced pass-through may be attributable to increased power of banks bestowed by the interbank market – following the further liberalisation of the financial system. This may seem counter-intuitive as the interbank market was intended to deepen the financial market and aid the transmission of money policy. However, the introduction of the interbank market opened a further avenue for banks to source (and possibly use excess) reserve thereby weakening the link between CBN borrowing and retail lending. Hence, commercial banks ceased to depend solely on the CBN (and retail deposits) for their sources while quitting prominent reliance on retail lending for their use. This

increased the power of banks (over their clients) and their ability to set rates slightly differently from what was obtainable before the interbank.

(3) *Financial underdevelopment increases mark-up*. The level of financial development has a significant effect on the pattern of policy-to-retail pass-through but a moderate effect for market-to-retail pass-through. However, in most cases when it is significant, accelerated financial development lowered the intercept term and hence, the mark-up. This is not surprising as the mark-up are indicative, among other things, of market risks and the profit appetite of the banks. In developed markets, risks are better analysed and incorporated marginally into mark-up relative to underdeveloped markets. Besides, underdeveloped markets are more susceptible to the problems of adverse selection and moral hazards. Hence, rather than ration credit, banks may incorporate risk premium into their prices as observed by Sander and Kleimeier (2004) and Gropp *et al* (2007).

(4) *Short-run stickiness relative to long-run*. In all the models, immediate pass-through is uniformly lower than the long-run counterpart. This is consistent with the findings of Mojon (2000), de Bondt (2002, 2005) and Gropp *et al.* (2007) among others. Policy would be deemed more effective if immediate pass-through were large. While instantaneous pass-through is fairly large in some cases it is nonetheless below unity, on average. This indicates rigidity of the short-run pass-through. Conversely, the long-run pass-through is somewhat complete for most retail and market rates, except for savings and 7-day rates. Hence, the analyses suggest the existence of short-run rigidity and partial long-run flexibility. Pass-through is, therefore, generally higher in the long- than short-run. Complete long-run pass-through is suggestive of the monetary policy efficacy. However, this further requires a high adjustment speed of short- to long-run pass-through. On the average, the *M.A.L* is about eight months for DR, three months for LR and one month for IBR. This indicates that the difference between short- and long-run pass-through is highest for DR and lowest for IBR. Thus, as Kwapil and Scharler (2006) pointed out, retail rates do not adjust instantaneously to policy rate variations but requires a lag.

(5) *Higher pass-through to lending rate vis-à-vis deposit rates*. In the different models presented above, adjustments are generally higher for LR than DR. This finding is

consistent with Hoffman and Mizen (2004), de Bondt (2005), Sørensen and Werner (2006), and Gropp *et al*. (2007). Again, this is further indicative of banks' market power, which allows them to adjust LR more than DR following monetary tightening. Indeed, significant pass-through overshoot is observed for LR in some cases. This unequal response would alter relative prices (between cost of borrowing and money's own rate) and the associated spread. Since monetary policy in Nigerian is largely aimed at controlling domestic credit, the ability to influence LR more than DR may be construed, in line with the views of Biefang-Frisancho Mariscal and Howell (2002), to imply monetary policy effectiveness. However, the lower gap between the lending-deposit rate pass-through in the short-run may suggest a weaker effect of policy.

(6) *Higher pass-through to maximum vis-à-vis prime lending rate.* Monetary policy changes also altered the MLR-PLR differential. Pass-through is consistently higher in the short- and long-run for MLR than PLR. Theoretical discussions in the literature suggest that banks protect prominent clients from market volatility than typical customers. Though pass-through to both MLR and PLR are high (relative to other retail rates) it is higher for MLR; thereby supporting this argument. The higher pass-through to MLR may also reflect market risks. The MLR-PLR spread signifies the risk premium which banks incorporated over and above normal PLR mark-up. In some cases, estimated pass-through coefficient overshot for both PLR and MLR. While PLR overshoot indicated market power and banks' ability to charge excess mark-up even on relatively less risky credit, MLR incorporated risk premium in addition to excess mark-up.

(7) *Pass-through increases with terms of maturity*. DRs with higher maturity tended to exhibit higher pass-through from policy rate both in the short- and the long-run. Comparing all DRs, pass-through is least for SDR followed by 7-day rate and is highest for over-12-month rates. This is comparable to Kwapil and Sharler (2006) who found short-term sluggishness in DR vis-à-vis long-term rates but contrasts the findings of Liu *et al.* (2008). While these studies examined short- versus long-term pass-through, we basically investigated pass-through among short-term rates. The higher past-through on deposits with longer maturity may indicate banks' desire to generate stable deposits and protect themselves from future uncertainties regarding inflation, interest rate and monetary policy actions.

5.5.2 The Nonlinear Model: Examining the Asymmetry in Pass-through

Theoretical and empirical discussions in the literature suggested that banks' pricing behaviour would differ between expansionary and contractionary monetary policy. Most empirical studies investigated this asymmetry in terms of the speed of pass-through. Following Greenwood-Nimmo *et al*. (2010), however, this section examines nonlinearity in the size of pass-through (with a cursory consideration of asymmetry in speed). As in the previous sub-section, empirical analysis is conducted in two phases: policy-to-market and market-to-retail pass-through. By extricating negative from positive MPR changes, the analysis encapsulates possible asymmetry in the pass-through process.[41] Positive asymmetry occurs if contractionary MPR changes induced larger adjustment than expansionary changes while asymmetry is negative if response is higher for expansionary than contractionary stance. Again, we adopt a general-to-specific approach by including twelve lags of the cardinal variables and achieving parsimony as earlier described. All computations and tests are conducted in line with those in the preceding sub-section.

5.5.2.1 Result of Asymmetric Policy-to-Market and Policy-to-Retail Pass-through

Tables 5.8–5.10 present the results of the asymmetric pass-through from policy rate to interbank and retail rates. In table 5.8, the results exclude exogenous variables (comparable to table 5.3). Most coefficients in the interbank equation are statistically significant except for the intercept and the short-run negative pass-though. Pass-through is found to be complete and symmetric in the long-run while exhibiting short-run positive asymmetry. The *M.A.L* also showed asymmetry in the speed of adjustment as MPR increases are immediately transmitted while reductions have two months lag. SDR and 7-day rates showed sluggishness in both the short- and long-run but negative asymmetry in the short-run. Long-run pass-through to SDR, though not statistically significant, is symmetric. Negative asymmetry is recorded for 7-day rate both in the short- and long-run. Other TDRs, however, generally exhibited long-run stickiness during tightening but complete pass-through during ease. For these rates pass-through had an overall negative asymmetry both in the short- and long-run. This shows that banks are more willing to lower deposit rates than raise them in response to

[41] See section 5.4.1

monetary policy changes; thus, indicating the pricing power of banks and their appetite for profit.

For LRs, pass-through is complete in the long-run both for positive and negative changes and is symmetric. In the short-run, however, both lending rates showed negative asymmetry which may mean that banks may prefer to ration credit in the short-run to avoid the problems of adverse selection and/or moral hazards. For all retail rates, adjustments to positive changes are slower than those for negative changes as shown by the asymmetric *M.A.L.* The $\bar{R}^2$ is generally low and ranging 14–40 per cent. The PSS-test could only confirm the existence of long-run relationship for interbank thereby implying that the above results may be spurious. Again, to correct the anomalies and allow for comparability with the interbank equation, the model is re-estimated to incorporate 1996-intercept- (and -slope)-dummies.

Table 5.8: Nonlinear-ARDL Results for Policy Rate Pass-through (Excluding Exogenous Variables)

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	3.47 (2.21)	0.54*** (0.19)	0.61*** (0.18)	0.92*** (0.28)	1.24*** (0.42)	1.30*** (0.43)	1.29*** (0.35)	1.84*** (0.58)	1.28*** (0.45)	1.23*** (0.45)
$\boldsymbol{\alpha}$	-0.37*** (0.08)	-0.03** (0.01)	-0.05*** (0.01)	-0.08*** (0.03)	-0.10*** (0.04)	-0.10*** (0.04)	-0.10*** (0.03)	-0.14*** (0.04)	-0.08** (0.03)	-0.08** (0.03)
$\boldsymbol{\beta^+}$	1.11*** (0.29)	0.03 (0.22)	0.27 (0.21)	0.61*** (0.22)	0.61*** (0.21)	0.61*** (0.20)	0.63*** (0.20)	0.67*** (0.19	0.99*** (0.24)	1.13*** (0.32)
$\boldsymbol{\beta^-}$	1.11*** (0.19)	0.31 (0.20)	0.52** (0.21)	0.70*** (0.24)	0.69*** (0.21)	0.73*** (0.20)	0.76*** (0.21)	0.78*** (019)	0.94*** (0.23)	0.98** (0.25)
$\boldsymbol{\gamma_0^+}$	1.00** (0.50)	0.15** (0.08)	0.11 (0.10)	0.09 (0.14)	0.16 (0.12)	0.23* (0.14)	0.33*** (0.10)	0.32*** (0.08)	0.28* (0.16)	0.31** (0.11)
$\boldsymbol{\gamma_0^-}$	0.14 (0.45)	0.29*** (0.07)	0.42*** (0.10)	0.50*** (0.14)	0.69*** (0.13)	0.56*** (0.10)	0.55*** (0.14)	0.75*** (0.15)	0.94*** (0.19)	1.05*** (0.25)
$\boldsymbol{\bar{R}^2}$	0.18	0.14	0.25	0.18	0.25	0.18	0.17	0.22	0.40	0.38
F-Test$_{(PSS)}$	6.02**	2.64	4.07	3.77	3.00	2.97	4.38	4.05	2.29	2.38
$\boldsymbol{\beta^+ = 1}$	YES	NO	NO	NO	NO	NO	NO	NO	YES	YES
$\boldsymbol{\beta^- = 1}$	YES	NO	NO	YES	YES	YES	YES	YES	YES	YES
$\boldsymbol{\beta^+ = \beta^-}$	YES	YES	NO$^-$	NO$^-$	NO$^-$	NO$^-$	NO$^-$	NO$^-$	YES	YES
$\boldsymbol{\gamma_0^+ = \gamma_0^-}$	NO$^+$	NO$^-$	NO$^-$	NO$^-$	NO$^-$	NO$^-$	YES	NO$^-$	NO$^-$	NO$^-$

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for β = 1 (YES connotes complete pass-through). $\beta^+ = \beta^-$ and $\gamma_0^+ = \gamma_0^-$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO$^+$ and NO$^-$ indicate positive and negative asymmetry, respectively).

The results presented in table 5.9 showed improvement from that in the previous table as all re-estimated coefficients are statistically significant. Again, the slope-dummies indicated a significant reduction in the size of long-run pass-through after 1996. SDR and 7-day displayed rigidity while other TDRs showed a somewhat complete pass-through. Asymmetries in the short- and long-run for all deposit rates are either negative or insignificant. For LRs, long-run pass-through is significantly overshot both for positive and negative changes. In the long-run, however, LR is positively asymmetric having switched from negative asymmetry in the short-run. The *M.A.L* indicates that MPR changes are fully incorporated into retail rates within two months; though, faster for negative than positive adjustments. The $\bar{R}^2$ show increased explanatory ability of the models ranging 43–80 per cent. For all equations except the SDR, the PSS-test confirmed long-run relationship. Correspondingly, lower AICs are recorded vis-à-vis the preceding model indicating the superiority of the re-estimated model. Overall, the introduction of the interbank market had a significant effect on the pattern of interest pass-through in Nigeria.

Table 5.9: Nonlinear-ARDL Results for Policy Rate Pass-through Including 1996 Dummies

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	3.47	4.63***	5.05***	6.42***	6.60***	6.73***	7.48***	8.74***	3.62***	5.67***
	(2.21)	(1.51)	(1.28)	(1.20)	(1.21)	(1.30)	(1.11)	(0.94)	(1.13)	(1.06)
$\boldsymbol{\alpha}$	-0.37***	-0.43***	-0.49***	-0.60***	-0.60***	-0.62***	-0.66***	-0.77***	-0.28***	-0.41***
	(0.08)	(0.14)	(0.13)	(0.12)	(0.11)	(0.13)	(0.11)	(0.09)	(0.09)	(0.08)
$\boldsymbol{\beta^{+}}$	1.11***	0.57***	0.78***	0.92***	0.92***	1.10***	1.06***	1.09***	1.46***	1.48***
	(0.29)	(0.11)	(0.07)	(0.07)	(0.09)	(0.09)	(0.08)	(0.05)	(0.14)	(0.12)
$\boldsymbol{\beta^{-}}$	1.11***	0.57***	0.79***	0.96***	0.96***	1.14***	1.10***	1.13***	1.39***	1.13***
	(0.18)	(0.11)	(0.06)	(0.07)	(0.09)	(0.10)	(0.08)	(0.05)	(0.14)	(0.12)
$\boldsymbol{\gamma_0^{+}}$	1.00**	0.28***	0.33***	0.44***	0.51***	0.73***	0.71***	0.70***	0.47***	0.61***
	(0.50)	(0.09)	(0.12)	(0.14)	(0.13)	(0.11)	(0.12)	(0.12)	(0.15)	(0.12)
$\boldsymbol{\gamma_0^{-}}$	0.14	0.41***	0.57***	0.74***	0.89***	0.88***	0.86***	0.98***	1.05***	1.18***
	(0.45)	(0.06)	(0.05)	(0.06)	(0.06)	(0.11)	(0.06)	(0.04)	(0.12)	(0.13)
Φ-Dummy		-2.08**	-1.01*	-0.03	-0.27	0.95	0.62	0.73	-0.85	-0.27
		(1.02)	(0.58)	(0.69)	(0.83)	(1.03)	(0.82)	(0.69)	(0.75)	(0.74)
α-Dummy		0.43***	0.52***	0.67***	0.65***	0.69***	0.73***	0.83***	0.31***	0.41***
		(0.15)	(0.12)	(0.11)	(0.10)	(0.12)	(0.12)	(0.07)	(0.08)	(0.07)
δ-Dummy		-0.25**	-0.40***	-0.62***	-0.61***	-0.75	-0.78***	-0.91***	-0.39***	-0.60***
		(0.10)	(0.10)	(0.11)	(0.11)	(0.17)	(0.13)	(0.10)	(0.10)	(0.11)
$\boldsymbol{\bar{R}^2}$	0.18	0.43	0.56	0.63	0.59	0.63	0.66	0.80	0.51	0.60
F-Test $_{(PSS)}$	6.02**	3.15	5.05**	11.28**	12.79**	8.87**	15.81**	29.73**	4.62*	9.19**
$\boldsymbol{\beta^{+} = 1}$	YES	NO	NO	YES	YES	YES	YES	YES	NO	NO
$\boldsymbol{\beta^{-} = 1}$	YES	NO	NO	YES	YES	YES	YES	NO	NO	NO
$\boldsymbol{\beta^{+} = \beta^{-}}$	YES	YES	YES	YES	YES	YES	YES	NO^{-}	NO^{+}	NO^{+}
$\boldsymbol{\gamma_0^{+} = \gamma_0^{-}}$	NO^{+}	YES	NO^{-}	NO^{-}	NO^{-}	YES	YES	NO^{-}	NO^{-}	NO^{-}

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). $\beta^{+} = \beta^{-}$ and $\gamma_0^{+} = \gamma_0^{-}$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO^{+} and NO^{-} indicate positive and negative asymmetry, respectively).

The impact of financial development on pass-through is again investigated by incorporating a proxy to control for its role. This is found to be statistically significant in the equations for IBR, SDR, 3-month, PLR and MLR. As in the previous models, the increases in the level of financial development lowered the spread and possibly the level of interest rates in the retail market though it showed considerably positive correlation with the interbank rate. The size of the coefficients are marginally different from those in the preceding table except, again, for IBR which showed non-negligible changes. Short-run positive pass-through in the IBR equation increased substantially and indicated an overshoot; higher than its long-run and short-run negative counterparts. In the long-run, pass-through is complete for positive but overshot for negative changes. The long-run thus displayed negative asymmetry while in the short-run there is positive asymmetry.

Table 5.10: Nonlinear-ARDL Results for Policy Rate Pass-through Including 1996-Dummies and M2/GDP

		Deposit							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	3.96**	5.23***	5.49***	6.99***	7.31***	7.38***	8.01***	9.16***	5.55***	7.73***
	(1.92)	(1.41)	(1.13)	(1.01)	(1.04)	(1.15)	(0.97)	(0.77)	(1.24)	(1.00)
$\boldsymbol{\alpha}$	-0.44***	-0.44***	-0.50***	-0.61***	-0.60***	-0.62***	-0.66***	-0.77***	-0.34***	-0.45***
	(0.08)	(0.14)	(0.12)	(0.11)	(0.11)	(0.12)	(0.10)	(0.09)	(0.09)	(0.07)
$\boldsymbol{\beta^+}$	1.20***	0.55***	0.77***	0.90***	0.90***	1.07***	1.04***	1.08***	1.37***	1.39***
	(0.21)	(0.10)	(0.06)	(0.06)	(0.08)	(0.09)	(0.07)	(0.04)	(1.10)	(0.10)
$\boldsymbol{\beta^-}$	1.59***	0.56***	0.77***	0.93***	0.93***	1.11***	1.08***	1.11***	1.27***	1.31***
	(0.21)	(0.10)	(0.06)	(0.06)	(0.08)	(0.09)	(0.07)	(0.05)	(0.10)	(0.10)
$\boldsymbol{\gamma_0^+}$	1.40**	0.29***	0.34***	0.45***	0.53***	0.74***	0.72***	0.70***	0.54***	0.65***
	(0.56)	(0.09)	(0.12)	(0.14)	(0.13)	(0.11)	(0.12)	(0.12)	(0.15)	(0.12)
$\boldsymbol{\gamma_0^-}$	0.42	0.40***	0.56***	0.72***	0.88***	0.87***	0.85***	0.96***	1.03***	1.15***
	(0.34)	(0.06)	(0.05)	(0.06)	(0.05)	(0.11)	(0.06)	(0.04)	(0.10)	(0.11)
Φ-Dummy		-1.96*	-1.07*	-0.09	-0.32	0.86	0.59	0.64	-1.81**	-1.52**
		(1.08)	(0.63)	(0.70)	(0.83)	(1.03)	(0.85)	(0.76)	(0.77)	(068)
α-Dummy		0.43***	0.53***	0.69***	0.68***	0.71***	0.74***	0.84***	0.43***	0.53***
		(0.15)	(0.12)	(0.10)	(0.10)	(0.11)	(0.09)	(0.06)	(0.09)	(0.07)
δ-Dummy		-0.27***	-0.41***	-0.63***	-0.64***	-0.77***	-0.80***	-0.92***	-0.52***	-0.73***
		(0.09)	(0.10)	(0.10)	(0.09)	(0.15)	(0.12)	(0.09)	(0.11)	(0.11)
M2/GDP	20.94***	-1.51**	-1.25	-2.05	-2.49*	-2.44	-2.10	-1.76	-4.52***	-6.13***
	(7.44)	(0.67)	(0.86)	(1.39)	(1.43)	(1.60)	(1.55)	(1.70)	(1.33)	(1.15)
$\boldsymbol{\bar{R}^2}$	0.21	0.44	0.56	0.64	0.61	0.64	0.67	0.80	0.52	0.64
F-Test$_{(PSS)}$	8.57**	4.14*	5.61**	11.16**	12.51**	9.48**	15.91**	29.24**	5.86**	14.27**
$\boldsymbol{\beta^+ = 1}$	YES	NO	NO	YES	YES	YES	YES	YES	NO	NO
$\boldsymbol{\beta^- = 1}$	NO	NO	NO	YES	YES	YES	YES	NO	NO	NO
$\boldsymbol{\beta^+ = \beta^-}$	NO^-	YES	YES	YES	YES	YES	YES	NO^-	NO^+	NO^+
$\boldsymbol{\gamma_0^+ = \gamma_0^-}$	NO^+	YES	NO^-	YES	NO^-	YES	YES	NO^-	NO^-	NO^-

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). $\beta^+ = \beta^-$ and $\gamma_0^+ = \gamma_0^-$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO^+ and NO^- indicate positive and negative asymmetry, respectively).

For the retail rates, pass-through is generally higher in the long- than the short-run. Again, SDR and 7-day showed sluggishness both in the short- and long-run. However, while SDR showed no evidence of asymmetry, 7-day exhibited short-run negative asymmetry. Other TDRs suggested complete (and symmetric) pass-through except for the over-12-month rate with statistically significant negative overshoot in the long-run and negative asymmetry both in the short- and the long-run. For LRs, short-run positive pass-through is sluggish compared with a complete negative pass-through. In the long-run, the *Wald*-test showed a significantly overshot pass-through in either stances and for both rates. Test of asymmetry also rejected the null of symmetry for each LR in the short- and long-run. Consequently, the short-run displayed negative asymmetry which switches to positive asymmetry in the long-run.

Controlling for financial development in the model improved the model diagnostics. First, the $\bar{R}^2$ was slightly higher than those in the previous model. The PSS-test now confirmed the existence of a long-run relationship in all equations; including SDR. The *M.A.L* suggested a full adjustment to the long-run level in less than two months in all cases. The negative *M.A.L* may also imply the role of expectation and the pre-emptive nature of banks. The re-specified models also had lower AIC than those in the preceding table thereby indicating that these were better than the earlier models.

5.5.2.2 Results of Asymmetric Interbank-to-Retail Pass-through

Asymmetry in the second phase of pass-through (i.e. market-to-retail) is investigated in this section and reported in tables 5.11 and 5.12. According to table 5.11, positive and negative changes in the IBR, are not transmitted to SDR whether in the short- or long-run. Indeed, significant short-run pass-through for positive IBR changes is only confirmed for TDRs of maturity between 3-months and over-12-months; for negative changes, pass-through holds only for over-12-month TDR in the short-run. In the long-run, all retail rates except SDR exhibit significant pass-through both for positive and negative changes. However, the pass-through is in most cases incomplete and symmetric (in size and speed) both in the short- and long-run. Generally, the models recorded low explanatory power with $\bar{R}^2$ of about 10–31 per cent, while PSS-test provided evidence (*albeit* weakly in some cases) of long-run relationship for most rates. Controlling for financial development again showed that its overall effect on the models is marginal with regards to asymmetry, size, sign and statistical significance of pass-through. Financial development, proxied by the ratio of broad money (M2) to GDP is weakly significant for LRs, and for 7-day to 3-month rates. While its coefficient bear negative signs for DRs, it nonetheless varied positively with LRs. Similar to the previous model, pass-through is generally low and significantly incomplete for all rates both for positive and negative changes in the short- and long-run.

Table 5.11: Nonlinear-ARDL Results for Interbank Rate Pass-through (Excluding Exogenous Variables)

	Deposits							Lending	
	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\Phi}$	1.01** (0.46)	1.82*** (0.55)	2.04*** (0.68)	1.99*** (0.57)	2.71*** (0.95)	2.66*** (0.73)	4.68*** (1.01)	1.67*** (0.56)	1.86*** (0.52)
$\boldsymbol{\alpha}$	-0.15** (0.07)	-0.23*** (0.07)	-0.19*** (0.06)	-0.16*** (0.04)	-0.23*** (0.07)	-0.20*** (0.05)	-0.37*** (0.07)	-0.08*** (0.02)	-0.07*** (0.02)
$\boldsymbol{\beta^+}$	0.01 (0.08)	0.31*** (0.04)	0.50*** (0.08)	0.47*** (0.08)	0.43*** (0.07)	0.45*** (0.08)	0.35*** (0.05)	0.39*** (0.11)	0.54*** (0.11)
$\boldsymbol{\beta^-}$	0.03 (0.07)	0.31*** (0.04)	0.48*** (0.08)	0.45*** (0.08)	0.42*** (0.07)	0.44*** (0.08)	0.34*** (0.04)	0.39*** (0.10)	0.53*** (0.12)
$\boldsymbol{\gamma_0^+}$	0.02 (0.01)	0.01 (0.02)	0.03 (0.03)	0.06*** (0.02)	0.06** (0.03)	0.06* (0.03)	0.07* (0.04)	0.01 (0.02)	0.02 (0.02)
$\boldsymbol{\gamma_0^-}$	0.02 (0.02)	0.02 (0.03)	0.01 (0.05)	0.02 (0.03)	0.04 (0.05)	0.07 (0.05)	0.19*** (0.04)	0.01 (0.01)	0.01 (0.02)
$\boldsymbol{\bar{R}^2}$	0.10	0.20	0.17	0.18	0.15	0.15	0.31	0.11	0.14
F-Test$_{(PSS)}$	2.16	5.79**	4.29*	5.91**	3.81	5.53**	8.23**	5.64**	4.94**
$\boldsymbol{\beta^+ = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
$\boldsymbol{\beta^- = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
$\boldsymbol{\beta^+ = \beta^-}$	NO^-	YES	YES	YES	YES	YES	YES	YES	YES
$\boldsymbol{\gamma_0^+ = \gamma_0^-}$	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for β = 1 (YES connotes complete pass-through). $\beta^+ = \beta^-$ and $\gamma_0^+ = \gamma_0^-$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO^+ and NO^- indicate positive and negative asymmetry, respectively).

The *Wald*-test for asymmetric pass-through could not reject the null of symmetry in the short- and long-run for all retail rates. There is also no evidence of asymmetry in the *M.A.L* in all cases. However, the PSS-test confirmed long-run relationship for all rates except 1- and 6-month rates. Though the $\bar{R}^2$ showed substantial improvement for SDR, it is generally below 40 per cent. The AIC coefficient however suggested that the model without the proxy are not better especially for LRs as well as SDR, 7-day and 3-month rates. Once again, the impact of financial development on pass-through of the interbank rate cannot be generalised for all retail rates.

5.5.2.3 Stylised Deductions from the Nonlinear Models

The deductions from the nonlinear models are similar to those derived from the linear models. The common findings include higher pass-through from MPR versus IBR, declining pass-through post-1996, financial underdevelopment increases mark-up, short-run stickiness relative to long-run, higher pass-through to LR vis-à-vis DR, higher pass-through to MLR than PLR, and pass-through increases with terms of maturity. However, further deductions can be made in terms of the asymmetry in the pattern of pass-through. These are listed below.

(1) *Overall sluggish pass-through from the interbank rate*. Similar to the case in the linear model, pass-through from IBR is never complete whether for positive or negative changes both in the short- and long-run. For the MPR, however, pass-through is incomplete only for SDR and 7-day rates; although it overshot for the negative changes to over-12-month and the LRs.

(2) *No evidence of asymmetry in the interbank market.* Pass-through from the interbank-to-retail rates is symmetric both in the short- and long-run, except for SDR where it exhibited negative long-run asymmetry. Conversely, there are evidences of asymmetric MPR pass-through to IBR and some retail rates in the short- and long-run. Hence, in response to changes in the policy rate, banks would adjust LR and DR differently depending on policy stance.

Table 5.12: Nonlinear-ARDL Results for Interbank Rate Pass-through Including M2/GDP

	Deposits							Lending	
	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\Phi}$	3.26*** (0.66)	2.27*** (0.70)	2.88*** (0.88)	2.54*** (0.63)	3.15*** (1.01)	3.05*** (0.74)	4.69*** (0.99)	1.49*** (0.53)	1.84*** (0.46)
$\boldsymbol{\alpha}$	-0.54*** (0.11)	-0.25*** (0.07)	-0.22*** (0.06)	-0.18*** (0.04)	-0.24*** (0.07)	-0.21*** (0.05)	-0.37*** (0.07)	-0.08*** (0.02)	-0.09*** (0.02)
$\boldsymbol{\beta^+}$	0.01 (0.02)	0.33*** (0.04)	0.53*** (0.08)	0.50*** (0.08)	0.46*** (0.08)	0.48*** (0.09)	0.35*** (0.06)	0.35*** (0.10)	0.43*** (0.09)
$\boldsymbol{\beta^-}$	0.02 (0.02)	0.32*** (0.03)	0.50*** (0.07)	0.47*** (0.08)	0.44*** (0.07)	0.46*** (0.08)	0.35*** (0.05)	0.36*** (0.10)	0.45*** (0.09)
$\boldsymbol{\gamma_0^+}$	0.01 (0.01)	0.01 (0.02)	0.03 (0.03)	0.06*** (0.02)	0.06* (0.03)	0.06 (0.03)	0.17*** (0.04)	0.01 (0.02)	0.02 (0.02)
$\boldsymbol{\gamma_0^-}$	0.02 (0.02)	0.03 (0.04)	0.03 (0.05)	0.04 (0.03)	0.05 (0.05)	0.08 (0.05)	0.19*** (0.05)	0.01 (0.01)	0.01 (0.02)
M2/GDP	-0.43 (0.81)	-1.91* (1.13)	-3.76* (1.90)	-2.41* (1.39)	-2.25 (1.84)	-2.16 (1.72)	-0.04 (2.32)	1.16* (0.70)	2.76*** (0.65)
$\boldsymbol{\bar{R}^2}$	0.35	0.21	0.19	0.19	0.16	0.15	0.30	0.11	0.17
F-Test$_{(PSS)}$	8.01**	5.53**	4.02	6.30**	3.53	5.84**	8.21**	6.87**	8.35**
$\boldsymbol{\beta^+ = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
$\boldsymbol{\beta^- = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
$\boldsymbol{\beta^+ = \beta^-}$	NO^-	YES	YES	YES	YES	YES	YES	YES	YES
$\boldsymbol{\gamma_0^+ = \gamma_0^-}$	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: Author's computations based on data from the CBN.

Note: Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *F*-test$_{(PSS)}$ is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). $\beta^+ = \beta^-$ and $\gamma_0^+ = \gamma_0^-$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO^+ and NO^- indicate positive and negative asymmetry, respectively).

(3) *Positive long-run asymmetry for lending rates but symmetric pass-through to deposit rates.* The LRs displayed positive asymmetry in the long-run, which indicated

that banks tend to increase them during contractionary policy but are less willing to lower them when MPR falls. Long-run pass-through is, however, symmetric for most DRs. The only DR which indicated long- (and short-run) negative asymmetry is the over-12-month rate. Overall, these imply that Nigerian banks are more willing to raise LR than DR thereby maintaining their profit mark-up. They further confirm banks' power in administering prices, and possible inelasticity of deposits and loans activities (given the underdeveloped financial market and dearth of viable substitutes to bank-products). Nonetheless, most retail rates are negatively asymmetric in the short-run indicating upward rigidity which could mean that while banks lowered rates almost instantaneously they transmit increased cost belatedly.

These deductions and those from section 5.5.1.3 are summarised in tables 5.13 and 5.14 below. Overall, the tables show that pass-through from the interbank market is incomplete while direct adjustment is considerably higher after policy changes. Hence, the link from the interbank market to the retail rates is considerably weak. Pass-through also reduced with the introduction of the interbank market suggesting diminished monetary policy transmission following market liberalisation. LRs respond more to policy changes than DRs. In the long-run, this response exhibit positive asymmetry for LR but symmetry for DR, indicating that banks are more probable to incorporate monetary tightening into LR than DR. The negative short-run asymmetry connote that even while lowering rates instantaneously (and raising them belatedly) banks are able to simultaneously maintain profitability and reduce default risk. In the second transmission phase, pass-through from the interbank market is generally low and symmetric. Hence, IBR pass-through is substantially sluggish and linear while that of MPR is, on average, higher and nonlinear. The higher pass-through from the policy rate vis-à-vis the interbank rate corroborates the findings of Sanders and Kleimeier (2004).

The behaviour of LR suggests that banks may ration credit in the short-run but not in the long-run. This follows the upward LR rigidity in the short-run and the incomplete pass-through of the positive changes in the policy rate as seen in tables 5.13 below. This finding is intuitively plausible as banks would be weary of non-performing loans and its costs in the short-run. In the long-run banks compensate for this risk by overshooting the pass-through and raising mark-up further.

Table 5.13: Summary of Pass-through from Policy Rate to Retail Rates

	Linear (Symmetric) Model				Nonlinear (Asymmetric) Model								
	SR-PT	**LR-PT**	**Speed**	**Complete**	**Short-run PT**		**Long-run PT**		**Speed**	**Complete**		**Asymmetry**	
	γ_0	β	α	$\beta = 1$	γ_0^+	γ_0^-	β^+	β^-	α	$\beta^+ = 1$	$\beta^- = 1$	SR	LR
Interbank	0.61 - 0.79	1.01 - 1.52	0.37 - 0.43	YES*	1.00 - 1.40	0.14 - 0.45	1.11 - 1.21	1.11 -1.60	0.37 - 0.44	YES*	YES*	+ve	NO
Deposits Rates													
Savings	0.24 - 0.36	0.15 - 0.55	0.01 - 0.46	NO	0.15 - 0.30	0.21 - 0.41	0.03 - 0.57	0.31 - 0.57	0.04 - 0.45	NO	NO	NO	NO
7-Day	0.36 - 0.49	0.61 - 0.81	0.02 - 0.51	NO	0.11 - 0.35	0.42 - 0.57	0.30 - 0.78	0.51 - 0.79	0.05 - 0.50	NO	NO	-ve	NO
1-Month	0.38 - 0.65	0.71 - 0.88	0.07 - 0.66	YES	0.09 - 0.45	0.50 - 0.74	0.60 - 0.92	0.70 - 0.96	0.08 - 0.61	YES	YES	-ve	NO
3-Month	0.51 - 0.73	0.61 - 0.87	0.11 - 0.63	YES	0.16 - 0.54	0.69 - 0.90	0.63 - 0.93	0.69 - 0.96	0.10 - 0.61	YES	YES	-ve	NO
6-Month	0.45 - 0.82	0.74 - 1.04	0.08 - 0.66	YES	0.23 - 0.74	0.55 - 0.89	0.61 - 1.10	0.73 - 1.14	0.10 - 0.63	YES	YES	NO	NO
12-Month	0.47 - 0.79	0.68 - 1.03	0.09 - 0.66	YES	0.33 - 0.72	0.55 - 0.87	0.63 - 1.06	0.76 - 1.10	0.10 - 0.66	YES	YES	NO	NO
>12-Month	0.61 - 0.86	0.72 - 1.06	0.12 -0 .79	YES	0.32 - 0.71	0.75 - 0.98	0.67 - 1.10	0.78 - 1.13	0.14 - 0.78	YES	YES*	-ve	-ve
Lending Rate													
Prime	0.70 - 0.87	0.86 - 1.46	0.09 - 0.30	YES*	0.28 - 0.55	0.94 - 1.06	0.99 - 1.47	0.94 - 1.39	0.08 - 0.35	YES*	YES*	-ve	+ve
Maximum	0.80 - 1.02	0.82 - 1.60	0.07 - 0.44	YES*	0.32 - 0.65	1.06 - 1.19	1.14 - 1.49	0.98 - 1.39	0.08 - 0.45	YES*	YES*	-ve	+ve

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Figures represent the lower and upper range of estimates extracted from tables 5.3–5.12. *SR-PT* and *LR-PT* stand for short- and long-run pass-through, respectively. Figures under *speed* are reported in absolute values. *Complete* measures the extent of pass-through: *NO*, *YES* and *YES** indicate incomplete, complete, and overshoot, respectively. *Asymmetry* tests for possible lopsidedness in response: *NO*, *+ve*, and *–ve* indicate symmetry, positive asymmetry, and negative asymmetry, respectively.

Table 5.14: Summary of Pass-through from Interbank Rate to Retail Rates

	Linear (Symmetric) Model				Nonlinear (Asymmetric) Model								
	SR-PT	**LR-PT**	**Speed**	**Complete**	**Short-run PT**		**Long-run PT**		**Speed**	**Complete**		**Asymmetry**	
	γ_0	β	α	$\beta = 1$	γ_0^+	γ_0^-	β^+	β^-	α	$\beta^+ = 1$	$\beta^- = 1$	SR	LR
Deposits Rates													
Savings	0.02 - 0.03	0.10 - 0.14	0.09 - 0.12	NO	0.01 - 0.02	0.01 - 0.02	0.01 - 0.02	0.02 - 0.04	0.15 - 0.54	NO	NO	NO	-ve
7-Day	0.01 - 0.02	0.29 - 0.31	0.18 - 0.19	NO	0.01 - 0.02	0.02 - 0.04	0.31 - 0.33	0.31 - 0.33	0.23 - 0.25	NO	NO	NO	NO
1-Month	0.01 - 0.02	0.44 - 0.45	0.16 - 0.16	NO	0.03 - 0.04	0.01 - 0.04	0.50 - 0.54	0.48 - 0.50	0.19 - 0.22	NO	NO	NO	NO
3-Month	0.03 - 0.04	0.41 - 0.42	0.16 - 0.17	NO	0.06 - 0.07	0.02 - 0.04	0.47 - 0.50	0.45 - 0.48	0.16 - 0.18	NO	NO	NO	NO
6-Month	0.04 - 0.05	0.40 - 0.41	0.23 - 0.24	NO	0.06 - 0.07	0.04 - 0.06	0.43 - 0.46	0.42 - 0.44	0.23 - 0.24	NO	NO	NO	NO
12-Month	0.05 - 0.06	0.39 - 0.40	0.20 - 0.21	NO	0.06 - 0.07	0.07 - 0.09	0.45 - 0.48	0.44 - 0.46	0.20 - 0.22	NO	NO	NO	NO
>12-Month	0.11 - 0.12	0.33 - 0.35	0.35 - 0.36	NO	0.07 - 0.17	0.19 - 0.20	0.35 - 0.36	0.34 - 0.35	0.37 - 0.38	NO	NO	NO	NO
Lending Rate													
Prime	0.01 - 0.02	0.39 - 0.41	0.08 - 0.09	NO	0.01 - 0.02	0.01 - 0.02	0.35 - 0.39	0.36 - 0.39	0.08 - 0.09	NO	NO	NO	NO
Maximum	0.01 - 0.02	0.54 - 0.57	0.08 - 0.09	NO	0.01 - 0.02	0.01 - 0.02	0.43 - 0.54	0.45 - 0.54	0.08 - 0.09	NO	NO	NO	NO

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Figures represent the lower and upper range of estimates extracted from tables 5.3–5.12. *SR-PT* and *LR-PT* stand for short- and long-run pass-through, respectively. Figures under *speed* are reported in absolute values. *Complete* measures the extent of pass-through: *NO*, *YES* and *YES** indicate incomplete, complete, and overshoot, respectively. *Asymmetry* tests for possible lopsidedness in response: *NO*, *+ve*, and *–ve* indicate symmetry, positive asymmetry, and negative asymmetry, respectively.

5.5.3 The State-space Model: Analysis of the Dynamic Pass-Through

The estimation of the time-varying pass-through within a state-space framework is conducted only for symmetric MPR adjustments. The dynamics of interbank-to-retail pass-through is disregarded given its poor performance in the preceding ARDL models while we concentrate on linear analysis for simplicity. The model is estimated by setting the lag length at $m = 2$ in order to ensure a manageable parameterisation and simplify the model further. However, to allow for flexibility and ensure an optimal/robust outcome, different combinations of the variances $\boldsymbol{R}$ and $\boldsymbol{H}$ matrices are systematically assumed in our models. This enables us to determine the best specification as follows. First, the models are estimated with general non-negativity constraints in both matrices, and then re-estimated when $\boldsymbol{R}$ and/or the diagonal elements of the $\boldsymbol{H}$ matrix are restricted to zero or unity. This is conducted for two cases: (1) where the long- and short-run components of the state equation are allowed to be stochastic; and (2) where the short-run component is forced to be recursive. Converging models with the smallest AIC statistic is selected as the preferred model. Generally, our analysis selected the second case so that we specific the long-run component of the state equation as stochastic processes and the short-run component as recursive processes.

Analyses in this section focus on the dynamics of the long-run $\{\beta_t\}$ and the immediate $\{\gamma_{0,t}\}$ pass-through.[42] The matrix of exogenous variables $(\boldsymbol{Z}_t)$ included a proxy for the level of financial development $\{z_{1,t}\}$ computed, again, as the ratio of broad money (M2) to GDP and a dummy variable $\{z_{2,t}\}$ that took the value of zero pre-1996 and unity thereafter. The dummy allows for comparability of the interbank equation vis-à-vis the other rates. To ensure robust and valid inferences, model diagnostics are performed on the predicted residual series and evaluated at the 5 per cent level of significance.

Results of the estimated parameters are presented in table 5.15 below. The estimated variances reported are for the random disturbances of the signal equation $\left(var(\eta_t) = \boldsymbol{R} = \sigma^2_{\eta_t}\right)$, and those of the estimated parameters $\{\alpha_t\}$ and $\{\delta_t\}$, where $var(v_{1,t}) = \sigma^2_{\alpha_t}$ and $var(v_{2,t}) = \sigma^2_{\delta_t}$, respectively. The figures suggest low variances in all cases, which exceeded unity only for the over-12-month rate. Table 5.15 also showed the final state of the stochastic and recursive parameters (i.e. the estimated coefficients as at the last data observation, 2011:M1). The first three parameters (i.e. the long-run components) are specified as stochastic processes while the short-run parameters are recursive. In January 2011, 7-day rate showed the weakest long-run pass-through at 3 per cent while MLR with a 38 per cent overshoot is strongest. Immediate pass-through is generally low and ranging 21–64 per cent (lowest: SDR, highest: IBR).

The table further indicated that the intercept term is significant in almost all equations except IBR, 12-month and over-12-month rates. These are higher for LR than DR with IBR in-between. This is reflective of banks' pricing behaviour where LR is marked-up more than DR. Results of the fixed parameters also showed that financial development is somewhat important in the pass-through process; being statistically significant in six

[42] Where $\{\beta_t\} = -\{\alpha_t\}^{-1} \times \{\delta_t\}$ as earlier defined

equations. Furthermore, similar to deductions in the preceding section, financial development varied inversely with mark-up (by reducing banks' power). The last of the fixed level coefficients, the 1996 intercept dummy, is generally not significant in the model indicating that introduction of the interbank rate had not affected the mark-up. Thus, the results for retail rates can be simply compared with those of the IBR without loss of information.

Table 5.15: Estimated Parameters of the State-Space Models

	IBR (1)	SDR (2)	7-Day (3)	1-Mth (4)	3-Mth (5)	6-Mth (6)	1-Yr (7)	>1-Yr (8)	PLR (9)	MLR (10)
$var(\eta_t)$	0.99	0.02	0.22	0.00	1.00	0.10	0.99	1.33	0.00	0.00
$var(\upsilon_{1t})$	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01
$var(\upsilon_{2t})$	0.07	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01
Final State of Stochastic and Recursive Parameters										
α	-1.16	-1.08	-0.50	-0.99	-0.97	-0.96	-0.38	-0.76	-0.82	-0.84
δ	0.65	0.22	0.01	0.61	0.51	0.04	0.26	0.39	0.47	1.16
β	0.56	0.21	0.03	0.62	0.53	0.04	0.68	0.52	0.56	1.38
γ_0	0.63	0.21	0.25	0.26	0.37	0.38	0.41	0.51	0.53	0.56
γ_1	-0.79	-0.01	0.02	-0.10	0.07	-0.05	0.07	0.10	-0.02	-0.08
γ_2	-0.13	0.01	0.02	-0.08	-0.01	-0.04	0.03	0.12	0.01	-0.01
ψ_1	0.09	0.02	-0.08	-0.08	-0.24	0.01	-0.12	-0.09	-0.04	-0.03
ψ_2	-0.03	-0.02	-0.09	0.04	-0.04	0.02	-0.04	-0.08	-0.00	-0.03
Fixed Level Parameters										
Φ	7.06	4.54***	4.09***	5.93**	3.12*	6.88**	3.33	4.15	12.94***	12.85***
	(9.61)	(1.22)	(1.32)	(2.31)	(1.63)	(3.48)	(2.19)	(2.97)	(1.45)	(1.86)
Ξ_1	-0.48***	-0.02	-0.07***	-0.09**	-0.07*	-0.07	-0.06**	-0.05	-0.07*	-0.06
	(0.18)	(0.03)	(0.02)	(0.04)	(0.04)	(0.05)	(0.03)	(0.05)	(0.04)	(0.05)
Ξ_2		-0.82*	-0.32	-0.69	-0.95	-0.24	-0.41	0.15	-0.06	0.45
		(0.46)	(0.86)	(1.31)	(1.02)	(2.74)	(1.69)	(2.23)	(2.60)	(1.49)
LL	-558.6	-363.4	-414.4	-500.1	-518.2	-545.9	-568.6	-623.7	-483.9	-520.9
AIC	6.29	2.37	2.70	3.26	3.37	3.54	3.69	4.04	3.14	3.38
$Q_{k=12}$	4.58	21.25*	9.40	13.00	14.98	11.30	11.20	13.62	24.33**	13.47
	[0.97]	[0.06]	[0.66]	[0.36]	[0.24]	[0.50]	[0.51]	[0.32]	[0.04]	[0.33]
$AR_{h=12}$	0.15	34.01**	1.72	32.35	18.90	30.40	20.22	20.37	14.02	18.61
	[0.99]	[0.02]	[0.98]	[0.05]	[0.28]	[0.07]	[0.18]	[0.17]	[0.41]	[0.27]
J-B ($\times$ 1000)	2.51***	2.02***	5.26***	1.27***	0.83***	1.04***	0.16***	0.43***	3.08***	7.03***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

Source: Author's computations based on data from the CBN.

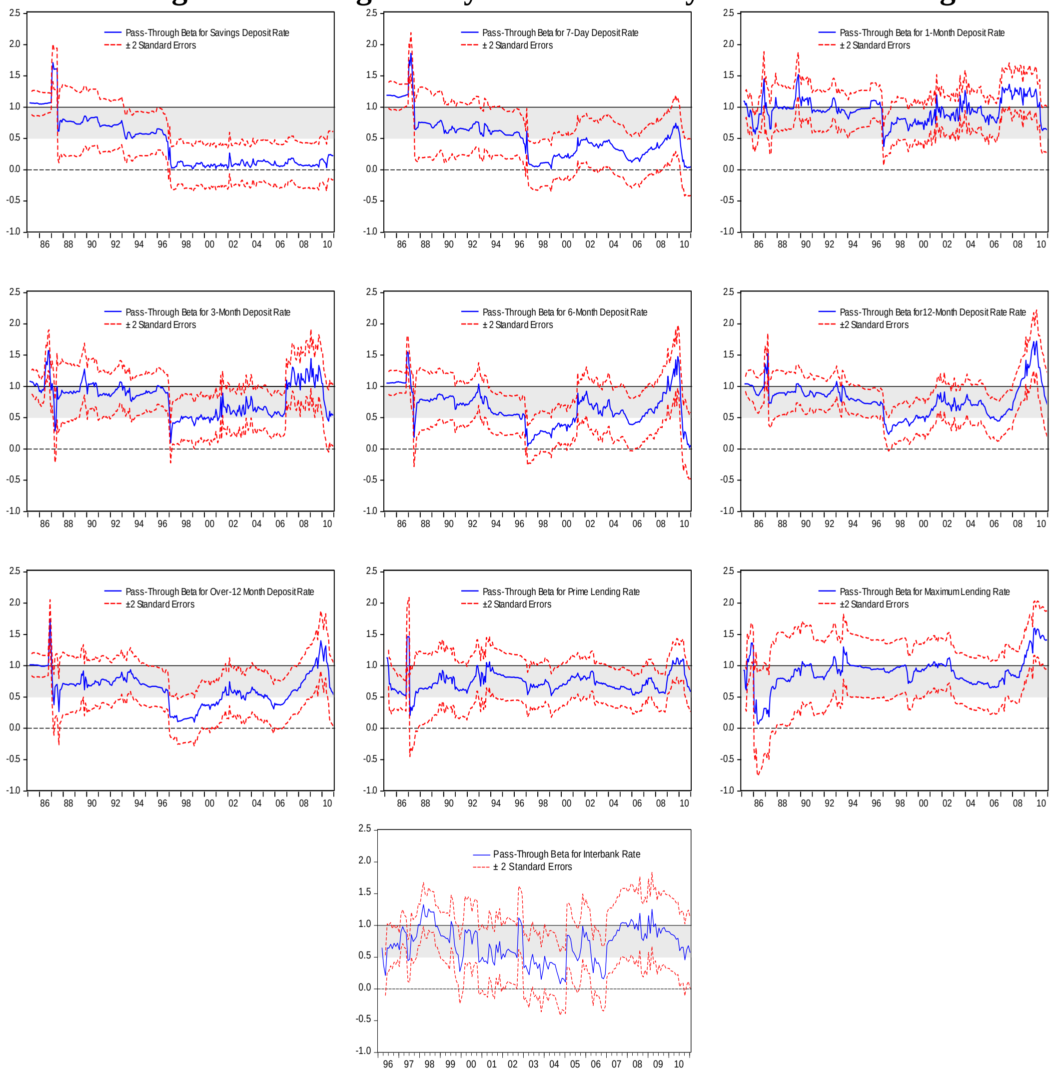
Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1985 to January 2011 except the interbank data which span January 1996 to January 2011. Figures in ( ) and [ ] correspond to standard errors and *p*-values. ***, **, * indicate significance at the 1%, 5% and 10% levels. $var(\eta_t)$ and $var(\upsilon_{it})$ represent the estimated error variances for the signal and state equations, respectively while Ξ is the matrix of coefficients of the exogenous variables. *LL* and *AIC* stand for log likelihood and Akaike information criterion, respectively. Q_k is the Q-statistic for testing k^{th} lag serial-correlation while *J-B* is the Jarque-Bera test for normality. AR_h is the ARCH(h) correlogram Q-test of squared residuals for evaluating heteroskedasticity in h lags.

Robustness analysis is conducted on the predicted residual of the signal equation. According to Commandeur and Koopman (2007), the assumption of independence is considered most important, followed by that of identical distribution. The assumption of normality, though desirable, is the least important the violation of which does not undermine our inferences. To test independence, the *Q*-test of serial-correlation is conducted on the predicted residuals with lag $k = 12$. The null of no serial-correlation up to the twelfth lag is only rejected for PLR. Heteroskedasticity is investigated via an ARCH(h) test of squared predicted residuals with $h = 12$ while normality is tested using the Jarque-Bera statistic. Overall, the diagnostic results for the equations showed that in virtually all cases the models are independently and identically but not normally distributed. Thus, while they may pass as white noise they are nonetheless generally non-Gaussian.

Analysis of the dynamic pass-through of $\{\beta_t\}$ is depicted in figure 5.4. The plot depicts the traverse of $\{\beta_t\}$ together with ±2 standard errors. For most of the series, pass-through tended to be relatively stable until 1986 when the first phase of financial liberalisation commenced. Furthermore, pass-through generally seemed to be statistically complete until 1990s (though it remained above 0.5 afterwards). For SDR and 7-day rates, the series are significantly different from zero at the 5 per cent level prior 1996 but became statistically insignificant, thenceforth. This indicated that SDR and 7-day rates had not responded to MPR changes since 1996. Most other rates, however, showed statistically significant pass-through throughout the sample period with occasional blips of insignificance (or overshoot). IBR exhibited more volatility in the $\{\beta_t\}$ traverse than other rates; though with complete pass-through in general. The results presented in figure 5.4 are comparable with those contained in table 5.3 (which is also uncorrected for slope-dummies). In both sets of results, pass-through to SDR and 7-day rates are largely insignificant but is significant for other retail rates ranging 0.5–1.0 in most cases. Again, pass-through is also higher for LR than DR and has generally diminished most recently.

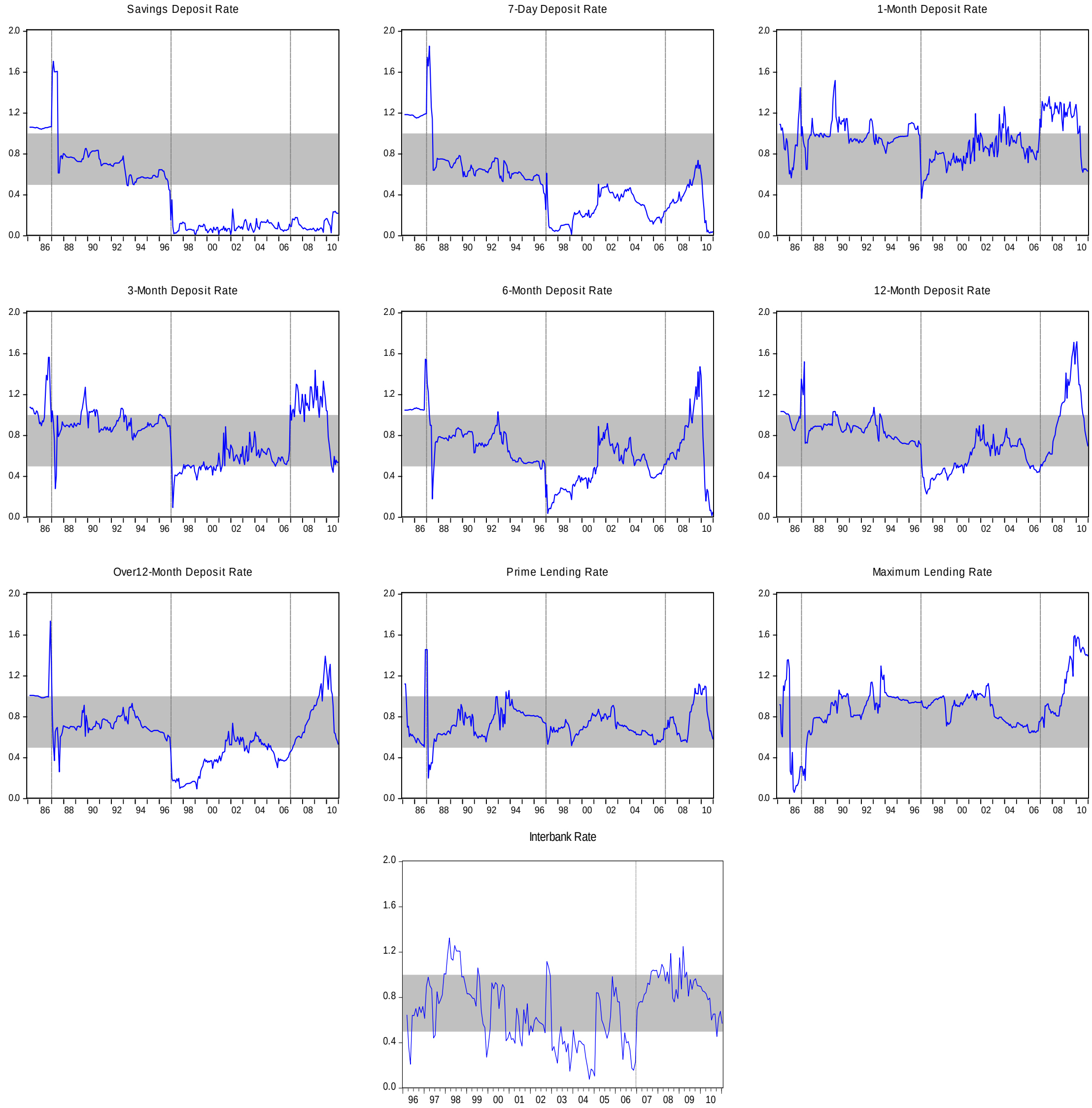
However, the plots indicated some level of uniformity in the trends of the dynamic pass-through. Over time, $\{\beta_t\}$ tended to rise and fall at approximately the same time; thereby suggesting regime shifts. This observation is more discernible in figure 5.5. Three distinct regimes are identifiable *viz*: 1986, 1996, and 2006. This implied a considerable regime shift every decade. Before 1986, the pass-through coefficients were relatively stable owing largely to the prevalent practice of administratively fixing interest rates during that period. The CBN literally set banks' retail rates then. Following liberalisation, banks could freely fix interest rates at their desired levels. Hence, the pass-through coefficients jumped considerably in the retail rates but declined sharply almost immediately. Thereafter, pass-through tended to meander within the 0.5–1.0 band until 1996 when it again diminished rapidly. The 1996 structural break coincided with the introduction of the interbank system which enabled banks to trade among themselves thereby creating another avenue for sourcing reserve aside the central bank. This meant that banks reacted less to MPR, at least for some time, since there now existed another market for reserves.

Figure 5.4: Long-run Dynamics of Policy Rate Pass-Through



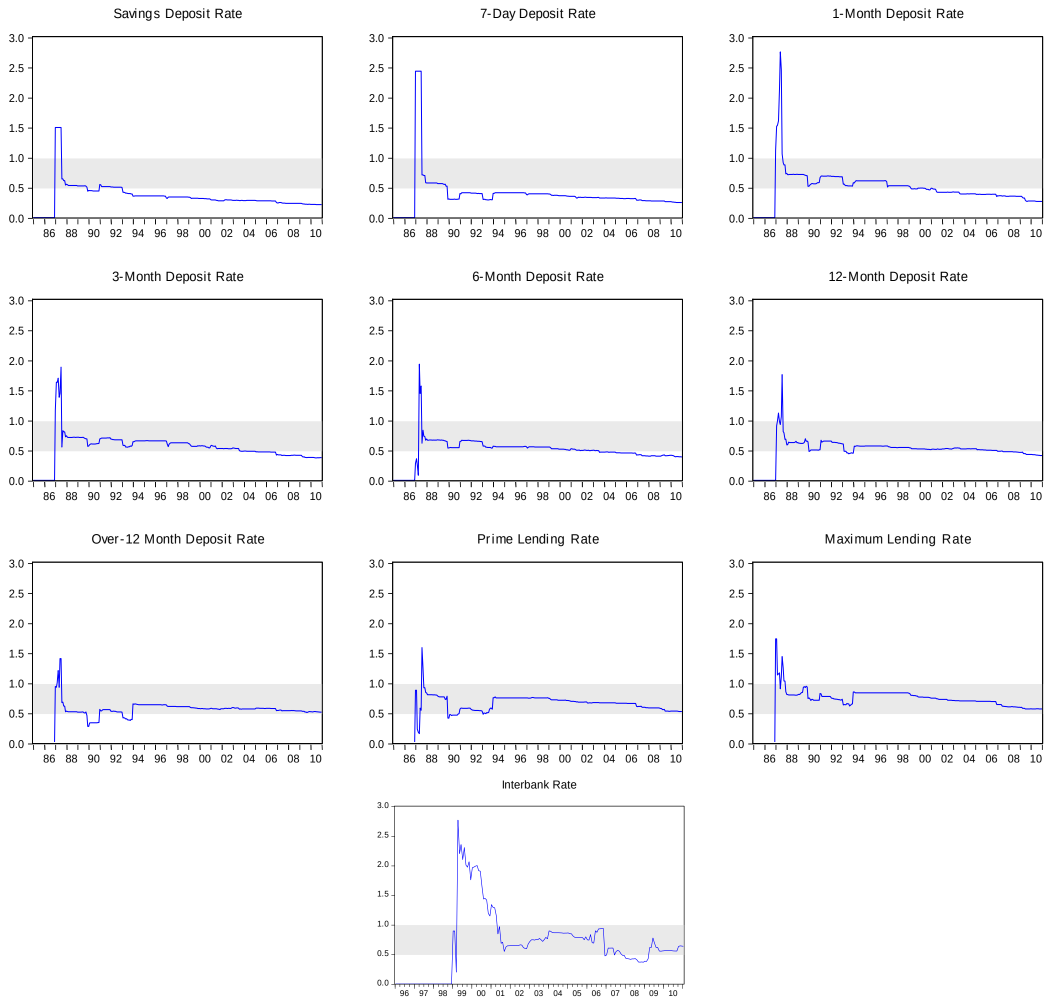
Circa December 2006, another general shift in the pattern of pass-through occurred, which coincided with the MPR reform aimed at ensuring effective anchorage of retail and market rates. Correspondingly, the pass-through coefficient displayed a sudden rise in most rates, causing overshoot in some cases. This suggests that the introduction of the new framework in December 2006 had the desired effect on the retail rates as it elicited higher responses from banks following policy actions. However, this was short-lived. A fourth period of shift (though not highlighted in figure 5.5) was the universal plunge noticeable in 2009. This regime break can be attributed to the concurrent global financial crisis and/or the near collapse of about 40 per cent of Nigerian DMBs due to malpractice, poor corporate governance, and inadequate regulation of the banking system. Besides, this decline corroborated the views of Gropp *et al.* (1995) and Bredin *et al.* (2002) that pass-through diminishes with recessions.

Figure 5.5: Structural Shifts in Policy Rate Pass-through



While the long-run pass-through had largely fluctuated over time, the short-run (i.e. instantaneous) pass-through had maintained a downward trend. The path of short-run pass-through is depicted in figure 5.6. Apart from the one-off jump at about the beginning of the sample, the coefficients of the short-run pass-through showed steady decline. Furthermore, the short-run pass-through coefficients are lower than those in the long-run and are generally incomplete. As noted earlier, the lower short-run pass-through vis-à-vis the long-run suggests that commercial banks do not fully adjust to policy changes instantaneously but rather over a lag. The continued fall in the short-run coefficient can thus imply an ever widening monetary policy lag. This is consistent with the findings in the ADRL estimations. Hence, this state-space analysis confirms short-run rigidity *albeit* at an increasing rate.

Figure 5.6: Time Dynamics of Short-run Pass-Through



Overall, the results from the state-space model do not differ substantially from those of the linear and nonlinear-ARDL models. Thus, general deductions are identical to those in section 5.5.1.3 where pass-through is found to be comparatively higher for LR than DR, among other findings. However, in addition to these, results from the state-space analysis suggested that monetary policy had become less potent over the sample period (apart from the three years between December 2006 and December 2009). This is made obvious by the downward structural shifts of 1986, 1996 and 2009. Monetary policy effectiveness was further debilitated by the low and reducing level of the short-run pass-through, which increased the outside lag of policy changes.

5.6 Conclusion

In recent times, monetary policy in Nigeria has evolved to the use of the short-term interest rate to moderate inflation. This is thought to be transmitted via a number of channels including the interest rate channel which describes the responsiveness of market and retail rates to policy rate. Transmission under this channel can be divided into two stages *viz*: policy-to-market and market-to-retail (de Bondt, 2005). The design of this form of monetary policy assumes a complete pass-through at each stage of transmission. However, the robustness of the interest rate channel in an economy is directly related to the level of development of the financial market (Gigineishvili, 2011). For developing countries with weak and unsophisticated financial markets monetary policy, via this channel, may be less effective (Weeks, 2009; 2010). Hence, the structure of the interbank market would play a key role in the monetary policy process. In Nigeria, the interbank market is pivotal in the monetary policy design. The CBN regularly monitors this market to conjecture developments in the retail market and state of the real economy in general. Hence, efforts are continually made to effectively anchor IBR to MPR. However, even if these were properly linked, a necessary condition for effectiveness of this type of monetary policy is that retail rates be adequately anchored as well.

Under the interest rate channel, the pass-through from policy rate may differ between rates, markets, maturity and policy stance. Furthermore, the size and speed of pass-through may change over time so that in some periods, monetary policy may be more effective than in others. This chapter investigated the pattern of policy-to-market (and -to-retail) and market-to-retail pass-through in Nigeria. The methodologies adopted allowed us to determine the size, speed, and time-path of interest rate pass-through in the short- and long-run. Empirical investigation was conducted to capture the practicalities of monetary policy in Nigeria. Thus, the analyses tested the transmission from policy to interbank and then to retail rates while including a proxy to control for the impact of financial (under)development.

Among the key findings was that the link between interbank and retail rates is weak while pass-through from policy rate is higher. This can reduce the effectiveness of monetary policy since the CBN attempt to influence retail rates via the interbank market. The fact that retail rates responded directly to policy changes suggested that policy may nevertheless be effective and that the CBN may have to de-emphasise its focus on the interbank market. The current practice of deducing the course of the real economy from the performance of the interbank market alone may be misguiding and may lead to wrong policy outcomes. Arguably, the weak market-to-retail link is attributable to sharp (daily) fluctuations of IBR, reflecting market conditions, relative to infrequent (monthly or sometime quarterly) adjustment of retail rates. The infrequently altered retail rates would thus associate more with the policy rate which also changes occasionally. This was hinted by Borio and Fristz (1995) who opined that in the face of a volatile money market the policy rate may explain changes in the retail rates better. Therefore, the two phases of monetary policy may not be statistically relevant to the Nigerian case and there may just be one phase which the CBN ought to monitor.

In fact, not only is the pass-through from IBR low, the introduction of the interbank market itself had a diminishing effect on the pass-through process. The market was introduced in 1996 to, among other things, deepen the financial market and enhance the transmission of monetary policy. Financial deepening, generally, should afford economic agents (banks, households, and enterprises) alternative avenues for sourcing and investing their funds. However, the interbank market only granted this access to banks and, inevitably, increased their market power over retail customers thereby debilitating the transmission process. The actions of the CBN, in 2006, aimed at improving the link between policy, interbank and retail rates had a temporary positive impact which tapered-off after three years. Financial development was found to have a significant effect on the pattern of pass-through from policy rate to retail rate but a moderate effect on the pass-through from IBR. It nonetheless reduced the mark-up in most interest rates. The continued shallowness of the Nigerian money market may be connected to the dominance of government securities over corporate securities and the crowding-out of non-bank public by the banking system. This then have the overall effect of putting bank customers in a disadvantaged position, increasing banks’ power and undermining the pass-through.

Another important finding is the existence of short-run stickiness relative to the long-run, which is consistent with the findings of Mojon (2000), de Bondt (2002, 2005) and Gropp *et al.* (2007) among others. As observed earlier, policy would be more effective if immediate pass-through is large. While short-run pass-through was fairly large in some cases it was nonetheless incomplete in most cases and was consistently less than the long-run coefficient. The time-varying analyses further revealed that the short-run coefficient had a downward trend. This indicated that monetary policy was becoming less effective with time; because as the immediate response diminishes, the full adjustment lag would be elongating *ceteris paribus*. On the average, the *M.A.L* of the ARDL models suggested that monetary policy changes were completed within eight months for most DRs, three months for LRs and one month for IBR. The continued decline of the short-run pass-through means that the lags can get even longer. If it takes three to eight months (or more) for the interest rates to fully adjust, then it would take even longer for policy to impact on the real economy. Again, this has implications for the overall effectiveness of monetary policy.

The low level of financial development which limits the access of non-bank private sector to the market tilts market power in favour of the banks vis-à-vis their retail customers and weakens the transmission process. Empirical analysis provided further evidence of increased market power of banks in the system. First, pass-through was higher to LRs than DRs; consistent with de Bondt (2005), Gropp *et al*. (2007), Hoffman and Mizen (2004), and Sørensen and Werner (2006). This unequal response would affect the relative prices between cost of borrowing and money's own rate thereby altering the spread. According to Biefang-Frisancho Mariscal and Howell (2002) this ought to make monetary policy more effective. This would be true for a credit-driven economy while it would indicate ineffectiveness in a savings-based one. Given that NCM model is derived from household inter-temporal optimisation of consumption (and savings), the result can portend overall ineffectiveness. Second, pass-through to retail rates is in part asymmetric. While LRs exhibited positive long-run asymmetry, DRs responded symmetrically. Thus, banks are willing to raise LRs following monetary tightening but reluctant to lower them during ease; thus, maintaining high profit mark-up. This is indicative of inelasticity of retail customers to both deposits and loans, which is again attributable to financial underdevelopment and dearth of viable substitutes for bank products.

Furthermore, Nigeria banks are not risk-neutral as indicated by the consistently higher pass-through to MLR than PLR (both in the short- and long-run). Theoretical discussions in the literature suggest that banks would protect their prime customers from volatility in the market while conveying more of the changes to ordinary customers. In addition, underdeveloped markets may be more exposed to the problems of adverse selection and moral hazards. Hence, rather than ration credit banks may incorporate risk premium into the interest rates they charge (Sander and Kleimeier, 2004; Gropp *et al.*, 2007). However, our finding of negative asymmetry, instantaneously, suggests the possibility of rationing at least in the short-run. The higher pass-through to MLR may be indicative of the risky nature of the market, so that the MLR-PLR spread reflects the risk premium which banks charged over and above the normal mark-up on PLR. In some cases, overshot pass-through is estimated for LRs. The PLR overshoot showed banks' market power and ability to charge excess mark-up even on relatively less risky loans while MLR incorporated risk premium in addition to the excess mark-up.

Overall, the analysis indicated that pass-through is stronger from policy to retail rates. However, the size of pass-through both in the short- and long-run had diminished over time. Thus, monetary policy (in the form of interest rate policy) had become weaker with time and the response lag of policy is increasing. While the inability of IBR to anchor retail rates may essentially pose no threat, the considerable market power of DMBs in price determination had an adverse effect on the pass-through process. This may be reflective of the inadvertent exclusion of non-bank private sector from the money market and low substitutability to DMBs' products. In essence, for interest rate policy to be effective in Nigeria there may be the need to ensure that financial markets are deepened, so that all players and agents have considerable access to the market, and there is a wide array of instruments and securities to choose from. Secondly, the CBN may need to de-emphasise the focus on the interbank market as it is more-or-less redundant in the monetary policy transmission process.

6 THE EFFECTIVENESS OF MONETARY POLICY IN NIGERIA: HOW RESPONSIVE IS PRIVATE INVESTMENT?

6.1 Introduction

While pass-through to retail rates assumedly reflects the first effect of monetary policy, the intermediate effect is captured in the reaction of AD and/or its components. For many developing countries like Nigeria, the understanding of this responsiveness remains inadequate. Monetary policy effects may differ among AD and its components. These differences may even be wider, depending on the country's level of financial and real development, thus, culminating in ambiguous policy outcome under IT and NCM framework. Key components of AD usually considered here are consumption and investment although the NCM model places emphasis, almost exclusively, on consumption. Given the nature of the Nigerian economy and the importance of financial markets for investment, this chapter focuses on the responsiveness of investments to monetary policy changes in the interest rate.

Changes in monetary policy stances may affect investment via two main channels: the credit and the interest rate channel. This is so because the ability of CBs to change the short-term nominal interest rates enables them to influence the conditions in the credit market (Fontana, 2009b) and the viability of investment projects (Stiglitz and Greenwald, 2003). Thus, monetary policy would have both price and quantity impacts on investment. Increases in the interest rate will increase the cost of capital, reduce the viability of projects, increases uncertainty and risks associated with investments, and reduce the amount of finance (both internally and externally) committed to investments. Credit demand and total investments would thus be reduced. By the same token, the risk and uncertainties of investments impedes banks' willingness to lend (given the possibility of lower expected profits if the borrowers default). Thus, credit rationing and/or reduced demand for loans lower the overall credit allocated to the private sector, which subsequently leads to reduced investment. However, even when credits are unconstrained, changes in the interest rate may have an overriding impact on investment. Traditionally the relationship between investment and interest rates are deemed inverse, although recent empirical and theoretical studies have shown that the relationship can be rather complex and dependent on a number of conditions.

For developing countries with unsophisticated institutions and markets, investments may depend more on other factors than those related to monetary policy. In these countries, firms would rely more on internal financing rather than external sources (Fry, 1995). This is because large informal sector and underdeveloped money markets leads to the financial exclusion of many potential investors both from the capital and the money markets. Another critical determinant relevant for developing countries is the scale of public sector investments in infrastructure and amenities. In this regards, public investment, rather than crowd-out private investment, would complement it by providing a favourable investment field (Greene and Villanueva, 1991).

Though the focus of this chapter is to investigate the effect of monetary policy (particularly interest rates) on investment, the empirical analysis is conducted to estimate, as extensively as possible, the impact of other important determinants. The analysis is conducted using quarterly data spanning 1985:Q1–2011:Q2 for a number of variables including average lending rates, private and public sector investments, and GDP, among others. A total of fourteen explanatory variables entered the initial empirical framework but were later pruned to six by using various tests to eliminate highly collinear or redundant variables. Econometric estimations of the relevant elasticities followed an ARDL cointegration framework, to accommodate the non-stationarity of economic variables. This enabled us to investigate possible nonlinearity in the interest-rate-investment relationship. Given the dichotomy of the Nigerian economy, the analysis is conducted for oil, non-oil and total investments.

The results generally indicate a monotonic but nonlinear relationship between the interest rate and investments in Nigeria. This nonlinearity does not depend on the level of interest rate, but rather on the size of change and stance of monetary policy. Essentially, large changes (of about 150 basis points or more) in monetary policy rates induce a sizeable inverse effect on investment while the effects of moderate changes are ambiguous. These effects are larger for the non-oil sector (which may be financially constrained) than the oil sector (which is deemed to always have sufficient financing). The results also indicate that credit availability have a positive effect in the short-run but reduce investments in the long-run. This may be due to the practice of short-term (rather than long-term) lending among Nigerian banks. Political and economic uncertainties are also found to lower long-run investments. Overall, government investment is found to be the most important determinant of investment in the long-run, where it showed a complementary effect; although in the short-run, it tended to crowd-out private investment. The long-run complementarity may be due to the provision of enabling business/investment environment, while the short-run substitutability is attributable to excessive competition for external funds with the private sector. In general, the results suggest that as long as monetary policy changes are sizeable (and affect the credit availability) it may be able to control investment and AD. However, given that the recent monetary policy norm is to adjust policy rates by between 25-50 basis points, this implied that policy would be ineffective in achieving its objective and can even cause distortions to the system.

The rest of the chapter is divided into ten sections. In section two, following this introduction, a brief justification is provided for studying the investment component of AD rather than the consumption component which is the core of the NCM derivation of AD. Section three contains theoretical and practical discussions of the impact of monetary policy on investment particularly with regards to the price and quantity effects. A general outline of the competing standard theories of investments is conducted in section four, while the discussion is narrowed to developing countries in section five. Sources and types of data as well as stylised analysis are presented in section six, while section seven shows the methodology and presents the model specification. In section eight, econometric analysis is conducted; the results and implications of which are then discussed in section nine. The chapter concludes in section ten.

6.2 Monetary Policy and Aggregate Demand: Why Study Investment?

In the NCM model, monetary policy is represented by an interest rate rule (like the Taylor rule) the effect of which is transmitted through an *IS*-type AD equation to the overall target of inflation (Arestis, 2007; Arestis and Sawyer, 2008b; Clarida *et al.*, 1999; and Meyer, 2001).[43] It is implicitly assumed, within this model, that policy induced changes in interest rates would impact on the components of AD, especially consumption and investment. Responses of these components would then be reflected

[43] In the literature, the NCM model is also variously referred to as the new-Keynesian or new neoclassical synthesis models.

in the AD. However, the degree or pattern of responsiveness of individual components may (or may not) differ comparatively. In some economies, it may be possible that investments respond more to interest changes than consumption, while the converse may hold for other economies. It may also be possible that these components respond equally to policy changes, or do not respond at all.

Many academics and policymakers recognise the significance of investment in the monetary transmission process through the AD channel (Emmons and Schmid, 2004). Yet, according to Arestis and Sawyer (2008a, 2008b), most recent researches on the NCM model (as expounded for instance in Galí (2008), Walsh (2003,ch.5) and Woodford (2003,ch.4)) have focused on the link between inter-temporal household consumption and AD. Thus, implying that monetary policy affects AD solely through households' decision to consume or save. In these works, the direct effects of interest rate through the investment expenditure are usually overlooked and are surmised via the savings channel. McCallum and Nelson (1997) somewhat justified the exclusion of investment from the AD framework and argued that

> "there is very little connection at cyclical frequencies between capital stock movements and those in aggregate output and consumption variables. In large part this is because a typical year's investment is very small in relation to the existing stock of capital" (p.7).

However, AD is determined by investment flows rather than stock of capital (Baddeley, 2003). Thus, as noted by Dupor (2001) this line of argument mislays the *raison d'être* for endogenising investment in the NCM framework – not only is investment a substantial part of GDP, it is also the most volatile component of AD (e.g. it more than quadrupled consumption volatility in the USA). Baumann and Price (2007) equally observed that, in the UK, investment accounted significantly for oscillations in AD and is twice more volatile than other components. According to Fazzari *et al*. (2010), the absence of an explicit analysis of investment behaviour is puzzling. They noted that

> "[w]hile abstracting from investment [in the NCM model] may improve tractability, this modelling choice

> eliminates a cyclically volatile component of [AD], an important channel through which interest rates affect demand, and the most widely studied linkage between financial markets and macroeconomic performance" (p.2010).

Their analysis showed that the interest rate elasticity of investment is more important in explaining monetary policy transmission than the usually preferred elasticity of consumption. This is consistent with the view of Modigliani (2003) who opined that the interest rate elasticity of consumption would generally be less significant than that of investment. Furthermore, Angeloni *et al*. (2003) and Peersman and Smets (2003) provided evidence that monetary policy effect of AD in the Euro area is predominantly driven by investment rather than consumption. In addition, Dupor (2001) and Fazzari *et al*. (2010) suggested that accounting for the elasticity of investment in the NCM framework enhances stability and determinacy of the model. These studies, therefore, represent a compelling rationale for studying the monetary policy effect of investment in a NCM framework. Nonetheless, studying both investment and consumption, concurrently presents a challenge in terms of thorough treatment of the subject and lack of proper focus. Hence, one may decide to conduct separate but detailed analysis of both components. For reasons of space and given that the overall focus of the study is for a developing country, Nigeria, the analysis of AD would be conducted only for investment.

For developing countries, there may be other far reaching reasons to concentrate on investment rather than consumption. This is centred on poverty and its effect on consumption and savings. For many poor people, inter-temporal consumption is quixotic as all their income is consumed contemporaneously on necessities and consumption is irresponsive to interest rate changes. However, the NCM model assumes that all households are not only rational but able to choose between contemporaneous consumption and saving depending on interest rate dynamics. This implicitly assumes generally well-to-do households with a conventional liquidity preference. Rising interest rates, thus, increases the opportunity cost of consumption and households would prefer to save by channelling their money into interest bearing deposits and deferring consumption. According to Kieler and Saarenheimo (1998), the effectiveness of interest rate in this case, however, depends on the level of income and the marginal propensity to spend. Higher consumption propensity implies smaller savings, while at the same time lower levels of income heightens propensity. Essentially, interest rate elasticity of household decisions diminishes with consumption propensity. Implicitly, the NCM assumes that propensity to consume out of current income is always significantly less than unity, so that household consumption decisions are interest rate elastic. In many poor developing countries, this assumption maybe violated since overall consumption propensity would be near unity. This would lead to a collapse of the inter-temporal optimisation analysis, thus enfeebling the core of the NCM-based monetary policy. For Nigeria particularly, the NBS (2010b) reported that up to 83.1 per cent of household disposable income was consumed between 2007 and 2010, suggesting a propensity of 0.83 overall. This presents a strong indication of possible inelastic response of household to monetary policy changes in the interest rates. However, the aggregate impact would depend on other characteristics of the country e.g. the incidence of poverty.

Developing countries have many poor people. The World Bank defines poverty "as not having enough today in some dimension of well-being" like income or consumption.[44] In very poor societies, household's propensity to consume would be extremely high so that saving is on the average very low. Poverty and underdeveloped financial markets mean that access to consumer credits in developing countries is limited – since poverty would usually connote lack of adequate/acceptable collateral. With the inability to save and the lack of consumer credit, consumption will not respond to interest rate changes.[45] Nigeria is characterised as a developing country with a high incidence of poverty. According to information on the World Bank website, the 2004 poverty headcount shows that about 83.9 per cent of Nigerians live below $2.00/day, while 64.4 per cent are below $1.25/day. Given this substantial level of poverty and the high propensity to consume, it therefore can be deduced that quantitative interest rate interaction with (inter-temporal) consumption would be minimal. Thus, the interest rate effect of AD in Nigeria can be augmented via its

[44] See discussions on *Measuring Poverty: Defining Welfare Measures* from the World Bank website: http://web.worldbank.org/... accessed October 7, 2011.

[45] Elasticity generally depends on the proportion of income spent on a particular commodity and the degree of substitutability. For poor people, who often spend almost all their income on food which has no close substitutes, the interest rate elasticity of consumption (of such a necessity) would thus be zero.

investment component. This chapter would consequently concentrate on the responsiveness of investments to changes in the interest rate.

6.3 Competing Theories on the Determinant of Investment

While economists agree on the importance of investment in an economy there are, however, divergent views on its core determinants. The different theories discussed in the literature include the neoclassical, accelerator, Tobin's-*q*, real options, post-Keynesian, and Kaldorian/Kaleckian models, among others. A brief discussion on these theories is provided in this section.

6.3.1 The Neoclassical Theories

As stated earlier, the neoclassical theory generally derived from the works of Fisher (1930), Jorgenson (1963) and Modigliani and Miller (1958). It is hinged on the assumptions of a perfect capital market *cum* a rational and profit maximising investor.[46] There is also the assumption of an optimal capital stock towards which the firm adjusts so that investment is based on the desire to attain this optimal level of capital stock. In general, investments are considered reversible and instantaneous – i.e. without adjustment costs (Munthali, 2008).[47] Jorgenson's contribution to neoclassical analysis includes the assertion of perfect capital-labour substitutability and the incorporation of taxes and relative prices into the user cost that determines optimal capital. Neoclassical analyses emphasise the role of the interest rate (or the user cost of capital) in the investment process and suggest an inverse investment-interest rate function. They also recognise the accelerating effect of output in the investment model. However, neoclassical theories have been criticised for a number of their assumptions. These criticisms centre on the non-recognition of the adjustment costs and delivery lags as well as the assumption of independence between investment and financing decisions (Baddeley, 2003).[48]

6.3.2 The Accelerator Theories

Different versions of the accelerator theories have been developed over time. The crux of these is, however, the assumption that growth of output demand/sales is the key

[46] Modigliani and Miller further assumed that the cost of capital is independent of source of the capital.
[47] According to Munthali (2008) neoclassical analysis assumes the existence of a perfect second hand market for capital goods so that if fixed investment becomes non-viable firms can easily dispose of such capital goods at no cost.
[48] See Baddeley (2003) for a full treatment of these criticisms.

driver of fixed investment. By emphasising output rather than cost effect, accelerator theories are based on a Keynesian sticky price framework (Baddeley, *op.cit*). The theories assume the existence of an optimal/desired capital stock adjustment which determines the evolution of investment. Like the neoclassicals, initial accelerator models supposed immediate adjustments of capital stock and static expectations; an assumption that was corrected in later models. However, accelerator models assume a fixed capital-labour ratio in contrast to the flexible ratio of the neoclassical model. The various accelerator models are discussed below.

6.3.2.1 Fixed Accelerator

The fixed (or simple) accelerator model represents the earliest version of the models and is considered in some sense naive due to its underlying assumption. It is essentially based on the Keynesian framework of fixed-prices with no factor substitutability and the absence of dynamics in adjustment and expectation (Baddeley, *op.cit*). The implied instant adjustment of capital stock imposed by the model is an unjustifiable restriction (Erdinc, 1997). This is because lags are fundamental to the investment process since decisions taken in previous periods affect current investment spending. Simple accelerator models, in addition to the theoretical shortcomings, also lack empirical support in the literature especially due to the absence of lags.

6.3.2.2 Flexible Accelerator

Given the inability of the simple model to effectively explain capital adjustments, the flexible model was developed. This introduced distributed lags structures into the models using Koyck's transformation (Munthali, *op.cit*). According to Baddeley (*op.cit*) the introduction of dynamic lags into the model was essential to the understanding of capital adjustment as this portrays the partial adjustment process inherent in the investment process. Lags are important because they capture delays in investment decisions, ordering, installation, etc. The introduction of lags also encapsulates the effect of expectations in the investment process. Unlike the simple version, flexible accelerator models found more empirical support in the literature. However, lack of *a priori* knowledge of the optimal lag length meant that its introduction was *ad hoc*. This, together with the retained assumption of a fixed capital-labour ratio, formed the main criticism of the flexible accelerator model.

6.3.2.2 Financial Accelerator

Technically, the financial accelerator theory differs from the previous variants in that it links macroeconomic changes in output (i.e. AD) to microeconomic (i.e. firm level) investment decision through the financial markets, while the previous variants associated a firm's demand with its investment. It is based on the crucial role of external finance in investment in an imperfect credit/capital market. The ability of firms to borrow from the financial market depends on the net-value of their assets. In the presence of asymmetric information between lenders and borrowers (and the associated problems of moral hazard and adverse selection), credit worthiness is assessed mainly by the net-worth of a borrower's collateral. Borrowers with more collateral have higher net-worth and can access external finance more cheaply (Peersman and Smets, 2001). Thus, financial accelerator principle is due to the dependence of external financing cost on the borrower's net-worth (Bernanke and Gertler, 1989). The principle suggests that declines in aggregate output would reduce investment, since asset prices deteriorate with recession. This reduces net-worth, worsens financing condition, raises the cost of capital and increases credit rationing. The inability to generate sufficient funds affects investment expenditure adversely. Inadequate investment, in turn leads to lower economic activity which furthers the recession. The effect continues in a loop and ceases only when an appropriate exogenous shock ensues. A basic limitation of this principle is that this financial acceleration may be propagated differently during recession than during boom an effect not captured adequately by the model.

6.3.3 Tobin's-q Model

An important feature of the neoclassical and accelerator theories is the omission of the roles of uncertainty, expectations and adjustment costs in the investment process. The q-theories that emerged, consequently, tried to capture these directly via a dynamic optimisation analysis (Baddeley, *op.cit*). Q-theories infer expectations and uncertainty from the stock market information and distinguish between internal and external adjustment costs; the former affecting only the (representative) firm, while the latter affect the entire industry/macro-economy. In the Tobin's-q model, investment by a profit maximising firm is decided by weighing the market value of capital (mv) against its replacement cost (rc) [i.e. $q = mv/rc$], assuming a perfect capital market.

Investment is postulated as a positive function of q and is undertaken only if $q \geq 1$. Though, the q-theories have some empirical success, they are nonetheless fraught with a number of problems both practical and econometric. Citing Turner (1993), Munthali (*op.cit*) noted the practical difficulty of accurately pinpointing a firm's return from stock market data. Baddeley (*op.cit*) annotated the problems of serial-correlation which has bedevilled the theory due probably to the inability of the stock market data to adequately capture of uncertainty.

6.3.4 The Real Option Theories

All the investment theories presented so far inadequately incorporated uncertainty and inherently assumed reversible investments. The real options theories posit that in the real world investment in fixed assets are irreversible. This is because investment involves a sunk cost and market for second hand capital goods is limited. Inability to reverse investment (i.e. disposing existing capital at no cost) inflicts further cost on the firm when such investment loses viability (Baddeley, *op.cit*). In an uncertain world the probability of success or failure of an investment venture in the future is unknown. A combination of uncertainty and irreversibility of investment forms the basis of the real options theories as exposited by Dixit and Pindyck (1994). The theory postulates an inverse relationship between investment and uncertainty for rational profit maximising investors. Essentially, in the presence of uncertainty it pays a firm to delay investment and wait for additional information. This additional information may be the only difference between the success and failure of investment. Accordingly, without acknowledging the opportunity cost associated with the option to investment, using the standard discount rate analysis may lead to over-investment. In real options analysis, uncertainty is treated as measurable and is usually proxied in empirical studies by the variance(s) of some macroeconomic variables.

6.3.5 Post-Keynesians Theories

Post-Keynesian analysts of the determinants of investment reject the assumption of rational expectation and profit maximisation which underlies some of the other theories discussed so far. They also contest the measurability of uncertainty as expounded by the real options model while concurring with its inverse effect on investment. Following Keynes, they emphasise the importance of psychological factors (like animal spirit and herd behaviour) on investments as against rationality.

Post-Keynesians theories are hinged on the "limits to rationality, the importance of profits and the effects of money and finance on investment activity" (Baddeley, *op.cit*, p.133). They also reject the Modigliani and Miller (1958) assertion of financing inconsequentiality and argue that costs would vary with sources of finance as financial markets are imperfect. For instance, they highlighted the distinction between the cost of internal versus external financing of investment. The analyses of internal versus external financing by Michal Kalecki and Nicholas Kaldor are prominent in this area of the post-Keynesian theories.

Kaleckian/Kaldorian theories analyse the importance of profit/cash-flow in the capital accumulation process. According to these, a profitable firm would access external finance cheaper than a less profitable firm. Moreover, profit relates positively with cash-flow and increases institutional savings. A firm with high retained profits can finance more investments internally at zero interest rate. Indeed, profit reduces the cost of investment in two ways: it increases the proportion of zero-cost internal finance; and, it enhances the ability of firms to borrow cheaply (since it raises the net-value of the firm). Investment is therefore postulated to vary positively with profitability. Kaleckian/Kaldorian approach, nonetheless, recognises the bi-directional relationship that existed between investment and profit. In addition to profit, Kaleckians emphasise the significance of capacity utilisation to investment and postulate a positive relationship. Thus, investment would only be undertaken when a firm's expected demand/sales exceeds its installed capacity (Sawyer, 1982; 1999; Fazzari and Mott, 1986). Capacity utilisation and/or its changes are considered critical for investment. Investment under the Kaleckian/Kaldorian approached is thus determined by profits/cash-flow, corporate savings (or retained profits), and capacity utilisation (or expected demand/sales).[49] Generally, post-Keynesians also advocate the role of government in curbing financial markets speculations thereby reducing the concomitant uncertainty.

6.4 Monetary Policy and Private Investment

According to Fontana (2009b), "by adjusting the short-run nominal interest rates, [CBs] are able to affect lending conditions in the credit market and, more generally, to

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[49] There are a number of differences between Kalecki's and Kaldor's treatment for instance on issues of savings, retained profits and distribution at macro and/or micro levels. However, we provide only a peripheral and brief discussion of their views of what factors they generally considered important.

determine the cost and availability of liquidity throughout the economy" (p.110). Monetary policy changes in the interest rate would have both price and quantity effects on banks' behaviour which are conveyed to investors directly or indirectly. The price effect is seen through the pass-through to banks' interest rates while the quantity effect comes via the amount of credits available to private investors. This credit channel may be seen as the indirect route through which monetary policy affects investment, while a more direct effect is associated with the hurdle rate for discounting investment. Changes in interest rate, vis-à-vis this hurdle discount rate, directly determine whether an investment retains or loses its viability. For projects that are considered profitable, investors' expected returns are high and investments are undertaken using either internal or external finance. When investors depend largely on external finance, this can be sourced either through bank loans or equity. The monetary policy effect, coming through the credit channel, would thus depend on the demand (depending on investors expected return) and supply (depending on banks' expected return) of credits. In this section, the monetary policy effects of investment are discussed first for the impact of credit, and then the role of the interest rate.

6.4.1 The Credit Effect of Monetary Policy on Investment

Finance – its availability and cost – is extremely critical for investment; given the underlying quantity and price factors that influence investors' decisions. Naturally, increased availability of finance is expected to boost investments, while increased costs may retard it. Whereas the interest rate (the price factor) embeds the cost of finance and the hurdle rate for discounting investment, availability (the quantity factor) refers to the amount, source and type of finance. For any investment, firms may source funds internally (savings, retained profits, etc) or externally (bank debt or equity). Each of these sources has its associated costs which are either implicit (in terms of interest income foregone by using internal finance) or explicit (in terms of interest charges or capital market costs of external financing). Though these are all affected directly or indirectly by monetary policy, our emphasis in this section is on bank debt financing. Given that higher quantity of finance increases investment, bank credit would be expected to correlate positively with investment. So that the more credit a firm secures the more investment it is able to undertake; thereby suggesting the importance of the credit channel.

Under the credit channel, monetary policy is transmitted to the real sector of the economy through the demand or supply of credit. The former depending on the expected profitability of investment, while the latter relates to credit rationing due to banks' expected profit from lending. The interaction of the demand and supply factors determines the amount of banking system's credits to the private sector. Transmission of monetary policy through the credit channel occurs through two separate but sometimes reinforcing routes: the bank lending channel and the balance sheet channel. The bank lending channel emphasises the effect of monetary policy on banks' reserves and their credit creating ability, while the balance sheet channel highlights the effect of policy on borrowers' balance sheet, collateral and the associated risk perceptions. With regards to the former, post-Keynesian analysis (under the endogenous money framework) indicate that the banking system creates credit *ex nihilo* (irrespective of reserve restrictions) and is essentially a price-maker but quantity-taker (Fontana, 2009b). Thus, banks are able to accommodate all credit demand at any given price. This ability notwithstanding, banks' willingness to lend would depend on creditworthiness of borrowers which in turn depends on risk perception and availability of acceptable collateral. This rationing, is to some extent, derivable from the effects of the balance sheet channel; which highlights impact of monetary policy on borrowers' financial assets, their wealth, the value of their collateral and their risk attribute.

Monetary policy stance basically depends on the business cycle; tightening is favoured in periods of expansion while a lose policy is apt during contraction. During economic expansion, tight monetary policy causes interest rates to rise. However, as noted by Stiglitz and Weiss (1981), and Stiglitz and Greenwald (2003), rising interest rates generally increases borrowers' risk (for both new and outstanding loans), while reducing banks' expected returns; it also lowers the expected returns on projects and encourages risky investments with potentially high payoffs. Concurrently, the resultant increase in the risk content of both new and outstanding loan causes the level of banks' liquidity to decline (Fontana, 2009b). This thus makes banks to tighten both price and non-price requirements, irrespective of credit demand.

Lavoie (2009) separated credit demand into notional demand (which is the total demand for loans) and effective demand (which captures the demand by creditworthy clients); the difference of which represents credit rationing. Banks' decision to ration credit may be due to the problem of information asymmetry (Stiglitz and Weiss, 1981) or the principle of increasing risk (Kalecki, 1937; see also Lavoie (*op.cit*), and Fontana (*op.cit*)). The former emphasises rationing among otherwise *observationally indistinguishable* borrowers while the latter is based on discrimination among distinguishable groups. Stiglitz and Weiss (1981) analysis of credit rationing posits that following a tight monetary policy, since banks would prefer a higher expected profits, they would refuse credits to borrowers who are willing to pay higher rates because such borrowers may also be willing to invest in high-risk projects. Thus, banks would maximise their profits by lending at a lower rate to those with less default risk. Hence, a rise in monetary policy rate increases the pool of high-risk borrowers and reduces banks' willingness to lend.

Post-Keynesian analysis of credit rationing using the principle of increasing risk goes beyond this argument by suggesting that banks would partition borrowers according to their observable risk profiles. Such partitioning may be based on observable characteristic like debt-load, possession of acceptable collateral, borrowers' track record, etc. The price and quantity of credits determination then follows a step-function where *observationally indistinguishable* borrowers within groups are offered similar price (subject to other issues relating to information asymmetry). Between groups, lower risk premium (and more favourable terms) is offered to creditworthy borrowers and this premium increases with borrowers' risk profile; hence, the principle of increasing risk (Lavoie, *op.cit*; Fontana, *op.cit*). Banks may, therefore, place credit restrictions among identical borrowers (subject to the problem of moral hazard and adverse selection due to information asymmetry) or between borrowers with identifiable risk attributes. In general, what is important is that rising interest rate increases borrowers' risk, reduces viability of projects, increases probability of default, may lower banks' expected returns, and would cause credit rationing among borrowers. The converse is also true in periods of loose monetary policy.

Changes in monetary policy by affecting the level of banks' liquidity would also affect their liquidity preference. For instance, monetary policy increases in interest rates, which are expected to cause a general increase in the market and retail interest rates, would again heighten borrowers' risks. Given the increased risks of default, the lower expected return for banks, and the increased yield from relatively risk-free government securities, banks would be better-off if they channel funds away from risky private sector lending into risk-free government financial assets. This portfolio re-arrangement ensures that the expected returns of banks are increased even during tight monetary policy and effectively limits lending only to those with the lowest default risks. According to Weeks (2009, 2010), this portfolio induced rationing is endemic among developing countries, especially those of the sub-Saharan region. Since the perceived risk-free profile of government debt allows the public sector to usurp the available funds, this may result in a form of crowding-out of private sector credit.

The amount of credit to the private sector observed at any time thus reflects firms' demand for loans (willingness to borrow) and banks' supply of credit (credit rationing). Given the increased risks and uncertainties and the resultant lack of confidence banks may, in addition to discriminating against borrowers, also discriminate between loan tenures; favouring short-term rather than long-term credits. This would lead to the dichotomy of type of finance into construction finance and investment finance *à la* Davidson (1982) and Graziani (2003) as cited in Lavoie (2009). The former fundamentally captures initial finance for short-term bridging purposes while the latter refers to final finance for long-term investment purposes. Lavoie (*op.cit*) suggested that initial finance is sourced from banks for covering, among others, employees' wages/salaries and suppliers cost while final finance is used to acquire capital goods. Where long-term credits by banks are absent, firms may only obtain short-term finance for *construction* while they would rely on other sources/types of finance for *investment*. In this case, since most of the credit to private sector would have a short-term feature, the relationship between investment and credit may be positive only in the short-run but undefined in the long-run.

Overall, the volume of credit to the private sector is determined by both the demand for and the supply of credit. Monetary policy increases in interest rates may tip projects, which were hitherto profitable, into becoming unprofitable. This diminishes the amount of investments which firms would undertake; thus, firms' demand for credit financing would also be reduced. The reduced demand notwithstanding, the overall quantity of credits would also depend on bank willingness to lend. The increased uncertainty about firms' true value, the increased risk of default and reduced expected returns/profits (for banks and firms) which accompanies tight monetary policy affects banks' liquidity preference and results in credit rationing. This reduced lending further diminishes investment. Thus, a tight monetary policy would, through the credit channel, affect investment by reducing the demand and supply of private sector credits. The effect of private sector credit on investment would now depend on whether the finance is short- or long-term. Empirical analysis by Calomiris and Hubbard (1989) showed that credit constraints explained significantly the fluctuations in AD (or investment). Similarly, Aghion *et al*. (2005) using a panel of countries, showed that credit rationing increases the volatility but lowers the mean of investment, particularly for long-term investment.

6.4.2 The Price Effect: Relationship between Interest rate and Investment

Irrespective of the availability of finance, interest rates play an important role in the investment process. According to Stiglitz and Greenwald (2003), small changes in interest rate (of about twenty-five or fifty basis points) will have significant effects on investment, even if firms do not face any financing constraints. Changes in interest rate will not only affect the discount rate for investment – which determines the expected profitability – it will also affect the liquidity preference. In a world of imperfect information, changes in interest rates affect uncertainty with respect to the success of investment so that firms may prefer to enhance their expected returns by channelling their investible funds into interest bearing financial assets rather than in physical capital. Interest rate may thus affect investment through a number of medium which may present a rather complex interrelation between both variables.

Though the relationship between investment and interest rate is important in economic theory, knowledge of its characteristics remains inadequate (Beccarini, 2007); given the diverse (sometimes perverse/atypical) and somewhat difficult to reconcile results from various empirical researches. The conditions under which some of these findings are obtainable are yet to be fully understood. According to Baddeley (2003), theoretical analysis of the investment-interest rate link can be traced back to the seminal works of Irvin Fisher and Maynard Keynes in the early 1900s.[50] In his 1930 book titled *The Theory of Interest*, Fisher postulated that investment would occur until

[50] The discussions in this paragraph and the next are based largely on Baddeley (2003).

expected return on investment coincides with the prevailing level of interest rate (Baddeley, *op.cit*). This was analogous to Keynes's analysis of marginal efficiency of capital in *The General Theory of employment, Interest and Money* of 1936. Fisher's expected return on investment and Keynes's marginal efficiency of capital both represent the discount rate for evaluating investment. Fundamentally, investment is considered viable only if this discount rate surpasses or equates the contemporaneous market interest rate.[51] If the prevailing interest rate rises above the discount rate, *ceteris paribus*, investment becomes less profitable and should not be undertaken. This is based on the premise that the opportunity cost of investment (i.e. the interest income foregone by committing funds to investment) rises.[52] Both Fisher and Keynes postulate an inverse relationship between investment and the real interest rate. While Fisher's analysis concentrated on mathematical (or objective) importance of the role of interest rate, Keynes's recognised the additional influence of other subjective factors like uncertainty, expectations and animal spirit (Baddeley, *op.cit*). Fisher's analyses forms the bedrock of most investment theories including the neoclassical theories while Keynes's with emphasis on subjective factors foreshadows the post-Keynesians' and the real options models.

Baddeley (*op.cit*) again observed that Fisher's work was advanced by Jorgenson (1963) who showed that investment (i.e. adjustment to capital stock) would continue until marginal benefit equals marginal cost for rational profit maximising firms operating under perfect competition. The marginal cost is the user cost of capital which incorporates depreciation and price of capital goods to the Fisherian real interest rate while the marginal benefit is defined as the increment to the expected future output. Jorgenson's model assumes perfect substitutability between capital and labour (based on a Cobb-Douglas production function) so that elasticity of factor substitution is negative-unity with respect to the user cost and positive-unity with respect to output. This directly implies a unit long-run user cost elasticity of capital stock. Jorgenson (*op.cit*) nonetheless suggests an interest rate elasticity of investment less than unity.

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[51] The discount rate is used henceforth to represent the hurdle rate at which firms evaluate investment. In the literature various terms have been adopted including expected rate of return, internal rate of return, net present value (NPV) rate, expected cost of capital, marginal cost of capital, etc.

[52] This also reflects the liquidity preference of firms with regards to either making financial investment or physical investment. See also Lavoie (2009) and Fontana (2009b)

Like Fisher's (and Keynes's), Jorgenson's analysis indicates an inverse relationship between (opportunity) cost of capital and investment.

Under the NCM, the expected monetary policy effect on investment is based on this inverse relationship emphasised by neoclassical theories. However, under certain conditions the relationship between investment and interest rates may become complex and non-negative (Rose, 2000). In this regards, recent studies have suggested that investment may not always be monotonically decreasing in the interest rate due to factors like uncertainty which were earlier described by Keynes. As observed by Emmons and Schmid (2004), a probable shortcoming of many theoretical models relating monetary policy to investment is the inadequate incorporation of the timing option (or other important factors) that may characterise investment decisions. The non-inclusion of these factors also explains why a number of empirical studies have sought for an inverse investment-interest rate relationship unsuccessfully. Nonetheless, changes in the monetary policy rate would affect investment (inversely or otherwise) by first-and-foremost affecting the prevailing market interest rates. Changes in these interest rates would affect investment both directly through the opportunity *cum* user cost (the interest rate channel) and/or indirectly through its regulating effect on credit availability (the credit channel).

Many recent studies of the interest rate effect of investment have followed Jorgenson (1963) approach and have investigated the size of user cost elasticity of capital. However, the results differ across studies and countries although they mainly reported an inverse relationship. Mojon *et al*. (2002) investigated the relationship between investment, monetary policy and the interest rate for the euro area using Jorgenson's cost of capital approach. Their result upheld the Cobb-Douglas specification having found the long-run elasticities of user cost of capital and the output (proxied by sales) to be negative and positive unity, respectively.[53] For the USA, the elasticity of investment to user cost was within a range of –0.50 to –1.00 (Hasset and Hubbard, 1997). Baumann and Price (2007) rejected the result of a one-to-one relationship between the user cost and investment having found an elasticity of about –0.40 in the

[53] Most studies using the Cobb-Douglas production function are associated with high user cost elasticities. See Chirinko *et al*. (1999) for discussion.

UK. Similarly, Chirinko *et al*. (1999) estimated a low elasticity of –0.25 which they suggested implied a weakening of the monetary transmission mechanism.

It is worth mentioning that the sensitivity of investment to user cost would be different from the interest rate elasticity as contained in Jorgenson (1963). This is irrespective of the fact that the user cost embeds the interest rate. The responsiveness to user cost – which incorporates interest rate, taxes, relative prices and depreciation – is pertinent in the controversies about the nature of the transmission mechanism (Chirinko *et al*., *op.cit*). Significant elasticities of the user cost (vis-à-vis the interest rate) may actually be due to its non-interest rate components. Furthermore, other factors (especially data related) can obscure the detection of the true investment-interest rate relationship. The results in Chirinko *et al*. (*op.cit*), Hasset and Hubbard (*op.cit*), Mojon *et al*. (*op.cit*) were based on micro-level data analysis of user cost. However, with aggregated data it had been difficult to detect a significant interest rate effect of investment (Blanchard, 1986; Mojon *et al*., *op.cit*). As Bakhshi *et al*. (2003) showed, this may be due to mis-measurement associated with the typical index of user cost when using aggregate-level data. It may also be due to the violation of the assumption of a monotonic inverse relationship as investment may have non-negative or even nonlinear responses.

Another reason for the weak evidence of interest rate elasticity, according to Chirinko *et al*. (*op.cit*), is the inherent simultaneity bias in the relationship, capital market frictions or firm heterogeneity. Simultaneity bias emanates from the fact that some explanatory variables in investment models are themselves endogenous within the model, thereby concealing the actual relationship and biasing the inferences thereof. The problem of capital market frictions relate to the functioning of the market so that glitches (e.g. market and/or economic underdevelopment or recessions) that affect market confidence may weaken the investment-interest rate relationship. Firm heterogeneity would undermine the relationship, if investments by some group of firms respond in one way to interest rate changes while the response of others are in the opposite direction; thus, cancelling each other out.

This kind of outcome was investigated by Mojon *et al*. (2002) and Gaiotti and Generale (2002), among others. While Mojon *et al*. did not find evidence of firm heterogeneity in interest rate sensitivity between large and small firm’s investments, Gaiotti and Generale found that monetary policy changes of user costs affect larger firms less than smaller ones. According to Beccarini (2007), heterogeneity of firms complicates the relationship further as it introduces nonlinearity in the investment-interest rate function. Thus, using linear estimation methods, as in Mojon *et al.*, may not capture the true relationship. Asymmetric/nonlinear relationship between the interest rate (or the user cost) and investment has been suggested in the literature by Kieler and Saarenheimo (1998), Weise (1999) and Capozza and Li (2001) among others.

Weise (1999) opined that asymmetries are due to uncertainty and rigidities such as irreversibility and indivisibility of investment. Irreversibility occurs when investment decisions by firms cannot be retracted at zero cost. In many cases investments are characterised by technological and/or market induced irreversibility (Caballero *et al.*, 1995). According to the real options theories, uncertainty and irreversibility cause asymmetry by creating a positive benefit for delaying investments. In the presence of uncertain payoffs, lower interest rates, rather than spur investment would make deferral more appealing (Rose, 2000; Capozza and Li, 2001; Emmons and Schmid, 2004; and Chetty, 2007).[54] Thus, under certain conditions, in the real options models, investment and interest rates may correlate positively. Capozza and Li (*op.cit*) showed that high uncertainty (about future cash flow, high growth rate, high interest rate volatility) or very low levels of interest rate are sufficient to cause positive investment responses. Their result suggests a nonlinear relationship since high interest rates would, thus, induce an inverse response of investment.

Such possible nonlinearity was proposed by Chetty (2007) who showed that interest rates may under some conditions yield a backward bending investment function. Under the real options theories, Chetty opined that deferred investment may increase the interest expense of a firm because of the associated delay of cash-inflow. Higher interest rate heightens the debt burden thereby compelling the firm to expedite investment (rather than defer) in order to raise cash-flow to offset outstanding loan obligations; thus, generating a positive investment response. Hence, increases in interest rate would have both the typical neoclassical inverse effect by increasing the

[54] Low(er than average) interest rates are usually associated with weakening economy in need of stimulus. The inherent poor outlook in this circumstances and the reduced profitability of projects during such periods make investment an unattractive option.

discount rate and an atypical effect which combine to create a backward bending function. Principally, Chetty argued “that at low rates, an increase in interest rate increase investment demand by enlarging the set of projects for which the discount rate exceeds the returns to delay” (p.84).

Capozza and Li (2001) and Beccarini (2007) suggested that high interest rate volatility may also cause nonlinearity in the investment-interest rate relationship; creating a Chetty-type backward bending investment function. This, according to Beccarini (*op.cit*), is because interest rate volatility relates positively with both investment and the level of interest rate. Hence, the level of interest rate may indirectly (through its variance) be positively correlated with investment, though this is thought to occur only when the interest rate variance is considerably high. Invariably, nonlinearity depends on the level of interest rate uncertainty. However, high uncertainty in interest rate may also increase the benefits of delayed investment so that essentially asymmetry reverts to the timing of investment. Capozza and Li (*op.cit*), Beccarini (*op.cit*) and Chetty (*op.cit*) all suggested that relationship between investment and interest rate would differ depending on whether the level of interest rate was high or low. This can be compared somewhat with Rose (2000) who showed that the investment would tend to zero at extremely high or extremely low levels of interest rate.

In the above studies, the threshold for the backward bending function is based on the relative sizes of growth rate and interest rate. Capozza and Li (*op.cit*) suggested that positive region would emerge when growth rates are high or when interest rates are very low. This, according to Chetty (*op.cit*), is because at low level of interest rates, growth rate is likely to be higher than the interest rate. This implies that when growth rates surpass interest rates a positive relationship would exist, while the relationship would be negative when interest rate exceed growth rate. Thus, the threshold would be at the point where the growth rate balances the prevailing interest rate. The relationship between growth and interest rates, according to Capozza and Li (*op.cit*), is based on the premise that in periods of high growth, projects become more viable since project internal rate of return (IRR) rises faster than hurdle discount rate.

Other forms of nonlinearity discussed in the literature include the business cycle asymmetry suggested by Weise (1999) and Peersman and Smets (2001). These studies argued that monetary policy changes in interest rates would have stronger effect in periods of recession vis-à-vis booms based on the financial accelerator model. Essentially during recession firms' cash-flows dwindle, internal finance declines and firms require more external finance. The recession and the increased external finance requirement depresses the net-worth of firms and the value of their collateral thereby leading to an increase in the cost of external finance. This would nonetheless depend on the policy stance. For instance, policy ease may have weaker effect than tightening during booms but a converse outcome in recessions. Kieler and Saarenheimo (2001) also showed that nonlinearity may occur depending on the structure/level of financial market development. They opined that monetary policy may have higher impact for variable-rate financing than for fixed-rate financing.

In some cases, it is argued that the investment-interest rate relationship may be monotonically increasing. As Munthali (2008) observed, in developing countries the relationship between investment and interest rate may be positive. This is based on the popular McKinnon (1973) and Shaw (1973) postulation of a positive relationship between private investment and real money balances in these countries. According to Munthali (*op.cit*), restricted access to credit and capital market by many firms in developing countries culminates in the accumulation of cash balances prior to investment. Thus, investment and cash balances would correlate positively. Cash balances are postulated to relate directly with deposit rates so that, by transitivity, deposit rates and investment would correlate positively. Thus, if policy rate increases are passed-through to deposit rates, investments could increase.

Atypical or perverse investment-interest rate relationships have important implications for monetary policy. Generally, monetary policy is designed under the neoclassical assumptions of a monotonically decreasing investment function which may actually be incorrect. The relationship may be non-negative under certain conditions. Given the diverging effects of probable positive and negative responses of investment to interest rate, the overall impact of monetary policy action can be ambiguous (Emmons and Schmid, 2004). According to Capozza and Li (2001), "if increases in the interest rate can accelerate investment spending, then extreme care must be taken when monetary decisions are designed to transmit restraint to the economy through their effect on investment" (p.518). Consequently, it is of paramount importance for monetary policymakers and/or researchers to recognize the conditions for this atypical relationship.

The theoretical relationship between investment and interest rate (typical or atypical) are in most cases derived at firm level. On an aggregate level, this becomes even more complicated. Though it would usually be intuitively convenient to assume that all firms would act alike on the average, so that the aggregate relationship would be a simple integration of all firms, in reality firms' behaviours differ. As noted earlier, firm heterogeneity may be a source of asymmetry in the relationship given that at different levels of interest rates, firms of different sizes, types or sectors may conduct, expedite or defer investments as the case may be.[55] Monetary policy is expected to have a general effect on the aggregate economy rather than few firms so that the inability to correctly determine the expected policy outcome poses a threat to policy objective and the well-being of the overall economy. While some (category of) firms may behave typically others may be perverse/atypical. The overall effect would then depend on the relative weight of each group's investment in the whole.

In Nigeria, firm heterogeneity may be considered between the oil and non-oil sector. This is for two reasons. First, it captures the somewhat lopsided dependence of the economy on oil. Secondly, it can separate firms into large (oil sector) and not-so-large (non-oil sector) categories. This does not mean that non-oil sector firms are necessarily small, but rather implies that oil sector firms are more-or-less large. Besides, oil sector firms are hardly affected by domestic macroeconomic policies but by international developments. Such disaggregation may allow policy to focus on the more desirable effect on the non-oil sector. Again, while an inverse relationship is usually expected on the aggregate, a positive relationship may sometimes ensue over the course of the business cycle. This is because when the economy is booming, investments increases and interest rates can rise through the central bank's non-accommodating policy stance. However, such tight monetary policy is expected to decelerate investment. This kind of outcome may also be different among categories of firms. Overall, the aggregate impact of interest rate would depend on its effect on the investments of the dominant sector (or group(s) of firms).

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[55] In particular, firms differ in their profitability and the availability of internal funds.

6.5 Private Investment in Developing Countries

High investment-GDP ratios are features of industrialised and affluent developing countries rather than poorer ones suggesting a developmental role of private investment (Greene and Villanueva, 1991). Investment is important in every country particularly developing ones. Yet its determinants in these countries remain to be fully understood as no coherent theory of investment in developing countries exists (Soyibo, 1996). The various theories (of the determinants of investment) discussed above have become conventional and used extensively to understand investment behaviour in many applied research. Fundamentally, the theoretical and empirical analyses which underlied the proposition of these theories are founded on market dynamics in advanced economies. Institutional structures are essentially different between developed and developing countries so that the determinants of investment in these countries may differ considerably. Generally, the conventional theories postulate that investments are affected by key macroeconomic and financial variables. However, while some of these variables like interest rate (or cost of capital), output (i.e. economic) growth, demand/sales/capacity utilisation and macroeconomic uncertainty are generally important, other variables (like public investments, political conditions, etc) omitted in these models are critical for developing countries. Thus, the underlying assumptions of these theories may be untenable in developing countries. As observed by Greene and Villanueva (*op.cit*),

> "it [is] generally...hard to test this model[s] in developing countries, because key assumptions (such as perfect capital markets and little or no government investment) are inapplicable, and data for certain variables (capital stock, real wages, and real financing rates for debt and equity) are normally either unavailable or inadequate" (p.39).

Similarly, Blejer and Khan (1984) argued that "institutional and structural factors present in most developing countries – such as the absence of a well-functioning financial markets..." makes such models unsuitable (p.380). Again, Kieler and Saarenheimo (2001) underscored the importance of the structure *cum* level of financial market development in this regard. Financial, money and capital markets are typically unsophisticated and vestigial in developing vis-à-vis advanced countries; thus, escalating market imperfection. This imperfection means that market coordination of economic activities via the prices mechanism may allocate resources inefficiently. Again, the problems of information asymmetry may be deeper in developing countries, thereby furthering the existence/emergence of informal/shadow financial markets and its inherent leakage. Low net-worth firms who are unable to access the financial markets resort to informal sector for funds, even at rates higher than that obtainable at the formal markets. Hence, availability rather than cost (of capital) may become critical for private investment in developing countries. Given the indivisibility of investment, firms who are unable to borrow externally from the financial markets may have to accumulate inside money to fund investment (Fry, 1995). This is akin to the McKinnon (1973) and Shaw (1973) analyses that hypothesise accumulation of real money balances as a key determinant of investment in these countries. It is also consistent with post-Keynesian highlight of the importance of internal finance by emphasising that agents would amass cash/funds to finance investment due to high cost or dearth of external finance.

Developing countries, like Nigeria, are characterised by large number of micro, small and medium scale enterprises operating in the informal sector. These are usually classified as risky and are placed on the lower rung of the creditworthiness continuum due to the problem of information asymmetry between lenders and borrowers. Thus, enormous external finance constraints confront these businesses as they are too small to access equity finance via the capital market and are considered risky for bank credit. High cost and dearth of investible funds are more constraining for this group than any other in the economy so that their investment is usually aligned to savings and internal funds. Yenturk *et al*. (2009) provided, somewhat, an evidence of the investment effect of savings in Turkey. Conducting a study of private investment behaviour for a small numbers of firms in Nigeria, Soyibo (1996) documented the dominant influence of internal over external finance (i.e. debt and/or equity). Soyibo also opined that consistent with McKinnon-Shaw hypothesis, investment would vary directly with domestic (deposit) interest rate in Nigeria.

The postulated positive correlation in the McKinnon-Shaw hypothesis is based on an assumed direct relationship between deposit rate and money balances which subsequently culminates in a positive investment-interest rate and investment-savings relationship. Essentially, under the McKinnon-Shaw approach, with interest rates restricted below equilibrium, investment is deemed to be constrained by savings, so that an increase in interest rate would lead to higher savings and then to higher investments. A positive investment-interest rate relationship has implications for monetary policy. Nonetheless, policy induced changes in interest rates can affect retail rates and investment via two means: by affecting the cost of credit (lending rates) or the opportunity cost of holding money (deposit rates). Increasing deposit rates would, however, affect firms' investment if the prevailing returns on deposits exceed returns of contemporaneous investment and if such investment can be delayed at no cost. Whether the prevailing relationship between investment and interest rate is inverse (as per the neoclassical theory) or direct (as in McKinnon-Shaw hypothesis) may also depend on the contribution of blue-chip companies vis-à-vis smaller enterprises to aggregate investment in developing countries. Based on the premise that internal funds are more important for smaller enterprises, a negative relationship may suggest that most investments are conducted by large firms. This nonetheless would not affect the expected positive relationship between investment and internal funds. Greene and Villanueva (1991) performing analysis for 23 developing countries found evidence of negative interest rate effect and rejected the McKinnon-Shaw hypothesis, while Hassan and Salim (2011) found no evidence of interest rate effect in Bangladesh.

Market underdevelopment, imperfection and failure in developing countries increase the role of government in these economies. Consequently, public expenditure and public debt (burden) are identified in the literature as affecting investment. Government capital expenditure and debt are connected to public investment which in turn relate with private investment. Greene and Villanueva (*op.cit*) suggested that periods of substantial debt crisis tend to correlate with lower private investment. The theoretical relationship between public and private investment in developing countries is undefined. Neoclassical analyses argue that government investment (and domestic credit) would crowd-out or substitute private investment (and credit). However, public investment is a policy variable used in the provision of infrastructure and public goods so that it may complement, boost and crowd-in private investments (Greene and Villanueva, *op.cit*; Munthali, 2008). Accordingly crowding-out would occur only when government spending leads to high cost or dearth of capital. Pastor and Maxfield

(1999) posited that crowding-in effect would be dominant in developing countries; a premise that was empirically supported in Greene and Villanueva (*op.cit*). Similarly, Blejer and Khan (1984) found complementary private-public-investments relationship in the long-run, but short-run substitutability while Hassan and Salim (2011) documented crowding-out effect in Bangladesh. The long-run complementarily reflects the supportive role of infrastructural spending.

Usually, governments borrow to finance long-term spending on infrastructures. Thus, the effect of debt burden comes through its impact on future capital expenditure. High debt-burden, thenceforward, reduces public expenditure on infrastructures and amenities, increases macroeconomic uncertainty, and reduces private investment. If so, private investment in Nigeria would be expected to have risen following the country's exit of external debt-burden in 2004. The interrelationship between investments (public/private) and debt is nonetheless complex. Thus, including both public investment and external-debt as regressors in an empirical model may lead to the problem of multicollinearity. This problem may even be deepened by crude oil dynamics. In Nigeria, oil plays a big role in the economy and influences the pattern of government expenditure. As expounded in chapter three, rising oil revenue reduces government debt needs, increases expenditure and consequently lowers budget deficits. Budget deficit can thus reflect the effects of oil, public expenditure and debt. Oil price changes would also capture the trends in government expenditure and debt burden. Rather than include all variables, for tractability, an omnibus proxy (e.g. oil prices or budget deficit) may be considered for the public sector effect of investment in the case of Nigeria.

Real options theorist emphasised the importance of uncertainty given the irreversible nature of investment. This uncertainty is usually discussed within the realm of economic uncertainty captured mainly be volatilities in some economic variables. However, in addition to economic uncertainty, developing countries are also fraught with political uncertainty. Munthali (2008) and Hassan and Salim (2011) observed that political instability deters private investment in many developing African countries. This effect is seen both in the inflow of foreign direct investment and in domestic investment. Political uncertainty can emanate from different factors like non-accountability and/or non-transparency of government and its officials, non-provision of socio-political and economic (property) rights, dictatorial and/or non-democratic governance, violence and insecurity, bumpy regime changes or elections. It may also be associated with political intrusion of economic policies e.g. a non-independent central bank (Pastor and Maxfield, 1999). Perceived uncertainty would shift the objectives of firms from investment and profit maximisation to the provision of security and stability (Baddeley, 2003). Hence, subsistence of any of these factors would repress investment. In Nigeria, the 1980s and 1990s were characterised by autocratic military rule; a period often associated with uneasiness and trepidation. Since the advent democratic governance in 1999, political scepticism has moderated substantially and is somewhat confined to election years.

Nigeria is an oil dependent developing country with a large government sector, inherently vibrant informal sector, and relatively unsophisticated financial market. Hence, there exists a large pool of potential determinants of investment in the country. While studies on developing countries (e.g. Greene and Villanueva, 1991; Yenturk *et al*., 2009; Hassan and Salim, 2011), focused primarily on the roles of government and savings most other studies of investment have been based on the more formal theories discussed in the preceding section. Since both approaches have merits, Baddeley (2003) noted "that concentrating on one specification of investment models to the exclusion of others may lead to an omission of factors that are central to the determinant of investment behaviour" (p.146). Consequently, we would consider an eclectic model of investment which focuses on the effect of monetary policy while taking account of the various theories discussed above.

6.6 Pattern and Trend of Investment in Nigeria: Data and Stylised Analysis

6.6.1 Data

This chapter utilises quarterly data from 1985:Q1 to 2011:Q2 sourced from the CBN and the NBS. The dataset include interest rates (capturing cost of capital), capital stock(K), investment(I), consumption(C), GDP(Y), GDP gap(Yg), consumer price index(CPI), inflation($\Delta CPI = \pi$), private sector credits(CPS), capacity utilisation(CU), corporate profits(PF), exchange rate(NER), crude oil price(PO), government investment(GI), fiscal deficit(FD) and total debt stock(TDS). Variables for macroeconomic and political uncertainties are also included. In the absence of reported data some variables (like capital stock and uncertainty) are derived using basic techniques which are described later in this section.

Cost of capital is proxied by the interest rate for two reasons. First is the fact that the study is on the investment effect of interest rate. Second, cost of capital, for instance in Fazzari *et al*. (2010) and Mojon *et al*. (2002) are computed from a suite of data including interest rate, relative prices of capital, tax rate and depreciation rate. However, Blejer and Khan (1984) observed that “in the absence of information on real financing and rates (debt and equity) it is not possible to calculate the service price or user cost of capital” (p.380). Apart from interest rate data, no comprehensive collection of the others is available for Nigeria. Although, this chapter intended to understand the impact of monetary policy on investment, the cost of capital is principally represented by the average lending rate (ALR) rather than the monetary policy rate (MPR). This is because private investors do not incur the MPR (which is only an indicative rate) but are confronted with the retail rates. Nonetheless, the role of MPR is subtly incorporated into our analysis. Average deposit rate (ADR)is also utilised in the preliminary data analysis essentially to investigate the McKinnon-Shaw hypothesis. ALR is defined as the quarterly averages of prime and maximum lending rates while ADR is the average of term deposits of 3-12 months maturity. All the interest rates are in real term derived by deflating the nominal rates using the conventional Fisherian equation

$$r_t = \left(\frac{1+i_t}{1+\pi_t}\right) - 1 \qquad 6.1$$

where r_t, i_t, and π_t are, respectively, the real and the nominal interest rates, and the inflation rate. Real GDP and its components are at 1990 constant prices. GDP gap is the log-difference of actual and trend GDP – the latter derived via the Hodrick-Prescott (HP) filter. Investment is the gross fixed capital formation of the private sector while consumption is the final consumption expenditure of households and non-profit firms. Given the non-availability of capital stock data, it was derived by assuming capital dynamics of the form

$$K_t = I_t + (1 - \delta_t)K_{t-1} \qquad 6.2$$

where δ_t is depreciation rate and $\delta_t K_{t-1}$ represents contemporaneous capital consumption. Capital stock is disaggregated into oil and non-oil components. Given that unavailability of sectoral data for $\delta_t K_{t-1}$ it was split linearly using the quarterly weights of oil vis-à-vis non-oil investments. Initial levels of capital (i.e. the 1985 level) for the three variants were obtained from the CBN macroeconomic model. However, given the extent of extrapolation involved, inferences based on the capital stock data may undermine our overall analysis. Hence, extreme care must be dully observed when interpreting the results. Credit availability is represented by total banking system credit to the private sector. GDP, investment, capital stock and (private sector) credit data are subdivided into oil and non-oil to capture the structure of the Nigerian economy. Corporate profit is the aggregate operating surplus derived from the GDP spreadsheet while capacity utilisation is the percentage of installed capacity of the manufacturing sector used during the period. Oil price is the quarterly average of the dollar per barrel price of bonny light (Nigeria's crude petroleum), while the nominal exchange rate is in naira per dollar. Where utilised, the real exchange rate is derived using the USA consumer price index sourced from the Bureau of Labour Statistics. All variables except the interest rates are in logarithm.

As discussed earlier, we identify both macroeconomic and political uncertainties as potential deterrents of investment in Nigeria. Many previous studies on investments, considering macroeconomic uncertainty, either used a single proxy of volatility (usually inflation, GDP growth or exchange rates variances) to measure uncertainty or employed a summary measure which aggregates various candidate variables (Munthali, 2008). In this chapter, macroeconomic uncertainty (EV) is derived by combining the volatilities of GDP growth, inflation and exchange rates using a principal component analysis (PCA). Two approaches are evaluated for generating these volatilities: a GARCH(1,1) and an implicit equation; preferring the one with the better PCA. Implicit volatility is derived as

$$EV = \left[\frac{1}{\sigma^{\theta}}(w_t - \overline{w})^{\theta}\right]^{\theta^{-1}} \qquad 6.3$$

where $w_t = (U_t/U_{t-1}) - 1$ is growth rate, $\overline{w}$ is its mean, $\theta = 2$ to ensure non-negativity, and σ is standard deviation. The implicit volatility measures deviation of individual observations from the mean, normalised by the standard deviation. This formula is applied separately to the output growth, inflation and exchange rates. The PCA is then employed to linearly transform and combine the observations (separately for the GARCH(1,1) and implicit equation) into a single variable which accounts for most variability in the original set. The variable thus generated is used to represent macroeconomic volatility. Political uncertainty (PV) is proxied by a dummy variable which captures military/autocratic rule and elections. This is because military rules are associated with dictatorship and suppression while elections in Nigeria are characterised by pre- and post- tensions. This dummy takes the value of unity for military and/or election years and zero otherwise.

6.6.2 Preliminary and Stylised Analysis

In conducting monetary policy, CBs expect interest rate rises to reduce AD via its components. Preliminary analysis in this section suggests that the correlation of interest rate and AD variables in Nigeria may not be inverse, at least contemporaneously. Table 6.1 contains contemporaneous correlations between investment related variables and the core determinants discussed earlier. First, contrasting neoclassical views, ALR correlation with capital stock and investment were low and positive. However, investment-GDP ratio correlated inversely with ALR consistent with findings in many studies for instance Greene and Villanueva (1991). This negative correlation does not however necessarily connote that increases in interest rate reduces investment, it may only show that GDP increases more than investment following to ALR changes. This is confirmed by the higher GDP-ALR correlation. So, while ALR raises investment it reduces investment/GDP ratio by raising the GDP to a larger degree. Not only does ALR increase GDP, in contrast to the NCM framework, it also increases the overall GDP gap although non-oil gap contracts. The ADR nonetheless correlated positively in all cases which may be a validation of the McKinnon-Shaw hypothesis. Overall, ALR have a higher (absolute) impact on investment than ADR.

Table 6.1: Partial Cross Correlation of Investment with Selected Determinants

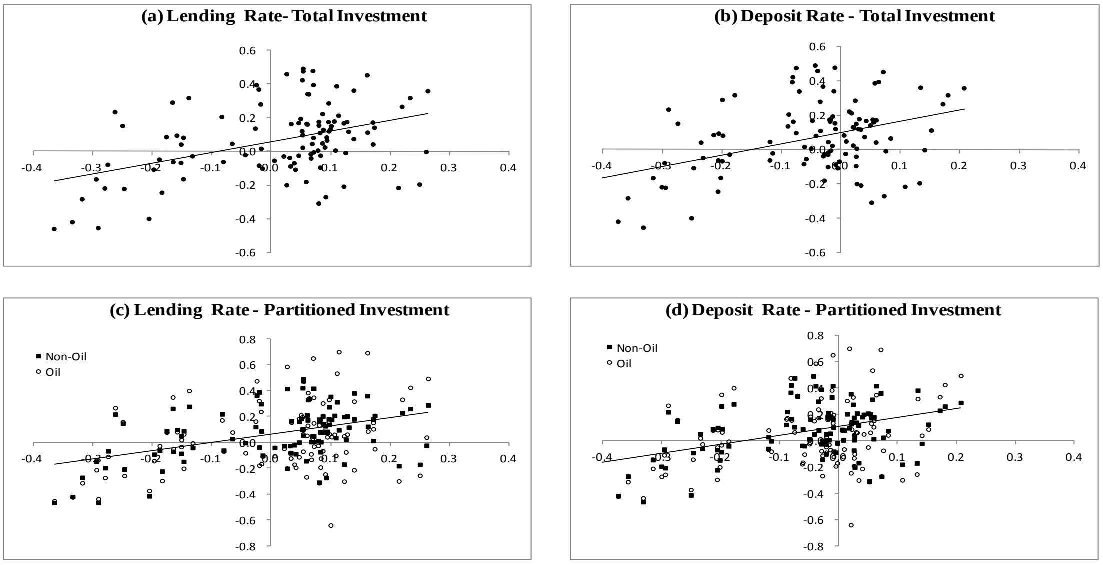
	Interest Rates		CPI	Private Sector Credit			CU	Profit	Output Growth			Oil Price	NER
	ADR	ALR		Total	N-Oil	Oil			Total	N-Oil	Oil		
Capital Stock	0.13	0.29	-0.23	0.23	0.23	0.29	0.18	-0.23	0.20	0.25	-0.16	0.32	-0.35
Non-Oil	0.14	0.30	-0.24	0.24	0.23	0.29	0.18	-0.24	0.21	0.26	-0.16	0.32	-0.35
Oil	0.11	0.28	-0.20	0.22	0.21	0.31	0.19	-0.21	0.18	0.23	-0.15	0.33	-0.34
Inv/Capital	0.09	-0.08	-0.03	-0.09	-0.07	-0.30	-0.24	-0.01	-0.07	-0.14	0.16	-0.34	0.29
Non-Oil	0.09	-0.08	-0.03	-0.08	-0.07	-0.31	-0.24	-0.02	-0.06	-0.12	0.14	-0.34	0.29
Oil	0.11	-0.07	-0.04	-0.08	-0.07	-0.27	-0.23	0.00	-0.07	-0.14	0.18	-0.35	0.29
Investment	0.20	0.26	-0.29	0.20	0.21	0.00	-0.07	-0.33	0.23	0.21	-0.02	0.14	-0.26
Non-Oil	0.20	0.27	-0.30	0.22	0.23	0.03	-0.03	-0.33	0.25	0.26	-0.07	0.15	-0.27
Oil	0.15	0.18	-0.20	0.06	0.08	-0.14	-0.23	-0.28	0.11	0.00	0.17	0.10	-0.18
Consumption	0.23	0.34	-0.33	0.32	0.31	0.25	0.22	0.33	0.34	0.40	-0.15	0.20	-0.36
Inv/GDP	0.01	-0.09	0.04	-0.12	-0.10	-0.33	-0.36	-0.10	-0.17	-0.26	0.14	-0.22	0.20
Non-Oil	0.00	-0.10	0.05	-0.11	-0.10	-0.31	-0.36	-0.09	-0.20	-0.27	0.14	-0.25	0.22
Oil	0.02	-0.02	-0.02	-0.12	-0.11	-0.33	-0.31	-0.14	-0.07	-0.16	0.15	-0.13	0.12
Cons/GDP	0.11	0.11	-0.11	0.21	0.20	0.20	0.34	-0.28	0.09	0.20	-0.13	-0.28	-0.05
GDP	0.21	0.33	-0.33	0.28	0.28	0.21	0.15	-0.27	0.34	0.37	-0.11	0.28	-0.37
Non-Oil	0.21	0.32	-0.32	0.28	0.28	0.20	0.16	-0.27	0.34	0.39	-0.14	0.27	-0.35
Oil	0.21	0.33	-0.28	0.24	0.24	0.27	0.12	-0.23	0.27	0.23	0.06	0.32	-0.40
GDP GAP	0.07	0.05	-0.04	0.01	0.01	0.07	-0.03	-0.01	0.27	0.18	0.23	-0.05	-0.11
Non-Oil	0.00	-0.02	0.04	-0.04	-0.04	0.04	0.04	0.06	0.28	0.27	0.09	-0.08	-0.04
Oil	0.12	0.11	-0.13	0.05	0.05	0.07	-0.15	-0.11	0.05	-0.10	0.30	0.03	-0.16

Source: Author's computations based on data from the CBN and NBS.

Note: Row variables are growth rates except interest rates which are averages. ADR and ALR represent average deposit and lending rates, respectively. CU is capacity utilisation and NER is nominal ₦/$ exchange rate.

While the table shows the relationship between the interest rate and the level of investment, figure 6.1 shows the relationship with investment growth rate. Again, the relationship is positive both for deposit and lending rate (horizontal axis) even when investment (vertical axis) is disaggregated into oil and non-oil. Like in the table, the size of correlation is low though slightly higher for lending than deposit rate and for non-oil than oil investment. The larger non-oil correlation may be due to the fact that the oil sector does not react to monetary policy but to other international (and domestic) crude oil developments. Monetary policy in Nigeria is expected to affect the non-oil sector which react more to domestic conditions and policies.

Figure 6.1: Real Interest Rate versus Investment Growth Rate

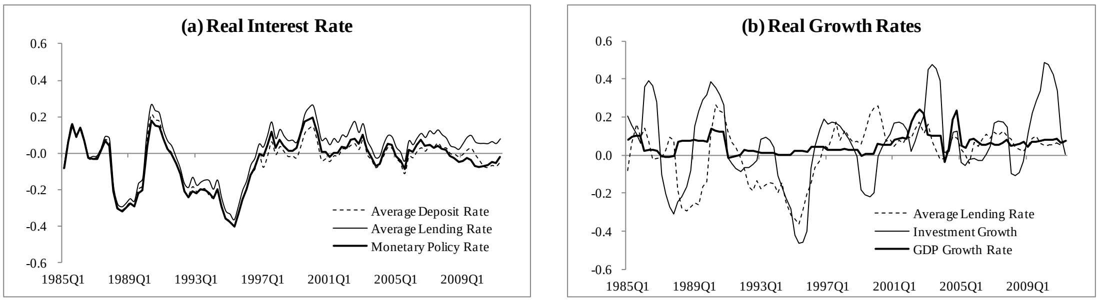


Data Source: CBN and NBS

A positive investment-interest-rate relationship justified variously in the literature for developing countries (in line with McKinnon and Shaw) has been due to the importance of savings (or accumulation of money balances) for investment. However, positive correlation may arise over a region due to nonlinearity in the investment-interest rate relationship. Cappoza and Li (2001), and Chetty (2007) indicated that this region would emerge when interest rates are low and below growth. Low interest rates would normally be below a firm's hurdle discount rate, thereby making investment viable even if rates were rising. Furthermore, higher output growth levels are associated with higher project IRR, thereby increasing investment viability. Thus, low interest rates reinforces higher IRR (via higher growth rates) to boost investment.

For Nigeria, real interest rates are usually low (in many cases negative) and are below GDP growth rate. This is seen in figure 6.2 which shows the trends in real interest and expenditure growth rates. Panel (*a*) shows that for most portion real interest rates are negative while for the rest they are mostly close to zero. The sample means for deposit and lending rates are -5.2 and 1.2 per cent respectively. Visual inspection of panel (*b*) seems to support the backward bending hypothesis especially between 1993 and 2003. This thus provides an alternative explanation to the positive relationship vis-à-vis that of the McKinnon and Shaw hypothesis.

Figure 6.2: Trends in Real Interest and Expenditure Growth Rates

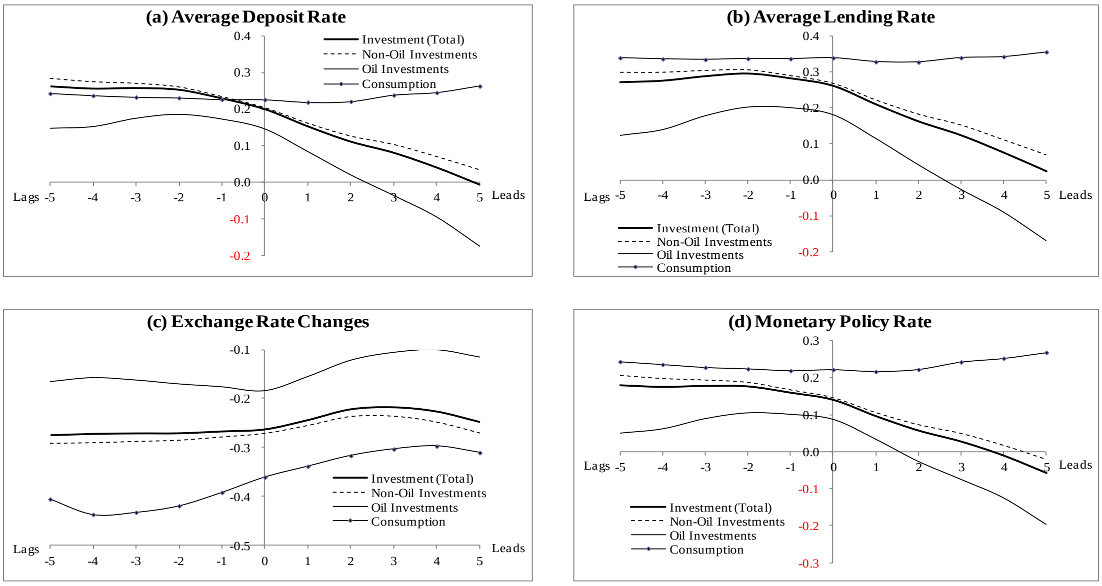


Data Source: CBN and NBS

However, this positive relationship does not hold continuously across time and differs both for investment and consumption. The inter-temporal relationship between interest rate and private expenditure is shown in figure 6.3 below. Panels (*a*), (*b*), and (*d*) showed that the relationship is stronger for non-oil than oil investments, and mostly highest for consumption. While expenditures varied positively with past and contemporaneous interest rate, generally, the relationship tended to become negative between current investment and expected interest rate. Essentially, prevailing interest rate do not reduce investments but expected interest rate changes would reduce planned investments. The effect of interest rate expectation however depends on time. Total (and non-oil) investment would only correlate negative with five-quarter-ahead interest rate expectations while oil investment would react to two-quarter-ahead expectations, suggesting that non-oil drives total investment. Thus, future interest rate hikes increases uncertainty which lowers the rate of investment, particularly in the oil sector. The negative reaction to future interest rates is one quarter earlier for monetary policy rate indicating a probable pass-through lag of 3 months.

As noted earlier, NCM model are based on the inter-temporal relationship between consumption and interest rate. Generally, the relationship between interest rate and consumption does not vary with time and is fairly constant across lags and leads, even as consumption in Nigerian largely constitutes necessities like food with low elasticity. The continued positive inter-temporal correlation for consumption may, however, connote that interest rate increases household's income. This would imply that individual had accumulated financial assets the return of which finances their consumption. Given the high incidence of poverty in Nigeria, this may imply that rich households enjoy substantial rentier income.

Figure 6.3: Inter-Temporal Relationship between Real and Financial Variables



Data Source: CBN and NBS

Over the entire sample period investment grew faster, on the average, than consumption expenditure and is twice as fast for the 1999-2011 period particularly for non-oil investments (see table 6.2). Investment is also more volatile than consumption as shown by the standard deviations of their respective growth rates, consistent with the views of Baumann and Price (2007) and Dupor (2001) for the UK and USA, respectively. Fluctuations in average investment growth rates and volatility are also in tandem with overall GDP's vis-à-vis consumption growth rate.

Table 6.2: Growth Volatilities and Averages for GDP and its Components

	Average				End Period (2011:Q2)	Standard Deviation			
	Whole Sample	1985-1990	1991-1998	1999-2011		Whole Sample	1985-1990	1991-1998	1999-2011
Consumption	6.55	5.81	6.06	7.22	21.51	17.01	14.67	9.19	21.56
Gross Investment	8.46	12.62	-2.88	13.72	0.39	23.20	27.37	16.88	22.37
Non-Oil	9.06	11.67	-2.23	15.04	1.10	22.16	25.94	16.94	20.77
Oil	7.70	14.87	-4.06	11.79	-2.52	30.47	32.04	17.22	34.46
Government	14.69	-6.87	28.07	16.47	-25.20	55.60	20.94	69.66	54.79
Net Exports	47.06	86.27	-30.06	77.59	-9.66	145.90	150.86	80.88	158.76
Exports	15.27	36.29	2.98	13.05	-17.94	36.47	56.15	27.12	24.18
Imports	15.89	23.28	13.68	13.77	-21.05	32.95	18.93	21.46	42.81
Total GDP	**5.81**	**6.58**	**1.91**	**7.94**	**7.72**	**5.28**	**4.60**	**1.58**	**5.77**
Non-Oil	7.02	6.24	2.70	10.16	8.82	6.70	3.43	0.87	8.22
Oil	2.67	7.41	0.55	1.76	1.81	8.71	10.11	4.45	9.35

Source: Author's computations based on data from the CBN and NBS

These notwithstanding, analysis of contributions to GDP, in table 6.3, showed that consumption had more weight than investment in Nigeria. Consumption accounted for about 70 per cent of total income while investment had only a 10 per cent weight. Of this, non-oil investment accounted for 7 per cent while 3 per cent went to oil investment. The high weight of consumption reflects the high propensity to consume out of income (noted earlier in the chapter). The high weight of consumption to AD was also reflected in its contribution to demand growth where it appeared to be the major driver of GDP. A careful look at the table, however, reveals that though consumption contributes more to growth, investment drives growth dynamics. This is because increased growth rate is only recorded when investment accelerates and falls when investment slows down.

Table 6.3: Average Contribution of Components to Level and Growth of GDP

	Relative Weights					Contribution to Growth				
	Whole Sample	1985-1990	1991-1998	1999-2011	End Period (2011:Q2)	Whole Sample	1985-1990	1991-1998	1999-2011	End Period (2011:Q2)
Consumption	0.69	0.66	0.71	0.70	0.66	3.79	3.20	4.08	3.89	12.64
Gross Investment	0.10	0.13	0.10	0.09	0.13	0.61	1.15	-0.56	1.10	0.05
Non-Oil	0.07	0.09	0.07	0.07	0.10	0.51	0.71	-0.32	0.95	0.12
Oil	0.03	0.04	0.03	0.02	0.02	0.10	0.43	-0.24	0.15	-0.07
Government	0.09	0.08	0.11	0.08	0.10	0.46	-0.85	1.34	0.53	-3.74
Net Exports	0.12	0.13	0.08	0.14	0.11	0.95	3.08	-2.95	2.43	-1.23
Exports	0.35	0.27	0.35	0.39	0.36	3.13	5.61	-0.05	3.98	-8.39
Imports	0.23	0.13	0.26	0.26	0.25	2.18	2.54	2.90	1.55	-7.16
Total GDP	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**5.81**	**6.58**	**1.91**	**7.94**	**7.72**
Non-Oil	0.71	0.66	0.66	0.76	0.85	5.02	4.10	1.77	7.54	7.43
Oil	0.29	0.34	0.34	0.24	0.15	0.80	2.48	0.14	0.40	0.28

Source: Author's computations based on data from the CBN and NBS

Overall, it can be seen from the various tables and charts that while consumption is larger than investment (and other GDP components), volatilities and oscillations of AD are due essentially to investment dynamics. The high weight of consumption reflects the high degree of privation in the country and the accompanying high marginal propensity to consume. Most of this consumption expenditure goes to necessities and basics like food which are highly interest rate inelastic. Thus, monetary policy may be unable to affect the larger part of demand. The above analysis also shows that although oil is a major aspect of the Nigerian economy, it is the non-oil sector that drives investment and GDP. Our analysis would, thus, concentrate on the impact of monetary policy changes in interest rate on non-oil investments in Nigeria.

A cursory analysis of other determinants of investment is also provided (see table 6.1). Though most correlation coefficients in the table are low, *a priori* sign expectations (vis-à-vis investment) are satisfied for output growth, inflation, credit availability, oil price changes, and exchange rates. However, a puzzle emerges with the profit growth which related inversely with investment and AD variables in contrast to Kaleckian/Kaldorian view. Theoretically, increases in profit raise (corporate) savings and investment. The negative sign may mean that most firms do not retain and reinvest profits. Perhaps larger proportions of earnings are paid out as dividend to shareholders who redirect those funds into financial savings assets and consumption.

Capacity utilisation is also found to contrast the theoretically postulated direction. Post-Keynesian analysis suggests a positive investment effect of capacity utilisation. However, these were found to correlate inversely for Nigeria. This may be due to the fact that capacity utilisation in Nigeria is not entirely demand driven, but essentially reflects infrastructural deficiencies. For instance, firms have to generate their own electricity and provide their own security. The cost of these causes a decline in demand, sales and capacity utilisation. In Nigeria, capacity utilisation is very low – hovering around 43.5 per cent (see table 3.2) – so that increases in demand/sales does not cause an excess over installed capacity and as such does not prompt machinery procurement. Since new machineries are not required to meet increased demand, new investments are not undertaken and the relationship between capacity utilisation and investment thus becomes non-positive. Investments in machinery may thus not be due to increased capacity but probably due to other factors like technological advances. Capacity utilisation may therefore not constitute a viable determinant of investment in Nigeria.

6.7 Methodology and Model Specification

The theoretical determinants of investment are numerous and they vary with schools of thought. Though our focus in this study is on the monetary policy effect of investment, the roles of other relevant factors are also examined in order to ensure completeness. Monetary policy would affect investment through the user cost of capital – particularly retail interest rates. Many investment literature threat this relationship either as linear or monotonic while in reality it may not only be nonlinear but also non-monotonic. However, a good starting point would be to assume linearity and monotonicity for simplicity. Hence, the basic model is expressed as

$$I_t = \varphi + \beta r_t + \mathbf{\Gamma} \boldsymbol{Z_t} + \varepsilon_t \tag{6.4}$$

where I_t is the log of real investment, r_t is the real retail interest rate (i.e. ALR), $\boldsymbol{Z}_t$ is a $k \times 1$ vector of k non-cost determinants of investments and ε_t is the stochastic error term which is assumedly $iid(0, \sigma_\varepsilon^2)$. The subscript t indicates that the variables are time-series while φ, β,and $\boldsymbol{\Gamma}$ are the (conforming vectors of) long-run parameters to be estimated. The $\boldsymbol{Z}_t$ vector can contain any combination of determinants for the various schools discussed earlier thereby leading to a potentially large dimension of $\boldsymbol{\Gamma}$. This has implications for the degrees of freedom and the validity of our inferences. Besides, some of these factors may be correlated among themselves. Hence, the first task is to prune the dimension of $\boldsymbol{Z}_t$. This is achieved by conducting a preliminary analysis in which all potential variables are allowed into an over-parameterised model of I_t on $\boldsymbol{Z}_t$ alone. This model is then reduced using a combination of criteria. Highly collinear or redundant variables are deleted from the model leaving few variables that optimised the $\bar{R}^2$ and AIC. Multicollinearity is investigated via the variance inflation factor (VIF) and coefficient variance decomposition while redundancy is examined with the conventional likelihood-ratio test.[56]

Given that most economic variables are inherently non-stationary a cointegration analysis is conducted using the ARDL model *à la* Pesaran and Shin (1998) discussed in chapter five. Thus, equation 6.4 is rewritten in ARDL form to derive our benchmark model as

$$\Delta I_t = \mu + \alpha I_{t-1} + \delta r_{t-1} + \boldsymbol{\Xi} \boldsymbol{Z}_{t-1} + \phi(L)\Delta I_t + \theta(L)\Delta r_t + \boldsymbol{\gamma}(L)\Delta \boldsymbol{Z}_t + \eta_t \qquad (6.5)$$

where μ is the intercept, α is the error correction parameter, δ nests the long-run interest rate multiplier, $\boldsymbol{\Xi}$ is a vector which embeds the long-run elasticities of non-cost determinants and η_t is an error term assumed $iid\left(0, \sigma_\eta^2\right)$. The long-run multipliers are derived as $\beta = \delta/-\alpha$ and $\boldsymbol{\Gamma} = \boldsymbol{\Xi}/-\alpha$ as explained previously. $\phi(L)$, $\theta(L)$ and $\boldsymbol{\gamma}(L)$ are lag polynomials in the short-run variables with ϕ, θ and $\boldsymbol{\gamma}$ as short-run dynamic parameters. This specification enables the concurrent estimation of the short- and long-run effects of the determinants on investment. Again, the lag augmentation allowed the modelling of the possible delays between impulse, planning and actual investment.

[56] The VIF threshold was set to 2 implying a tolerance of 0.5. Tolerance=1/VIF and range from 0-to-1 for high-to-low multicollinearity, respectively. Our threshold thus represents the moderate scenario.

However, Capozza and Li (2001), Chetty (2007), Kieler and Saarenheimo (1998) and Weiss (1999), *inter alia*, showed that the path of investment may be nonlinear so that the linear model in 6.5 becomes inadequate in capturing the relationship. Given our focus, we thus modelled the nonlinearity in the investment-cost relationship. A threshold in the relationship was suggested by Capozza and Li (*op.cit*) and Chetty (*op.cit*) with output growth as the transition variable. However, monetary policy can have asymmetric impact on investment depending on the size and direction of change. Consequently, we specify two different threshold-ARDL (T-ARDL) models in order to capture these asymmetries. The first is a simple threshold model that tested the presence of Chetty's backward bending function using the level of growth rate as threshold, while the second is a momentum based threshold model which investigated the convexity of the function where changes in monetary policy rate is the transition variable.

The asymmetric ARDL model of Shin *et al.* (2009) discussed in the previous chapter partitioned the variable by assuming a single known zero threshold. However, threshold may be non-zero, multiple and generally unknown. To test the backward bending function we utilise a single, known, but non-zero threshold, g_t – which is the growth rate at time *t*. Greenwood-Nimmo *et al*. (2011) showed that in this case the asymmetric regressor, r_t, can be partitioned as

$$r_t = r_0 + r_t^{(1)} + r_t^{(2)} \tag{6.6}$$

where $r_t^{(1)}$ and $r_t^{(2)}$ constitute the partial sum processes of the changes in r_t in regime_1 ($r_t \geq g_t$) and regime_2 ($r_t < g_t$), respectively, and is derived as

$$r_t^{(1)} = \sum_{h=1}^{t} \Delta r_h \cdot \mathrm{I}_{\{r_t \geq g_t\}}, \; r_t^{(2)} = \sum_{h=1}^{t} \Delta r_h \cdot \mathrm{I}_{\{r_t < g_t\}} \tag{6.7}$$

where $\mathrm{I}_{\{r_t, g_t\}}$ is an indicator function that took the value of unity when the argument is true and zero otherwise. Thus, the simple T-ARDL[1] models is specified as

$$\Delta I_t = \mu + \alpha I_{t-1} + \delta^{(1)} r_{t-1}^{(1)} + \delta^{(2)} r_{t-1}^{(2)} + \boldsymbol{\Xi Z_{t-1}} +$$

$$+ \phi(L)\Delta I_t + \theta^{(1)}(L)\Delta r_t^{(1)} + \theta^{(2)}(L)\Delta r_t^{(2)} + \boldsymbol{\gamma}(L)\Delta \boldsymbol{Z}_t + \eta_t \tag{6.8}$$

where $\delta^{(1)}$and$\delta^{(2)}$ are asymmetric parameters which nest the asymmetric long-run multipliers $(\beta^{(1)}\text{and }\beta^{(2)})$, while $\theta^{(1)}$ and $\theta^{(2)}$ are the short-run parameters in regime_1 and _2, respectively. A test of asymmetry is conducted using the *Wald*-test for $H_0: \beta^{(1)} = \beta^{(2)}$ and $H_0: \theta^{(1)} = \theta^{(2)}$ for the long- and short-run, respectively.

To conduct the momentum based analysis, the possibility of multiple thresholds in the interest-rate-investment relationship is recognised. Changes in monetary policy rate may have different effect on investment depending on the size of the change or the stance of policy. Hence, the objective of the analysis in this case is twofold. First, to determine whether larger absolute changes in MPR affected investment more than smaller ones. Second, to investigate the effect of positive vis-à-vis negative nominal MPR changes on investment. Consequently, two unknown thresholds $(\tau^{(\cdot)})$ are specified leading to three possible regimes. The first threshold $(\tau^{(1)})$ defined the upper regime for large positive changes while the other $(\tau^{(2)})$ captured the lower regime for large negative changes. The middle regime denoted moderate (or zero) change regime. The analysis is designed to determine the effect of ALR on investment in different policy regimes. Hence, the momentum of MPR (i.e. ΔMPR) becomes the transition variable while the ALR is the regressor to be split, thereby reflecting the effect of retail lending rate on investment given changes in MPR.

In this case, the asymmetric regressor r_t is partitioned as

$$r_t = r_0 + r_t^{(1)} + r_t^{(2)} + r_t^{(3)} \tag{6.9}$$

where $r_t^{(j)}$ is the partial sum process for the changes in r_t in the j^{th} regime defined as

$$\begin{aligned} r_t^{(1)} &= \textstyle\sum_{h=1}^{t} \Delta r_h \cdot \mathrm{I}_{\{\Delta mpr_{t-d} \geq \tau^{(1)}\}} \\ r_t^{(2)} &= \textstyle\sum_{h=1}^{t} \Delta r_h \cdot \mathrm{I}_{\{\tau^{(1)} > \Delta mpr_{t-d} > \tau^{(2)}\}} \\ r_t^{(3)} &= \textstyle\sum_{h=1}^{t} \Delta r_h \cdot \mathrm{I}_{\{\Delta mpr_{t-d} \leq \tau^{(2)}\}} \end{aligned} \tag{6.10}$$

where $\mathrm{I}_{\{\Delta mpr_t, \tau^{(\cdot)}\}}$ is an indicator function that equals unity when the condition is satisfied and zero otherwise. $d \geq 0$ is the delay parameter reflecting the possible lag effect of monetary policy. The momentum T-ARDL[2] is thus specified as

$$\Delta I_t = \mu + \alpha I_{t-1} + \sum \delta^{(j)} r_{t-1}^{(j)} + \boldsymbol{\Xi} \boldsymbol{Z}_{t-1} + \phi(L)\Delta I_t + \sum \theta^{(j)}(L)\Delta r_t^{(j)} + \boldsymbol{\gamma}(L)\Delta \boldsymbol{Z}_t + \eta_t \quad (6.11)$$

where $j \in [1,2,3]$ represents the respective regimes. Again, $\delta^{(j)}$ are the asymmetric parameters containing the asymmetric long-run multipliers $\left(\beta^{(j)}\right)$ while $\theta^{(j)}$ are the short-run parameters. Test of asymmetry is again based on the *Wald*-test for $H_0: \beta^{(1)} = \cdots = \beta^{(j)};\ \forall j$, and $H_0: \theta^{(1)} = \cdots = \theta^{(j)};\ \forall j$, in the long- and short-run, respectively. The stochastic and unknown thresholds are estimated by conducting a grid search and selecting the pair (τ, d) that minimises the residual sum of squares (RSS) as follows

$$\hat{\tau} = \underset{\tau, d \in [0.15Q, 0.85Q]}{\operatorname{argmin}} RSS(\tau, d) \quad (6.12)$$

where RSS is derived from OLS regressions of equation 6.11 for different values of $\tau, d \in Q$, and Q is the set of all possible values of the transition variable after removing observations in the top and bottom 15th-percentile. The search is conducted sequentially in increments of 25 basis points for changes in MPR while limiting the delay to $0 \leq d \leq 4$ given the quarterly frequency of our data.[57] A likelihood-ratio test is used to test the validity of the estimated thresholds.

The ARDL equations 6.5, 6.8 and 6.11 are estimated using the OLS technique. Generally, an OLS estimation of an investment model based on its various determinants may be characterised by a number of problems like endogeneity bias, autocorrelation, and non-stationary of variables. Endogeneity bias results from the fact that many determinants of investment (e.g. output, profit, etc) are endogenous regressor which relate bi-directionally with investment and thus correlate with the error. The potential problem of serial-correlation is due to time-series nature of the data and the inherent time dependence of financial variables. While non-stationary is based on the fact that most economic data are $I(d)$, where $d > 0$. These can lead to the problem of spurious analysis and could invalidate our inferences. However,

[57] The search sequence is based on the monetary policy norm of adjusting base rate in multiples of 25 basis points.

according to Pesaran and Shin (1998), the ARDL approach has the advantage of producing consistent parameters estimate in the presence of these problems and irrespective of the mixture of $I(0)$ or $I(1)$ variables (see chapter 5). They also showed that adequate lag augmentation concurrently eliminates the problems of autocorrelation and endogeneity bias. To ensure valid inferences, it is essential to choose the correct order of the ARDL using appropriate criteria like the AIC.

Pesaran and Shin (*op.cit*) indicated that the estimators of the cointegrating parameters of the ARDL are Gaussian and efficient. These estimators also have the limiting normal distribution and are super-consistent, while estimators of the short-run parameters are consistent even in the presence of non-stationary variables. Furthermore, the ARDL approach produces economically interpretable cointegrating coefficients. As in the previous chapter, test of cointegration is conducted using the PSS bounds *F*-test which is applicable irrespective of the orders of integration of the variables. Assuming an unrestricted intercept, the PSS *F*-test of long-run relationships is performed, under the (joint) null of no cointegration as

$$H_0: \alpha = \delta^{(n)} = \boldsymbol{\Xi} = 0 \qquad (6.13)$$

where $n \in [1,2,3]$ is the respective regimes in the three ARDL variants. The *F*-statistic is then compared with the asymptotic critical values provided in Pesaran *et al*. (2001) as discussed in the preceding chapter. Following Shin *et al*. (2009), cumulative dynamic multipliers in these models are computed to analyse adjustment path to steady-state equilibrium after an impulse to regressors. This is derived as

$$\mathcal{M}_h^{(j)} = \sum_{\mathcal{L}=0}^{h} \frac{\partial I_{t+\mathcal{L}}}{\partial r_t^{(j)}}; \qquad h = 0,1,2 \cdots \qquad (6.14)$$

where $j \in [1,2,3]$ for the corresponding regime. The dynamic multipliers $\mathcal{M}_h^{(j)}$ tend to $\beta^{(j)}$ as $h \to \infty$. The duration of full adjustment $\left(\mathcal{M}_h^{(j)} = \beta^{(j)}\right)$ is captured by h which is plotted against $\mathcal{M}_h^{(j)}$ for the various models to show the adjustment traverses. In nonlinear models, $\mathcal{M}_h^{(1)} \neq \mathcal{M}_h^{(2)} \neq \mathcal{M}_h^{(3)}$ may hold, suggesting asymmetric adjustment in the various regimes.

Again, as in the preceding chapter, robust OLS analysis is conducted using the Newey-West method to provide HAC standard errors which ensures the validity of our inferences even in the presence of the classical problems. We evaluate the stability and correctness of our model specification using Ramsey's *RESET* with the null of no specification error. All restrictions and models evaluations are, again, conducted at the 5 per cent level of significance.

6.8 Empirical Analysis

To ensure a robust model of investment, empirical analysis begin with an eclectic over-parameterised equation and a search for important determinants. Twelve variables [including $CPI_t, CPS_t, CU_t, EV_t, \left(\frac{FD}{Y}\right)_t, \left(\frac{TDS}{Y}\right)_t, GI_t,\ K_t, Y_t, C_t, PF_t, PO_t$] featured in the search. Interest rates are excluded from the search since they constitute the focus of the overall analysis. Tests of multicollinearity and redundancy, pruned the variables to four [consisting CPS_t, EV_t, GI_t, Y_t] which are used as the main components of the $\boldsymbol{Z}$ vector. Nonetheless, PV is attached to the model as a dummy variable while PO_t is appended to the oil equation. Of the two definitions of EV_t, the GARCH(1,1) version is preferred given its superior performance in the preliminary search. Besides, the first principal component for the GARCH(1,1) explained about 50 per cent of the variances in the three series compared with 39 per cent explained by the implicit volatility version.

As in the preceding chapter, test of stationarity is conducted to investigate the time-series properties of (all admissible) variables using both the ADF and the KPSS tests. According to these, most variables are $I(1)$ apart from ALR and EV which are $I(0)$. Both tests, however, presented conflicting results for the oil investment (I_O) and oil output (Y_O) (see table 6.4). The mixture of $I(0)$ and $I(1)$ variables, as underscored earlier, would not affect the validity of our analysis given that the ARDL model and the PSS *F*-test remain valid even under this condition.

The ARDL model is estimated for total (I_T), non-oil (I_N) and oil (I_O) investments. A general to specific modelling approach is adopted with an over-parameterisation of four lags for the regressors and the regressand. The optimal lag-length of four is based on the AIC from a search of between one-to-eight lags. A parsimonious model is thereafter obtained by deleting insignificant dynamic regressors from the model complemented with the AIC criterion. For any set of potential parsimonious models, that with the least AIC is selected. Where variables are insignificant both in the long- and short-run, such variables are completed deleted from the model. Coefficients of the remaining significant short-run variables in the models are summed-up to derive the short-run dynamic parameter for the respective variables.

Table 6.4: Stationarity Test for Candidate Variables

	ADF			KPSS		
	Levels	1st-Diff.	Decision	Levels	1st–Diff.	Decision
Private Investment (***I_T***)	-1.79	-5.21***	$I(1)$	0.23***	0.06	$I(1)$
Non-Oil (***I_N***)	-1.21	-5.18***	$I(1)$	0.25***	0.06	$I(1)$
Oil (***I_O***)	-3.46**	-4.58***	$I(0)$	0.16**	0.05	$I(1)$
Lending Rate (***ALR***)	-4.05***	-7.84***	$I(0)$	0.08	0.03	$I(0)$
Private Credit (***CPS***)	-1.18	-9.96***	$I(1)$	0.29***	0.05	$I(1)$
Non-Oil (***CPS_N***)	-1.16	-9.93***	$I(1)$	0.29***	0.05	$I(1)$
Oil (***CPS_O***)	-2.17	-13.25***	$I(1)$	0.17**	0.07	$I(1)$
GDP (***Y***)	-1.30	-4.04**	$I(1)$	0.24***	0.07	$I(1)$
Non-Oil (***Y_N***)	-1.30	-4.04**	$I(1)$	0.26***	0.08	$I(1)$
Oil (***Y_O***)	-2.61	-4.73***	$I(1)$	0.11	0.06	$I(0)$
Public Investment (***GI***)	-1.61	-10.04***	$I(1)$	0.25***	0.04	$I(1)$
Economic Volatility (***EV***)	-6.13***	-8.58***	$I(0)$	0.13*	0.12*	$I(0)$
Oil Prices (***PO***)	-2.51	-8.88	$I(1)$	0.28***	0.04	$I(1)$

Source: Author's computations based on data from the CBN and NBS.

Note: The ADF-test was conducted under the null hypothesis of unit root using MacKinnon critical values of −4.04, −3.45 and −3.15 for the 1%, 5% and 10% significance level, respectively, while the KPSS-test was performed under the null hypothesis of stationarity with corresponding asymptotic critical values of 0.21, 0.14 and 0.11.

6.8.1 The Linear-ARDL Model

An abridged result of the symmetric ARDL is contained in panel (A) of table 6.5 below.[58] Column (1) presents the results for the total investment model, while non-oil and oil results are contained in the columns (2) and (3), respectively. All variables in the long-run portion of the columns are rightly signed except for the *CPS*, while in the short-run section ALR coefficient is positively signed. The results indicated a significant and substantial error correction mechanism (α) with quarterly adjustment speeds ranging from 22 to 53 per cent for I_T and I_O, respectively. The long-run ALR multipliers indicate a negative relationship with investments which is stronger for non-oil than for oil investments. It indicated that a 1-percentage point change in ALR reduces I_T, I_N and I_O by 0.4, 0.5 and 0.2 per cent, respectively. The coefficient of I_O is not only least but also insignificant, while I_N and I_T are significant at 5 and 10 per cent, respectively. In the short-run, all three are significantly positive with I_O having the largest coefficient. The negative long-run but positive short-run coefficients could indicate that interest rates changes do not

[58] Given the length of the original table an abridged version is presented in the main text containing the relationships of interest. The full table is however presented in the appendix.

deter investments which have already been ratified while planned investments can be altered by these. This finding is consistent with the earlier stylised analysis.

Credit availability, proxied by *CPS*, also showed a perverse but significantly negative long-run effect and significantly positive short-run coefficient for all three. This may be due to the reluctance of Nigerian banks to grant long-term loans and their preference for short-term bridge-finance loans. In many cases, banks in Nigeria try to limit the tenure of their loans to one year. The $\bar{R}^2$ at 0.91, suggested that the I_T model captured most variation in the regressand. This is, however, lower for I_N (0.79) and lowest for I_O (0.67). The PSS F-test confirmed the presence of a long-run relationship in the variables at the 5 per cent level.

6.8.2 The Simple T-ARDL[1] Model: Analyses of the Backward Bending Function

To test the possibility of a non-monotonic relationship, the investment function is re-estimated using the (nonlinear) threshold-ARDL with one threshold (T-ARDL[1]). Consistent with Capozza and Li (2001) and Chetty (2007) the threshold variable in this analysis is the real growth rate of output. This threshold represented the level at which real interest rates either lied above or below growth rate. Consequently, the threshold is given and required no estimation. For levels of interest rates above growth rate, the *a priori* expectation is a negative relationship, while below it we expect a positive relationship in order to confirm the backward bending curve.

The results of T-ARDL[1] are contained in panel (B) of table 6.5, where columns (5), (6) and (7) present models for total, non-oil and oil investments, respectively. Again, the ECM parameter (α) showed considerable adjustment speed for I_O, vis-à-vis the other models, and is correctly signed in all cases. The long-run coefficients of ALR are insignificantly positively signed in all three cases for rates above threshold (regime_1) but are negative for rates below the threshold (regime_2). These results could not confirm the presence of a backward bending curve as suggested by Capozza and Li (*op.cit*) and Chetty (*op.cit*). It instead presented evidence, *albeit* weakly, of a forward bending (non-monotonic) curve. The insignificance of regime_1 coefficients supported the findings of Rose (2000), who showed that investment-interest rate relationship diminishes at high interest rates. Sectoral comparison, again, indicated that interest rate changes do not affect oil sector significantly while the effect is significantly negative for I_T and I_N in regime_2. The *Wald*-test suggests long-run nonlinearity for I_T and I_N while I_O exhibited long-run symmetry.

Table 6.5: Result ARDL Model of Investment: Monetary Policy Effects

	(A)	**ARDL Model**		**(B)**	**T-ARDL[1] Model**		**(C)**	**T-ARDL[2] Model**	
	I_T	***I_N***	***I_O***	***I_T***	***I_N***	***I_O***	***I_T***	***I_N***	***I_O***
Regressor	(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)
μ	1.12*** (0.30)	1.19*** 0.30	-2.21* (1.15)	1.37*** (0.38)	1.53*** (0.27)	-0.22 (0.90)	2.98*** (0.52)	2.14*** (0.29)	0.80 (1.40)
α	-0.21*** (0.04)	-0.38*** (0.06)	-0.52*** (0.08)	-0.20*** (0.04)	-0.40*** (0.04)	-0.47*** (0.09)	-0.49*** (0.07)	-0.59*** (0.05)	-0.50*** (0.13)
$\delta^{(1)}$	-0.08* (0.04)	-0.19*** (0.06)	-0.11 (0.07)	0.03 (0.06)	0.02 (0.08)	0.10 (0.16)	-0.36*** (0.06)	-0.54*** (0.11)	-0.12 (0.11)
$\delta^{(2)}$				-0.14*** (0.04)	-0.20*** (0.06)	-0.05 (0.08)	0.20*** (0.04)	0.07 (0.05)	0.16** (0.07)
$\delta^{(3)}$							-1.12*** (0.23)	-0.40*** (0.10)	-1.02*** (0.36)
$\beta^{(1)}$	-0.37* (0.19)	-0.50** (0.19)	-0.21 (0.15)	0.19 (0.30)	0.06 (0.21)	0.22 (0.33)	-0.73*** (0.10)	-0.90*** (0.17)	-0.24 (0.21)
$\beta^{(2)}$				-0.74*** (0.22)	-0.49*** (0.17)	-0.10 (0.16)	0.41*** (0.06)	0.12 (0.09)	0.32** (0.14)
$\beta^{(3)}$							-2.27*** (0.44)	-0.67*** (0.17)	-2.03** (0.81)
$\Xi^{[CPS_{t-1}]}$	-0.04** (0.01)	-0.05** (0.02)	-0.03 (0.02)	-0.05*** (0.01)	-0.07*** (0.02)	-0.05** (0.02)	-0.06*** (0.02)	-0.09*** (0.03)	-0.05** (0.02)
$\Gamma^{[CPS_{t-1}]}$	-0.20** (0.08)	-0.13** (0.06)	-0.07* (0.03)	-0.27*** (0.08)	-0.17*** (0.06)	-0.11*** (0.03)	-0.14*** (0.04)	-0.15*** (0.05)	-0.11*** (0.02)
$\sum_{s=0}^{4} \Delta r_{t-s}^{(1)}$	0.15*** (0.05)	0.15** (0.07)	0.30** (0.12)	-0.14* (0.08)	-0.08 (0.09)	-0.23 (0.22)	-0.16 (0.12)	0.28* (0.15)	-0.20 (0.20)
$\sum_{s=0}^{4} \Delta r_{t-s}^{(2)}$				0.11** (0.05)	0.13 (0.08)	0.27** (0.12)	0.56*** (0.14)	0.74*** (0.15)	0.41*** (0.11)
$\sum_{s=0}^{4} \Delta r_{t-s}^{(3)}$							0.64** (0.28)	-0.48*** (0.13)	1.05* (0.57)
$\sum_{s=0}^{4} \Delta I_{t-s}$	0.26*** (0.06)	0.35*** (0.08)	0.17*** (0.05)	0.42*** (0.08)	0.62*** (0.09)	0.27*** (0.07)	0.40*** (0.08)	0.61*** (0.07)	0.24*** (0.06)
$\sum_{s=0}^{4} \Delta CPS_{t-s}$	0.14*** (0.05)	0.24*** (0.07)	0.10** (0.05)	0.16** (0.06)	0.23*** (0.08)	-0.03 (0.05)	0.13** (0.05)	0.33*** (0.06)	0.10** (0.04)
$\bar{R}^2$	0.91	0.79	0.66	0.91	0.86	0.68	0.96	0.91	0.71
RSS	0.10	0.25	0.71	0.10	0.17	0.72	0.03	0.10	0.66
AIC	-3.60	-2.76	-1.62	-3.59	-3.02	-1.67	-4.20	-3.30	-1.69
F-Test$_{(PSS)}$	6.09**	10.31**	8.94**	4.87**	18.67**	4.79**	10.58**	21.37**	3.82**
RESET	3.11* [0.06]	3.95** [0.03]	3.01* [0.09]	0.02 [0.89]	3.53* [0.06]	0.06 [0.81]	0.27 [0.43]	0.08 [0.72]	0.08 [0.77]
***LR-Sym*(1)** $\beta = \beta^{(1,2,3)}$				NO	NO	YES	NO	NO	NO
***LR-Sym*(2)** $\beta^{+} = \beta^{-}$							NO	NO	NO
***SR-Sym*(1)** $\theta = \theta^{(1,2,3)}$				YES	YES	NO	NO	NO	NO
***SR-Sym*(2)** $\theta^{+} = \theta^{-}$							NO	NO	NO

Source: Author's computations based on data from the CBN and NBS.

Note: Econometric estimation was conducted with *EViews 7.0* software using data are from 1985:Q1 to 2011:Q2. Figures in ( ) are standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *RSS* means residual sum of squares while *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F-test*($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using 5% asymptotic critical values from Pesaran *et al*. (2001). *RESET* is the *F*-statistic of Ramsey's specification error test using the squares of fitted residuals; *p*-values are in [ ]. *LR-Sym*(·) and *SR-Sym*(·) are *Wald*-tests for asymmetric multipliers in the long- and short-run, respectively, where test(1) investigates asymmetry in all regimes in a given model and test(2) is for positive or negative asymmetry in model C.

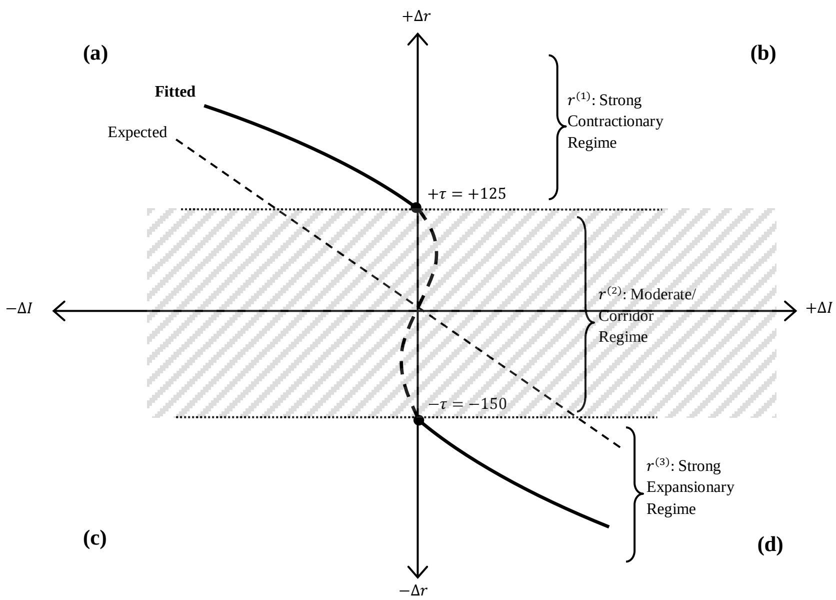
In the short-run, the coefficients are negatively signed in regime_1 but positive in regime_2. This may suggest that the backward bending curve may only be obtainable in the short- rather than the long-run. The coefficients are, nonetheless, insignificant for non-oil in both regimes but significant for oil only in the lower regime. The *Wald*-test indicated short-run symmetry for total and non-oil but asymmetry for oil investments. Private sector credit is, again, negatively signed in the long-run but is positive in the short-run. Though, the $\bar{R}^2$ and the AIC changed marginally for I_T and I_O, vis-à-vis the linear model, they improved reasonably for I_N to 0.86 and -3.03, respectively. Again, the PSS F-test rejected the null hypothesis at the 5 per cent level in all sectors. Comparing the ARDL with the T-ARDL[1] models suggested only a marginal improvement in the latter.

6.8.3 The Momentum T-ARDL[2] Model: Analyses of the Monetary Policy Effect

The T-ARDL[2] model contained two unknown thresholds $\left(\tau^{(1)} > 0 > \tau^{(2)}\right)$ which are estimated by searching sequentially over the grid set which contained the middle 70th-percentile of nominal Δmpr_{t-d} over the sample period. The search is conducted first for the positive threshold $\tau^{(1)}$ and then holding this constant, $\tau^{(2)}$is estimated; after which we re-estimated $\tau^{(1)}$. This search is conducted simultaneously for the thresholds $\left(\tau^{(\cdot)}\right)$ and the delay parameter (d). Following several iterations, we found $\tau^{(1)} = 125; d = 0$ and $\tau^{(2)} = -150; d = 1$ for I_T and I_O. However, for I_N, the results indicated $\tau^{(1)} = 125; d = 0$ and $\tau^{(2)} = -100; d = 0$. We also found a global single threshold of $\tau = -150; d = 1$ for I_T and I_O, while for I_N it is $\tau = 125; d = 0$. The single threshold model is, nonetheless, not analysed further in this study as we focused on the double threshold model. The validity of these thresholds are confirmed via a likelihood-ratio test, *à la* Hansen (2000), computed from the sum of squared residuals of the (unrestricted) linear-ARDL model, the restricted single (unknown) threshold model, and the restricted double (unknown) T-ARDL[2] model. This enables us to investigate the robustness of the threshold models and thus, ascertain that our results are not due to outliers.

Columns (8), (9) and (10) in panel (C) of table 6.5 contain the result of the T-ARDL[2] model for total, non-oil and oil investments, respectively. The speed of adjustment (α) is correctly sized and signed in all equations. It is also generally higher than those in the T-ARDL[1] model while a sectoral analysis indicated it is highest for I_N at 60 per cent vis-à-vis 49 and 51 per cent for I_T and I_O, respectively. The long-run multipliers are higher, in absolute value, for high momentum regimes $\left(r^{(1)} \text{and } r^{(3)}\right)$ than for the low momentum –corridor– regime $\left(r^{(2)}\right)$ in all cases. Basically, interest rates relate somewhat directly with investment when monetary policy changes are moderate, but inversely for sizeable policy changes (see figure 6.4). For I_T and I_O, accelerated monetary ease boosted investment substantially more than investment is retarded by increased monetary tightening. The converse holds for I_N. Hence, the multipliers are (absolutely) higher in regime_3 than in regime_2 for I_T and I_O but not I_N.

Figure 6.4: Fitted Long-run Investment-Interest-Rate Relationship



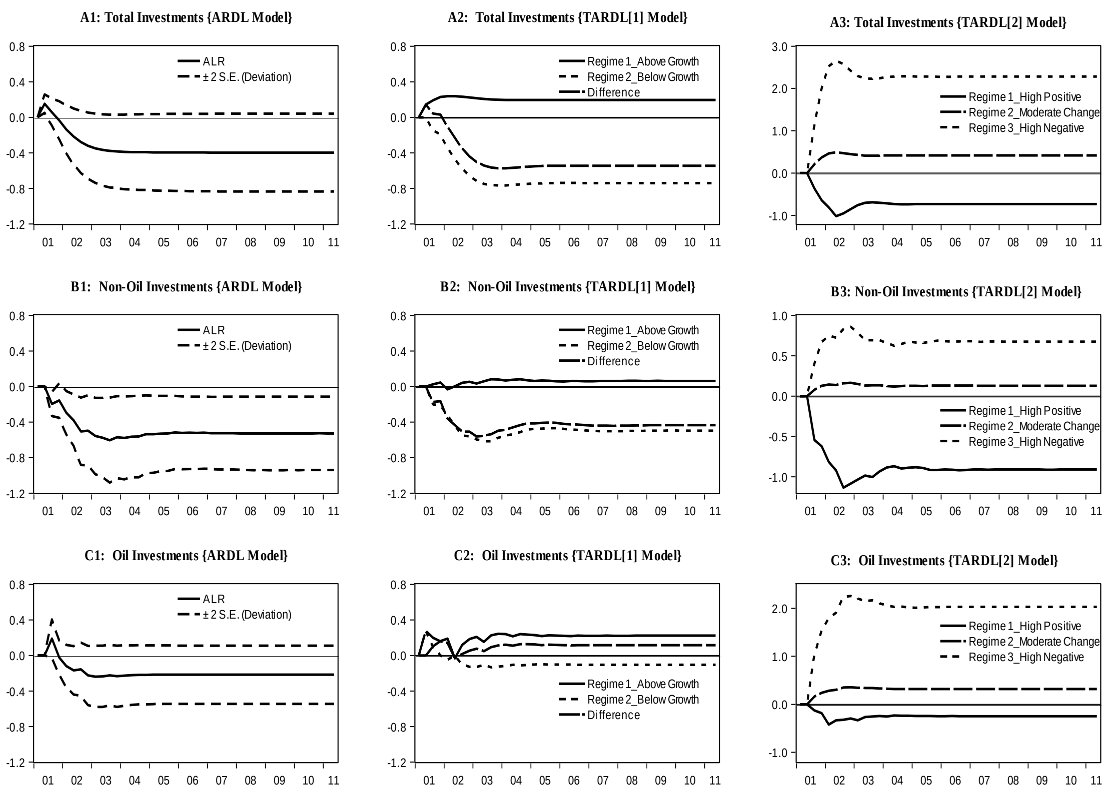
During accelerated monetary ease, an extra 1-percentage point fall in market rates increases I_T, I_N and I_O by 2.2, 0.7 and 2.0 per cent, while equally sized rise retards investments by 0.7, 0.9 and 0.2 per cent, respectively. The fall in I_O is nonetheless, not significant implying that regimes of substantial monetary policy tightening retards I_N significantly but has little effect on I_O. In the middle regime of moderate monetary policy changes, the multipliers are non-negative; being significantly positive for I_T and I_O, but insignificant for I_N. The *Wald*-test of asymmetry rejected the null hypothesis of symmetry among the three regimes in all equations. Similarly, the test found asymmetry between accelerated monetary tightening and ease in all cases.

In the short-run, accelerated tightening have a generally weak effect on investments. This may probably be due to long-term planning of investments. For I_T and I_O, the short-run multipliers suggested that a 1-percentage point fall in rates lowers investments, by 0.56 and 0.42 per cent in the median regime and 0.64 and 1.05 per cent in regime_3, respectively. However, the results indicated that I_N are lowered in the median regime but boosted in regime_3. This implied that sharp expansionary policies have significant short-term effects on I_N. The multipliers in the middle regime are significantly positive in all sectors. Other results showed that CPS coefficients remained negative in the long-run but are positive in the short-run. The T-ARDL[2] models showed a considerable better fit than the T-ARDL[1] as the $\bar{R}^2$ increased to 0.97, 0.91 and 0.71 for I_T, I_N and I_O , respectively. This indicated that the models explained a substantial amount of variations in the investments in Nigeria. In addition, the AIC also selected these models over the preceding one while the PSS *F*-test again confirmed the existence of a long-run relationship among the variables in all cases.

The results in the three linear and nonlinear-ARDL are also illustrated in the cumulative dynamic multipliers in figure 6.5. Columns 1, 2 and 3 show the results of the linear, T-ARDL[1], and T-ARDL[2] models, respectively, while the various aggregations of investments are contained in the rows. Cumulative dynamic multipliers, according to Shin *et al*. (2009), depict the adjustment trajectory, via short-run disequilibrium, to the long-run equilibrium when regressors of interest are shocked. The patterns in figure 6.5 suggested that, in the linear model, positive shocks to lending rates lower investment in all three investment aggregates, *albeit*, significantly for I_N. Furthermore, it takes approximately two years to revert to equilibrium for I_T and I_O, though the effects are insignificant almost throughout the life of the shock, while non-oil shocks required a longer time, about five years to eventually flatten out.

In the nonlinear model of T-ARDL[1], the asymmetric dynamic multipliers suggested that significant asymmetry in the responses as seen in the “difference” series which lay between regimes_1 and _2. For total and non-oil investments, this showed that when interest rates are below growth rate, shocks to the system are significantly negative and are persistent. Adjustments to the long-run equilibrium are, again, about three years for total and five years for non-oil investments. However, at higher levels of interest rate the response is insignificantly positive. For the oil sector, the response is generally muted and symmetric. Column 3 contains the traverse for the momentum threshold model. This showed that regimes of accelerated tightening have a persistent negative impact on domestic investments generally. Essentially, the effects of large ease and moderate stance disappeared after two years, while that of large hikes persisted and taking about four years to flatten out. This inverse effect is considerably larger for non-oil than for oil investments.

Figure 6.5: Cumulative Dynamic Multipliers



6.9 Discussions and Findings

The empirical analysis presented in table 6.5 and figures 6.4/6.5 contain a number of findings on the relationship between investments and interest rate and the role of monetary policy. Nonetheless, investment is determined by a battery of factors other than the interest rate (or monetary policy). Knowledge of the relative importance of interest rate in the investment process is also germane to the design of monetary policy. Our findings are thus presented in two folds: first, the effects of monetary policy on investment, and next, relative effects of other determinants.

6.9.1 Monetary Policy Effects

The investment-interest-rate relationship presented above has important long-term implications for the conduct of monetary policy and the Nigerian economy. Although an inverse relationship was suggested on the average by all models, our analysis found significant differences among sectors and models. Several key findings can be deduced from the result but the discussions would focus on the most important ones.

First, we find that the relationship is inherently nonlinear given the superiority of the nonlinear models and the significant asymmetry confirmed by the *Wald*-test. Thus, the interest-rate-investment relationship is better explained by a nonlinear rather than a linear model; consistent with the views of Fazzari *et al.* (2010), and Kieler and Saarenheimo (1998), *inter alia*. However, this nonlinearity may not be due to the level interest rate vis-à-vis growth rate as suggested by Chetty (2007) and Capozza and Li (2001), at least for Nigeria. The T-ARDL[1] model showed that at higher interest rate the relationship becomes insignificant. This finding, by showing that the relationship diminished at high levels, contradicted that of Capozza and Li (*op.cit*) but supported that of Rose (2000). Again, the results do not provide strong evidence of non-monotonicity, which in this case showed the inappropriateness of output growth as a threshold variable. Hence, the relationship is nonlinear but monotonic. Comparing the T-ARDL[1] with the T-ARDL[2] suggested that the latter captured the dynamics better than the former. The preferred three regime T-ARDL[2] model, thus, suggested that it is *changes*, rather than the *levels* of interest rates that are most important in determining investment and capturing the nonlinearities in the relationship (see figure 6.4). This finding was pre-empted by Fazzari *et al.* (*op.cit*) when they argued that “the investment component of [AD] depends on the change in real rates” rather than its levels (p.2013). Hence, irrespective of the level of interest rate, the responsiveness of investments to interest rates depends on nominal *changes* in the transition variable, the monetary policy rate. The investment-interest rate function is therefore asymmetric around changes in policy rate.

Second, the results (and figure 6.5) showed that the interest rate effect on investment is highest in regimes with strong monetary policy rate adjustments. In these extreme regimes, the interest rate effect is also inverse, in line with the neoclassical theories. However, in the corridor regime – with moderate monetary policy stance – the relationship between investment and market rates is positive and sometimes insignificant, thus perverse. In contrast to Stiglitz and Greenwald (2003), this implied that changing policy rates by between 25-50 basis points would be ineffective in achieving its objective and can even cause distortions to the system. Capozza and Li (2001) underscored the implications of this kind of perverse outcome for worsening long-run economic performance. More importantly, interest rate had no effect on non-oil investment in Nigeria, when policy changes are within the corridor. This has other implications given that policies are targeted at this sector; with the assumed inability to affect the oil sector. The reason for this result may be that moderate changes in policy rate would have limited impact on discount rate and planned investment, but may affect a projects' IRR and the option value of delay (Capozza and Li, *op.cit*). At best, the overall effect of interest rate on investment within this corridor regime is ambiguous.

The general implication of this is that interest and investments in Nigeria would relate inversely in the long-run, as long as changes in the policy rate are outside the perverse corridor. This long-run relationship is validated by the PSS F-test. Given our estimated thresholds, the effect of monetary policy would also differ between extreme regimes depending on whether the policy stance is expansionary or contractionary. The results also differed among investment types. Nonetheless, we find that monetary tightening would have a significant effect on all investment types when the hike surpassed (or equalled) 125 basis points. In regimes of loose policy, the effect becomes meaningful for rate eases of 150 basis points (or more) for total and oil while the threshold for non-oil is 100 basis points. Hence, while the thresholds for contractionary stance are the same, those for expansionary stance are different. If the policy objective is to encourage non-oil rather than oil investment then the reduction in policy rates should be $100 \leq \Delta mpr < 150$ for the outcome to be effective.

Again, tight policy would affect the non-oil sector more than the oil sector. This is not unexpected. The results nonetheless suggested that tight monetary policy may have larger adverse effect on non-oil investment than can be reversed by loose policy, while the converse holds for the oil sector. It is easier to lower non-oil investments than to increase them, while oil investments are easier to raise than to lower. This is shown by the larger long-run multiplier in regime_1 than regime_3, for non-oil investments and larger regime_3 multiplier than regime_1 in the case of oil investments. Essentially, as shown in table 6.5, every extra 1-percentage point rise in interest rate, in regime_1, slows non-oil investments by 0.9 per cent but a policy reversal of equal size can only boost investment by 0.7 per cent implying a long-term loss of 0.2 per cent. This result is also confirmed in figure 6.5, which shows large and sustained inverse effect of large rates hikes on non-oil investments but lesser and transitory improvements when rates are falling fast. While low changes may not affect non-oil investment, accelerated changes may have more reducing effect in the long-run. The implication of this for monetary policy under the NCM is that, in aggressive drive to control inflation, the growth path of an economy might be lowered permanently. For a developing country like Nigeria, this would further retard the development prospect for any given investment multiplier.

This implication may be obscured by the results of total investment which suggested that total investment is boosted more than it is deterred by monetary policy in extreme regimes. Such outcome was nonetheless due the synchronised movements of total and oil sector multipliers (in model (C) of the table), which can indicate that oil investments are important in the system. However, given the overdependence of the Nigerian economy on the oil sector and the government's desire to reduce its significant vis-à-vis the non-oil sector, care must be taken in this regard. Though domestic factors are important for oil investment, the most important determinants of developments in that sector are international (supported somewhat by the lower $\bar{R}^2$ in the oil models than others). Given the international dimension of the oil market, investors in the oil sector are not deterred by adverse domestic conditions like rate hikes but are quick to enjoy the benefits of rate falls. With the supposed inability to effectively influence oil sector, the focus of monetary policy in Nigeria should remain the non-oil sector, which responds more to domestic developments, but with the view to encouraging economic development rather than diminishing the long-run path.

With regards to the relationship between monetary policy rate and the retail lending rate, the delay parameter can connote the response lag. A possible deduction is that the delay parameter of one period found in some models may reflect a quarter lag in pass-through from policy to lending rates when rates when rates are falling. The delay of zero would thus connote a faster adjustment of lending rates in periods of tight monetary policy. This result is consistent with our findings in chapter five, which suggested that banks increased lending rates faster than they reduced them.

The analysis also revealed the effect of the credit channel of monetary policy transmission. Credit availability is found to retard investments in the long-run but to boost them in the short-run. In all three ARDL models, the boost is larger for the non-oil sector than the oil sector. Although the negative long-run effect is puzzling, it may however be attributable to the practice of short-term lending among Nigerian banks. Generally, banks prefer to provide short-tenured facilities to their clients, which may be rolled-over for another short-term if the bank is satisfied. This notwithstanding, Nigerian banks have sometimes, though rarely, provided medium term loans of up to five years but hardly ever exceeded that tenure for any single transaction. This behaviour may be due to uncertainty about the long-run course of the economy, coupled with the standard risk of default which thus increases the overall riskiness of credits. The short-tenure allowed banks to re-appraise credits regularly without getting locked-in to long-term risks. Consequently, in the short-run when credits are more available investments relate directly and significantly with CPS. This confirmed the importance of credit for investment and indicates that if more long-term credits were available, the long-run relationship may be positive. The monetary authorities may intervene by guaranteeing long-term credits which had been duly assessed for default risks attributable to macroeconomic uncertainties. This is particularly more important for the non-oil sector the elasticity of which was higher.

Overall, this shows that NCM-type monetary policy may hurt economic growth in the presence of IT. First, combining the results of the T-ARDL[1] and T-ARDL[2] presents a dilemma for the CBN. Given that the effect is only significant if the level of interest rates are low or if the size of changes are high, effective monetary policy may require the doubling or halving of rates, as the case may be. If this is so, monetary policy may have the unsavoury consequence of creating distortions and uncertainties in the country. Second, the nature of the sectoral differences in the response of investment is a source of concern. This is based on the finding that policy affects non-oil more than the oil sector coupled with the fact that contractionary policy lowers non-oil investments in the long-run more than expansionary policy can stimulate it. That non-oil investment responds to monetary policy adjustments more than oil investment, is by itself not an inconvenience; rather the problem lies in the form of asymmetric response to various policy stances. The finding that non-oil investment is quicker to decline than to rise following policy adjustment means that policy would have an overriding adverse consequence in Nigeria. Essentially, the net-effect of a 1-percentage point increase in policy rate, even if reversed immediate, would be negative. This implies that monetary policy would necessarily reduce the supply capacity in Nigeria, thereby constraining long-term economic well-being. Being a developing country, Nigeria, may therefore be careful in implementing this kind of policy as the growth prospect may be considerably and permanently impeded.

6.9.2 The Effects of Other Determinants: Examining the Standardised Coefficients

In tables 6.5 and the preceding analysis, while focusing on monetary variables, the effects of other determinants are subdued, although they had considerable influences on investments. The scaled coefficients are computed to indicate the relative importance of monetary variables vis-à-vis these other variables. Empirically, scaled coefficients are estimated for variables which are standardized to have variances equal unity in order to eliminate the unit of measurement. In this analysis, we estimated the scaled coefficient by multiplying the originally estimated coefficients with the ratio of the standard deviations for the regressand and regressor. Tables 6.6 and 6.7 present the computed scaled coefficients for the long- and short-run, respectively. The results showed that the important non-monetary policy determinants for total and non-oil investments are output (sales), government investment, economic and political uncertainties, while oil prices replaces political uncertainty in the oil sector model.

In the long-run, we found no output effect (but only in the short-run) for all investment types indicating that accelerator principles may be weak in Nigeria. Comparing the relative importance of all coefficients, table 6.6 shows that output is the least important, while government investment is the most significant determinant of private investment. The results indicated long-run complementarity but short-run substitutability between private and public investments, especially for non-oil investment. This is consistent with the overall findings of Blejer and Khan (1984) who examined 24 developing countries. This short-run crowding-out indicated competition between public and private sector for available domestic credit, while the long-run crowding-in suggested the importance of infrastructures and enabling environment (provided by government) for long-term planning and investment. According to Blejer and Khan (*op.cit*), the short-run substitutability can, however, connote the countercyclical nature of public investment rather than pure crowding-out. Relative to interest rate, which had maximum long-run elasticity of -0.2 per cent, public investment had elasticity slightly higher than unity. The interest rate elasticity is comparable to the user cost elasticity of -0.25 found in Chirinko *et al.* (1999). Although the actual point estimate of our significant interest rate elasticity ranged between -0.7 and -0.9 for non-oil and -0.7 to -2.3 for total investments, compared with the range of -0.5 to -1.0 found by Hasset and Hubbard (1997) for the USA and -0.4 suggested by Baumann and Price (2007) for the UK.

Table 6.6: Scaled Long-run Coefficient of Determinants

	(A) ARDL Model			(B) T-ARDL[1] Model			(C) T-ARDL[2] Model		
	I	*I_N*	*I_O*	*I*	*I_N*	*I_O*	*I*	*I_N*	*I_O*
	(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)
$\beta^{(1)}$	-0.12	-0.15	-0.09	0.06	0.01	0.09	-0.15	-0.16	-0.06
$\beta^{(2)}$				-0.22	-0.13	-0.04	0.10	0.02	0.10
$\beta^{(3)}$							-0.19	-0.13	-0.22
$\Gamma^{[CPS]}$	-0.32	-0.18	-0.30	-0.43	-0.23	-0.51	-0.22	-0.21	-0.47
$\Gamma^{[Y]}$	0.01	0.17	0.60	-0.09	0.14	0.35	-0.05	0.06	0.21
$\Gamma^{[GI]}$	1.12	0.88	1.26	1.12	0.80	1.19	1.00	1.01	1.13
$\Gamma^{[EV]}$	-0.22	-0.18	-0.17	-0.22	-0.06	-0.21	-0.26	-0.16	-0.26
$\Gamma^{[PV]}$	-0.21	-0.15		0.02	-0.11		-0.14	-0.12	
$\Gamma^{[PO]}$			-0.47			-0.49			-0.42

Source: Author's computations based on data from the CBN and NBS.

Note: Econometric estimation was conducted with *EViews 7.0* software using data are from 1985:Q1 to 2011:Q2.Scaled coefficients are standardised from point estimates of parameters by multiplying estimated coefficient of a regressor by the standard deviation of the regressand and scaling by the standard deviation of the regressor.

Using model C as the benchmark, macroeconomic uncertainty is found as another important determinant of investment in the long-run with an elasticity of over -0.2 per cent. The effect of interest rates is comparable with most other determinants the elasticity of which generally hovered around 0.2 per cent (in absolute value). In the short-run, the most important determinant of investment is output while interest rates and credits are the least important factors. Economic volatility did not however deter investment in the short-run. For oil investments, the price of oil is germane while government investments have complementary effects. This can either connote that the oil sector can compete effectively with public sector for available domestic credits or that a substantial portion of government investment is used to provide oil installation and/or infrastructures that would encourage the influx of oil investors into the country.

Table 6.7: Scaled Short-run Coefficient of Determinants

	(A) ARDL Model			(B) T-ARDL[1] Model			(C) T-ARDL[2] Model		
	I	I_N	I_O	I	I_N	I_O	I	I_N	I_O
	(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)
$\sum_{s=0}^{4}\Delta r_{t-s}^{(1)}$	0.08	0.08	0.12	0.04	-0.02	-0.05	-0.04	0.07	-0.03
$\sum_{s=0}^{4}\Delta r_{t-s}^{(2)}$				0.05	0.06	0.09	0.26	0.30	0.14
$\sum_{s=0}^{4}\Delta r_{t-s}^{(3)}$							0.08	-0.00	0.09
$\sum_{s=0}^{4}\Delta I_{t-s}$	0.26	0.34	0.16	0.41	0.61	0.27	0.39	0.60	0.24
$\sum_{s=0}^{4}\Delta CPS_{t-s}$	0.13	0.23	0.12	0.15	0.22	-0.03	0.12	0.32	0.11
$\sum_{s=0}^{4}\Delta Y_{t-s}$	0.77	0.44	0.65	0.42	0.54	0.50	1.47	1.25	0.59
$\sum_{s=0}^{4}\Delta GI_{t-s}$	0.38	0.43	0.40	0.28	0.10	0.47	-0.36	-0.59	0.47
$\sum_{s=0}^{4}\Delta EV_{t-s}$	-0.06	-0.07	-0.16	0.05	-0.10	-0.08	0.45	0.28	-0.06
$\sum_{s=0}^{4}\Delta PO_{t-s}$			0.48			0.42			0.48

Source: Author's computations based on data from the CBN and NBS.

Note: Econometric estimation was conducted with *EViews 7.0* software using data are from 1985:Q1 to 2011:Q2.Scaled coefficients are standardised from point estimates of parameters by multiplying estimated coefficient of a regressor by the standard deviation of the regressand and scaling by the standard deviation of the regressor.

Overall, the analyses of the standardised coefficients indicated that while interest rate is not the most important determinant of investment in the long-run, it is nonetheless key in the investment process. Apart from public investment with extremely large scaled coefficient, all other determinants have an average absolute elasticity of about 0.2 per cent while interest rates in the high and low regimes of panel C also have average absolute elasticity of 0.2 which is very comparable to the others. In the short-run, however, interest rates are seen as a weak determinant of investments vis-à-vis other variables.

6.10 Conclusion

In the NCM model, monetary policy depicts CBs' use of short-term interest rate to control inflation by influencing AD – through household consumption (Arestis and Sawyer, 2008b). The effects of interest rate through investment expenditure are usually overlooked within this model and at best are surmised through savings. However, investments constitute a substantial part of GDP, are its most volatile component, and provide the linkage between financial markets and the economy (Dulpor, 2001; Fazzari *et al*., 2010). Exclusion of investments would, thus, inhibit model stability and determinacy. Furthermore, in developing countries like Nigeria, with high incidence of poverty, consumption – largely of necessities – would be inelastic to price changes, including interest rate changes.

The relationship between investment and interest rates are in many cases expected to be inverse, in line with the neoclassical framework. In many empirical works, it has become difficult to find a significant inverse relationship when using aggregate data (Blanchard, 1986; Mojon *et al*., 2002). Other theoretical schools have proposed, however, that under certain condition a possible positive relationship may be expected. For instance under the McKinnon-Shaw framework of financial repression, low (deposit) interest rate are postulated to restrict savings which subsequently constraints investment; thereby supposing that investment are driven mainly by savings dynamics (Fry, 1995; Munthali, 2008). However, real options theories posit a positive relationship based on uncertainty and the options value to delay. Generally, in this setting uncertainty increases the benefit of delay. This is expected to hold at higher levels of interest rates, where an inverse relationship holds. When rates are low relative to GDP growth, expected returns on projects become higher than estimated risks so that even with rising interest rates firms continue to undertake investment (Capozza and Li, 2001; Chetty, 2007). Generally, this theory suggests a (non-monotonic) backward-bending investment function. Nonetheless, nonlinearity may exist in the investment-interest rate relationship for other reasons: heterogeneity of firms, lumpiness of investment, business cycles and monetary policy stance. These have implications for monetary policy. A positive relationship implies that monetary policy would have perverse effects. Nonlinearity may also mean that the relationship might differ between policy stances.

Monetary policy effect can also be transmitted through the credit channel. Generally, banks classify their borrowers according to risk categories and either charge a risk premium or ration credit (or both) to the riskiest borrowers. Hence, monetary policy may change the cost and credit availability. Credit constraint is, thus, a very important determinant which is expected to relate positively with investment. The link between monetary policy, credit and investment is seen through the risk-return relationship. During tight policy, increases are supposedly passed-through to lending rates, which are in turn reflected in discount rates. Investments with low expected returns become unviable, while those with high expected returns remain profitable and, thus, are undeterred by the increased lending rates. Given the direct risk-return relationship banks perceive these projects as highly risky and would not lend if the probability of default is considered high. In this regards, even a risk premium may become ineffective and banks would ration credits. The reduced availability of credit would thus deter further investments.

In Nigeria, banks seem too wary of lending given the continual perception of economic risk. Generally, loans are limited to short-term finances (up to two years), which are rolled-over upon maturity if they are properly serviced. Long-term loans (over five or ten years) are very rarely undertaken. This suggests that most investment would be financed by internal sources – savings and/or retained profits. Many potential determinants of investment are identified in the literature from various schools. The choice of which is most important would vary across countries and would depend on the characteristics of particular countries. Essentially, it has been argued that determinants of investments would vary between developed and developing countries.

In this chapter, we investigated the effectiveness of an NCM-type monetary policy framework on AD – proxied by investment. Monetary policy effect is captured essentially by interest rate changes, though the role of credit is also considered. In addition, we examined the potential effect of other determinants in an eclectic modelling framework in order to identify the most important factors. Empirical analysis is variously conducted to test for possible nonlinearity using threshold models. The possibility of non-monotonicity is also investigated. Overall, we tested whether monetary policy would have different effect in regimes of sharp expansions, sharp contractions, or moderate adjustments. Data for the analysis are of quarterly frequency spanning 1985:Q1-2011:Q2.

The main findings indicated, *inter alia*, that the relationship between investment and interest rates is nonlinear but monotonic. This nonlinearity depended on the size of change in monetary policy rate and not the level of interest rates. Sharp changes have larger and archetypical neoclassical effects while moderate changes elicited atypical responses which may cause indeterminacy. The interest rate effect of monetary policy is found to generally affect the non-oil more than the oil sector. Essentially, non-oil investments are easier to influence by strong policy contractions rather than strong expansions in the long-run. In the short-run however, investments are not deterred by policy rate although they are boosted by sharp expansionary stances. Thus, interest rate may generally not reduce current investment but may lower planned investment. Again, we found that the availability of credit have important implications for investment. Lack of adequate long-term credit lowers investments in the long-run. However, in the short-run when short-term external financing options are available the relationship becomes positive. This may be reflective of the notion of construction (initial) financing and investment (final) financing discussed in Davidson (1982), Graziani (2003) and Lavoie (2009), and may be underpinned by the fact that Nigerian banks are willing to provide short-term financing rather than long-term credits.

Considering the effects of other, non-monetary policy determinants, government investment is found to be (in general) the most important determinant of investment in the long-run where it showed a complementary effect. In the short-run, it tended to crowd-out private investment. The long-run complementarity may be due to the provision of enabling business/investment opportunity while the short-run substitutability may be due to the excessive competition for external funds with the private sector. Output growth is, however, the most important determinant of investment in the short-run. Oil prices are important only in the short-run for boosting oil investment. Political and economic uncertainties reduce long-run investments significantly. No evidence of the impact of profits (internal funds) and capacity utilisation is found in the analysis.

The implications of the results for monetary policy are critical. Nonlinearity in the relationship between interest rate and investment suggests that policy may have perverse and undesirable impact on investment, AD and the economy in general; especially if the thresholds for this nonlinearity are inadequately understood. Given that archetypical response is only possible when the MPR is adjusted by a minimum of about 150 basis points (in some cases), it means that if the CBN conformed with common practice of policy smoothening – with moderate/gradual adjustments (say by about 25-50 basis points) – then monetary policy would have ambiguous effects. However, a 'cold-turkey'-type large changes in MPR possess other challenges for the economy as it can increase uncertainties, financial fragility and undesirable effects in other sectors of the economy; thereby constituting a dilemma for the CBN.

Again, the fact that monetary policy affected the non-oil sector more than the oil sector is not surprising, as oil sector investments might relate more with external/international developments. What is rather disturbing is that monetary policy is able to reduce non-oil investment much more than it can boost it, so that the net-effect of policy in Nigeria would be adverse. In essence, monetary policy may lower the supply capacity, and thus reduce the developmental path of Nigeria. Nonetheless, the overall effect of policy on AD depends considerably on the relative sizes of these sectors. Though, the non-oil sector had more weight, both in terms of investment and GDP, the fact that oil drives government revenue (and by implication government expenditure) in Nigeria, suggest that changes in oil receipts (due to increased investment among other reasons) would affect public investment which would subsequently affect private investment and AD. This presents a rather complex picture of the interaction between oil, non-oil and government investments which the CBN may need to understand. Nonetheless, the CBN may focus on its ability to control non-oil investments subject to other factors although the outcome of such policy would be highly indeterminate.

Overall, NCM-type (inflation targeting) monetary policy may hurt economic growth. Synthesising the results of the T-ARDL[1] and T-ARDL[2] presents a dilemma for the CBN. Given that the effect is only significant if the level of interest rates are low or if the size of changes are high, effective monetary policy may require the doubling or halving of rates, as the case may be. If this is so, monetary policy can create distortions and uncertainties in the economy. Besides, the nature of the sectoral differences in the response of investment is a source of concern. That non-oil investment responds more to monetary policy than oil investment, is by itself not an inconvenience; rather the problem lies in the form of asymmetric response to various policy stances. The finding that non-oil investment is quicker to decline than to rise following policy adjustments means that policy would have an overriding adverse consequence in Nigeria. Essentially, the net-effect of a 1-percentage point increase in policy rate, even if reversed immediate, would be negative. Monetary policy would reduce the supply capacity in Nigeria and implying long-term sacrifices/costs. Being a developing country, Nigeria, may therefore be careful in implementing this kind of policy as the growth prospect may be considerably and permanently impeded.

7 INFLATION AND OUTPUT IN NIGERIA: THE RELATIONSHIP AND IMPLICATIONS FOR MONETARY POLICY

7.1 Introduction

Should central banks (CBs) be aggressively anti-inflation? Inflation is innately undesirable and costly: creating money illusion, uncertainties, relative prices distortions, and market inefficiency (Heintz and Ndikumana, 2011; Mishkin, 2007). Given the adverse consequences of inflation, the aforementioned question ought to be inconsequential and answered affirmatively except that disinflation also comes at a cost. The costs can vary across countries, business cycle, or time and can be considerable. Output losses and increased unemployment are some of the widely researched costs of disinflation usually captured by the PC. The cost of disinflation would depend on the slope and curvature of the PC. Contrary to the standard assumption of the NCM framework, the LR-PC may be non-vertical and nonlinear so that disinflation would have a long-run implication for output and unemployment. Inflation and disinflation would thus have adverse ramifications for social welfare so that task of policymakers would be to choose the option with the highest net benefit.

In this chapter, we analyse the implication of disinflationary policy for Nigeria following an NCM-PC. This is reflected in the relationship between inflation and output gap; with gap defined as the deviation of realised output from its potential. Econometric estimations are conducted using the ARDL cointegration framework given the possible non-stationarity inherent in economic variables. Following Shin *et al.* (2009) and Greenwood-Nimmo *et al.* (2011) linear and nonlinear-ARDL models are estimated in order to investigate the existence and degree of convexity or concavity of the PC. Given the dichotomy of the Nigerian economy, the analysis is conducted for oil, non-oil and total output gaps with a dataset spanning 1985:Q1–2011:Q4. To capture the effect of non-demand factors a supply-augmented PC is estimated by including exchange rate, oil prices, import prices and domestic spare capacity.

Our result indicated that LR-PC is not vertical but somewhat horizontal. This implies that irrespective of the level of output gap, inflationary pressures may persist or dissipate due to other non-demand factors. Hence, inflation in Nigeria is not an AD but rather an AS phenomenon (or may be driven by external factors such as global inflation). We also find negative sign on output gap coefficients further implying that supply shocks are more prominent than demand shocks. Generally, supply factors especially exchange rate and excess capacity were found to be the most important drivers in the long-run while import prices and excess capacity are the key determinants in the short-run. The finding on the excess capacity, has very important ramification for policy. Macroeconomic policies should endeavour to boost capacity utilisation. Since, the low capacity utilisation may be traced to the inadequate supply of public infrastructure which has the attendant effect of increasing cost of production, monetary policy should aim to reduce cost by ensuring lower lending rates and increased availability of credits to the productive sector. This would not only increase supply but would also ensure that domestic products can compete with imported counterparts. The offshoot of this is the reduced unemployment and enhanced social welfare. Basically attainment of higher social welfare would be Pareto efficient since the inflation-output trade-off is non-existent from the results.

The policy implication of the NCM is that CBs should focus on long-run price-stability and short-run output stabilisation. This implies an optimisation procedure with inflation minimisation as the objective function and output as the constraint. However, our findings suggests that for a developing countries like Nigeria, it may be more beneficial if the role is defined the other way round so that output growth maximisation becomes the long-run objective and inflation the short-run constraint. In this regard, CBs' role should be to encourage economic expansion and employment creation in the long-run while reducing inflation variability in the short-run.

This chapter is divided into seven sections. Following this introduction, section two provides a general discussion on the inflation-output relationship and considers the costs of disinflationary policies and its implications for developing countries. Section three narrows the discussion down to the relationship and welfare implications for Nigeria. Model specification, methodology and data are described in section four while empirical results and findings are presented in section five. The implications of these findings are analysed and discussed in section six while the chapter concludes with section seven

7.2 The Inflation-Output Nexus

According to the NCM model, price-stability should constitute the overriding objective of monetary policy. The consensus definition of price-stability implies an inflation rate around 2 per cent. This is usually justified on the proposition that inflation places a substantial penalty on the economy in terms of increased opportunity costs of holding money, relative price distortions and inefficient allocation of resources; all of which reduces economic wellbeing (Hagen and Hoffman, 2004). Under the NCM, inflation is an AD phenomenon, while supply-side factors are random and transitory. Hence, price-stability is accomplished by controlling AD irrespective of the source or cause of inflation. However, critics of the NCM argue that cost-pull inflation can be considerable and permanent which is worsened by the presence of hysteresis, so that contractionary policy can culminate into a permanent loss of output and a real welfare cost to the economy (Fontana, 2009a, Davidson, 2006). In essence, both inflation and disinflation can post an enormous cost on an economy, thereby posing a dilemma for policymakers. At any point, it would be apt to understand and compare the costs of disinflation with its benefit with a view to choosing a socially optimal option. The nature of the relationship between inflation and output, the cost (and benefits) of disinflation, and the implication of disinflation for developing countries vis-à-vis advanced countries are presented in this section.

7.2.1 The Phillips Curve [59]

Theoretical relationship between inflation and output is depicted by the PC. The relationship is based on the existence of the potential (or natural) level of output towards which the economy gravitates. This potential output is achieved if the economy uses all its resources efficiently; hence, at full employment. It thus represents the level of output that is obtainable when the economy is at the NAIRU. The existence of the NAIRU and the associated potential level of output are the bedrock of the NCM. At these *natural* levels of unemployment and output, there are no inflationary pressures and inflation is purported to be at an optimally targeted level. Output above the potential level creates a positive gap depicting excess demand that exerts inflationary pressures on the economy, while negative gaps produce deflationary pressures. Hence, the potential output represents the AS determined

[59] This sub-section derives largely from earlier discussions in section 1.3, some of which are reiterated to facilitate the arguments and flow of this chapter.

equilibrium level of output for the economy. As shown in chapter one, the second equation of the NCM is a PC (that is consistent with the natural rate hypothesis and) which describes the inflation-output relationship as

$$\pi_t = a_1 E_t \pi_{t+j} + a_2 \pi_{t-k} + \kappa(y_t - \bar{y}) + e_t \quad (7.1)$$

where π_t is the rate of inflation, $y_t - \bar{y}$ is the output gap showing the difference between actual output (y_t) and potential output $(\bar{y})$; thus, reflecting the AD effect. In this regard, policy goal is to achieve $y_t - \bar{y} = 0$ which ensures price-stability. Supply shocks are captured by the random disturbance term $e_t \sim iid(0, \sigma_e^2)$. Equation 7.1 differs from the standard neoclassical synthesis PC by relating output gap, rather than actual output, with contemporaneous inflation (Fontana, 2009a). It also incorporates new-classical feature of rational expectation captured by the current expectations of future inflation $\left(E_t \pi_{t+j}\right)$ as well as the new-Keynesian notion of price rigidities captured by inflation inertia (π_{t-k}). These forward and backward expectational characteristics are based on the arguments that workers build expectations into wage bargaining while markets may not clear continuously. Price rigidities are posited to be restricted to the short-run while continuous market clearing is obtainable in the long-run. Given the transience of price and wage rigidities in an economy, the inflation-output trade-off only exists in the short-run, thereby ensuring an oblique SR-PC. This is so because changes in prices and/or wages alter relative prices in the short-run, so that the short-run AS reacts to fluctuations in AD.

In the long-run, however, these market failures disappear leaving all prices and wages flexible so that relative prices are constant and AS does not respond to AD changes. The assumption of rational expectation coupled with the continuous market clearing in the long-run results in vertical LR-PC at the natural level of output around which the economy oscillates. In this regards, the condition $a_1 + a_2 = 1$ is assumed to hold in equation 7.1, implying that expectations are met alongside continuous market clearing and "providing a mechanism that ensures a transition to the long-run classic equilibrium" thereby eliminating the trade-off in the long-run (Meyer, 2001, p.3). The NCM-PC depicts that, "[AD] has [only] a transitory role in determining the equilibrium level of output and employment in the economy" (Fontana, 2009a, p.191).

This assertion formed the basis of the long-run neutrality of monetary policy and the postulation of low inflation as the long-run objective.

In the presence of shocks (whether from supply or demand factors) that take the economy away from its natural level of output and inflation away from its target, the central bank is expected – via the effect of short-term interest rate on AD – to re-align inflation with its long-run target. This policy stance is based on the assumption that supply shocks are random, transitory and with zero mean; thus, inconsequential for inflation or inflation expectations (Arestis and Sawyer, 2006). The assumption of random supply shocks with zero mean complements the premise of a constant NAIRU so that the natural level of output is unaffected by monetary policy shocks (Gali, 2008). Monetary policies are, thus, steered at demand shocks in order influence economic activity and rein-in inflation (Smith and Wickens, 2007). Hence, the final impact of monetary policy is on the rate of inflation and as such this should constitute the policy target. The fundamental trust of the NCM is that short-term interest rate management would only be effective (i.e. affect the rate inflation) if it impacts on the level of AD (Bain and Howells, 2009,ch.8). By assuming that inflation is a demand phenomenon, the NCM critically undermines other sources of inflation particularly cost related factors (Gnos and Rochon, 2007).

7.2.2 The Cost of Disinflation

The NCM-PC in 7.1 suggests linearity and symmetry in the inflation-output trade-off. Inflation responds identically to changes in output irrespective of whether it is above or below potential. Hence, during economic expansions, reductions in AD to combat inflation can be completely reversed without any permanent loss, when inflation returns to target. This linearity and the absence of long-run trade-off in the PC, connotes that the costs of disinflation is only temporary while the benefits are permanent. Violation of one or both of these assumptions would affect the cost-benefit analysis of disinflation and would have enormous ramifications for monetary policy. The trade-off inherent in the PC implies that disinflation leads to output losses which, *ceteris paribus*, results in increased unemployment. Correspondingly, attempts to reduce unemployment and expand output raises inflation which distorts inter-temporal decision and increases uncertainties in the economy. Hence, both inflation and unemployment (or output contraction) are undesirable in an economy as they can both lower welfare. The welfare analysis should thus favour that which provides net welfare benefit over that which represents net costs.

Economists do not dispute the existence of costs for disinflation, but the argument between proponents and critics of the NCM is based on the nature and lifespan of the costs. While the advocates argue that output loss is only temporary with a permanent benefit of lower inflation, critics are of the view that output loss has time-dependent effect which lowers the growth path of the economy permanently indicative of a hysteresis effect. Under the NCM, provided that the economy has not achieved price-stability, there exists the propensity to keep unemployment (output) above (below) the natural level; hence, the so called unemployment bias. The unemployment bias combined with the hysteresis may ensnare the economy in some form of vicious circle which requires continued contractionary policies to lower inflation (Fontana, 2009c). By proposing that the natural level of output is not independent of changes in actual output, the existence of hysteresis effect dismantles the argument of long-run inconsequentiality of AD. However, while the implications of hysteresis are clear for contractionary policies, they are less defined during expansions. This implies that while output contractions would lower the long-run growth path reversal of such contractions may not completely restore the economy back to its original trajectory thereby culminating in a permanent loss of growth. Thus, existence of hysteresis effect as well as its potentially different implications during booms and recession is a key source of nonlinearity and asymmetry in the inflation-output trade-off (Dwyer *et al*., 2010). These nonlinearity and asymmetry have implications for the costs of disinflation both in the short- and long-run.

Post-Keynesian disagreement with the NCM-PC model is based on the implications of *contractionary bias* for the economy in the long-run. Essentially, the conclusions of the NCM school that disinflation has no long-run cost rest critically on its assumptions of a natural level of output and a vertical LR-PC. The assumption of a linear and symmetric non-vertical SR-PC ensures that trade-offs are transitory and costless. Violation of any of these assumptions has grave implications for the costs of monetary policy. For instance, Davidson (2006) and Setterfield (2006) posited that in the absence of a natural level of activity, the argument of long-run neutrality of monetary policy collapses and the notion of overriding objective of price-stability falls apart.

Davidson (*op.cit*) thus described the assumption of a natural level of output and unemployment as superficial, while Setterfield (*op.cit*) showed that the long-run cost of disinflation becomes significant without such assumption.

For some post-Keynesians, the issue is not essentially that of the existence of a natural level of activity but that of the nature and definition of this notion. These accept the existence of some natural level at a point in time which is determined by product market conditions and productive capacity, rather than by labour market conditions as proposed by the NAIRU. By implication rather than a vague and immeasurable concept of NAIRU, a country's potential should be indicative of its productive capacity – measured by its human and physical capital. This natural level is envisaged to be continuously changing and path dependent; and does not act as a strong attractor for the actual level of unemployment. In essence actual activities drive the natural levels contrary to the NCM view. This is consistent with premise of a hysteresis effect. Basically, a contractionary policy lowers AD in the product market which causes firms to reduce investment and layoff some workers. These may result in diminished human capital which combines with retarded investment to lower the overall capital stock and the productive capacity in the long-run (Arestis and Sawyer, 2003; 2008a). The lost capacity further diminishes AS, re-opening an excess demand gap, which induces further depression of AD.

For the purpose of this study, discussions on the existence and nature of the natural level are not pursued. Rather we assume that the natural level exists and can be proxied by some kind of trend. Nonetheless, the issue of the costs of monetary policy still subsists and lies in the imposed shapes (and slopes) of the SR-PC and LR-PC. The vertical LR-PC implies that changes in monetary policy do not have any long-run effect on real output and that AS determines the equilibrium. If the LR-PC is non-vertical then attempts to disinflate would be non-neutral and can induce a permanent output loss. In the long-run, the NCM-PC also assumes fully realised expectations and no policy surprises or money illusion; hence, $\pi_t = E_t\pi_{t+j}$. In addition, prices and wages are completely flexible in the long-run, so that $\pi_t = \pi_{t-k}$. These two assumptions jointly suggest that in the steady-state equation 7.1 becomes

$$\pi = a_1\pi + a_2\pi + \kappa(y - \bar{y}) + e \qquad (7.2)$$

so that

$$\pi = \beta(y - \bar{y}) + e\ ; \qquad \beta = \frac{\kappa}{(1 - a_1 - a_2)} \tag{7.3}$$

The parameter in equation 7.3 is immensely important for the LR-PC. Given the usually assumed $a_1 + a_2 = 1$, a vertical PC connotes $1 - a_1 - a_2 = 0$ so that the parameter (β) becomes infinite at any given level of output gap. This would confirm the long-run neutrality of monetary policy. However, if $\kappa = 0$ then $\beta = 0$ suggesting inflation neutrality to output gap. The NCM-PC would thus be horizontal and monetary policy is unable to control inflation in the long-run but can only influence the real economy. Thus, this kind of result with a flat PC, demolishes the argument for IT. The two extreme cases show disinflation as absolutely costless and totally beneficial when PC is vertical, but non-beneficial and extremely costly, when it is horizontal. In both cases there is no trade-off. Between these extremes, $0 < \beta < \infty$ holds and the LR-PC becomes oblique thereby indicating a long-run trade-off. In this case, disinflation becomes non-costless and monetary policy is non-neutral.

The output cost of disinflation would depend on the size of β. A smaller size indicates that disinflation is more costly as the PC becomes flatter while a large size shows beneficial disinflation as the PC is steeper and output loss smaller. Effectively, therefore, the cost of disinflation is evaluated by the reciprocal, $1/\beta$, which indicates the response of output to unit changes in inflation (Turner, 1995). However, if $\beta < 0$ then the NCM-PC breaks down as inflation becomes not a demand factor but a supply-side phenomenon. Contractionary policies are, thus, confronted with the dilemma of falling output and rising inflation. Irrespective of the size of β in this case, disinflation becomes absolutely and extremely costly as policy can be caught in a vicious circle of contractions.

Evidence of flattening PC was provided by Dwyer *et al*. (2010), Kromphardt and Logeay (2011), and Rumler and Valderrama (2008) who investigated the long-run output-inflation relationship in various European countries and the USA. For the Euro area, Rumler and Valderrama (*op.cit*) estimated both a traditional and new-Keynesian PC and documented evidence of significant but diminishing relationship between inflation and output gap for all countries except Austria and the Netherlands. They conclude that this implies a weakening of anti-inflationary monetary policy approach.

Similarly, Kromphardt and Logeay (*op.cit*) investigated the relationship for four euro-zone countries, the UK and the USA. They found an oblique LR-PC which had flattened over the last two decades and consequently opined that the ECB should pursue expansionary policies notwithstanding the "unfounded fears of accelerating inflation" (p.59). Dwyer *et al*. (*op.cit*) used a graphical approach to plot the relationship between inflation and unemployment since the 1970s and showed a flattening of the PC since 1992. They attributed this to the change in monetary policy framework, while citing Bean (2006) who attributed the flattening to globalisation and world output gap. These studies indicated that flattening PC weakens the effectiveness of anti-inflationary policies since inflationary pressures might be due to factors other than domestic AD.

Irrespective of the degree of flatness or steepness, a positively-sloped LR-PC implies that a lower level of inflation can only be achieved at a lower level of output. Hence, the goal of price-stability would mean accepting a lower level of growth and a higher level of unemployment. The PC in equation 7.3, being linear and symmetric, nonetheless suggests that by choosing to revert to the original level of inflation, policymakers can restore output and employment back to their original level at no extra (or permanent) costs. By implication, the response of inflation to the output gap is identical irrespective of the sign and size of output gap. However, the PC whether in the short- or long-run can be asymmetric (i.e. sign dependent) or nonlinear (i.e. size dependent). Hence, inflation can respond differently between recession and expansions as well as between large and small recessions/expansions. The relationship between inflation and real economic activity may also depend on the level of inflation. For instance, Akerlof *et al*. (2000) show that the inflation-unemployment relationship is backward bending due to imperfect rational expectations; hence, nominal wage rigidity. At very high rates the PC is vertical, for moderate rates it is positively sloped and negatively sloped for low rates. Akerlof *et al*. (*op.cit*) thus observed that expectations are realised when inflation rates are high than when they are low. This would imply that when inflation rates are significantly high disinflation can be achieved at minimal cost but that a trade-off exists at low levels of inflation (Hagen and Hoffman, 2004).

Nonlinearity and/or asymmetry in the relationship may also be due to economic activity. In this regard, the PC in equation 7.3 rather than being obliquely linear may be convex, concave or kinked. A convex curve implies that inflation responds less to negative gaps than positive gaps, and conversely for concave curves. Clark *et al*. (1996) observed that with a convex PC proactive policy which prevents the economy from overheating is less costly than reactive policies. Basically the convex curve implies that allowing positive gaps to emerge would require larger negative gaps to offset the consequent inflation; thus leaving the economy with permanent output loss. This thus shows that the cost of disinflation is less than the benefit of re-inflation. If the curve is concave, however, then proactive policies would be sub-optimal and costlier than reactive policies and essentially disinflation would be very costly as it would lead to permanent output loss. Dupasquier and Ricketts (1998) and Filardo (1998) noted that a convex PC is likely in economy with constrained capacity (rather than those with excess capacity that can flexibly adjust to increased AD), while Stiglitz (1997) posited that due to asymmetric price adjustment, a concave curve is more probable in economies with imperfectly competitive firms. By operating near installed capacity, firms' become unable to react to increased demand during economic expansion particularly if they are uncertain that the expansion is permanent. Thus, since supply does not react adequately to higher demand, inflation becomes increasingly sensitive and the PC convex. In an economy with monopolistically competitive or oligopolistic firms with pricing power, a concave curve can emerge since these firms would be reluctant to raise prices (in order not to lose market share and turnover) in the face of economic expansion.

A number of studies (including Clark *et al*., 1996; Dwyer *et al*., 2010; Eisner, 1997; Filardo, 1998; and Turner, 1995) investigated and provided mixed evidence on the nature of nonlinearity and asymmetry in the inflation-output nexus especially for major developed countries. For instance, studying seven major OECD countries, Turner (*op.cit*) found that inflationary effects of positive gaps quadrupled the deflationary effects indicative of convex PC. Similarly, Dwyer *et al*. (*op.cit*) found evidence of a larger effect for positive gaps in the UK. However, Eisner (1997) showed results of a concave PC and concluded that as an economy grows increased efficiency prevents wages and inflation from rising which may indicate lack of capacity constraints. Complex nonlinearity has also been documented. For instance, employing a three-regime specification, Filardo (*op.cit*) found that overheating exerted more significant effect on inflation than slumps, while moderate gaps were insignificant. Thus, the PC is convex during overheating and concave at weak times. Similarly, adopting nonparametric methods, Baghli *et al*. (2007), reported an "*S*-shaped" PC for euro-zone countries which they observed reconciled the convexity versus concavity found in the literature. They nonetheless argued that this implied that large positive gaps are more inflationary than negative gaps are deflationary and that the central bank should act expeditiously when there is excess demand in order to avert any long-term costs.

Rather than incorporating nonlinearity into a PC, some studies investigated the cost of disinflation using *atheoretical* methods to compute the sacrifice ratio. This ratio measures the cumulative output gap, divided by change in trend inflation during a particular disinflation episode which shows the amount of output sacrificed per point disinflation. A very influential and seminal contribution by Ball (1994) estimated the sacrifice ratio for 65 disinflation episodes (between 1960 and 1991) in nineteen OECD countries and found it ranging between 0.75–2.92 with an average ratio of 1.40 overall. Ball thus generally opined that "disinflation is almost always costly" (p.167) and "a major cause of recession in modern economies" (p.155). Extending Ball's data, Caporale and Caporale (2007) found an average ratio of 1.46 ranging -0.85 to 10.35 and concluded that the sacrifice ratios had risen considerably, especially in the 1990s.

In addition to time variation, the sacrifice ratio may also differ depending on the monetary policy framework of countries. For instance, for 30 OECD countries, Gonçalves and Carvalho (2009) found a considerable 5.6 per cent fall in GDP (vis-à-vis its potential) per point decline in inflation and also that IT reduced this loss (by 7.0 per cent) to 5.2 per cent. Though this cost remained high, the authors concluded that inflation targeters were able to disinflate at reduced cost compared to non-targeters. However, Brito (2010) showed that adjusting for the Maastricht Treaty (among other assumptions) considerably changed the result in Gonçalves and Carvalho (*op.cit*). He concluded that there is no efficiency gain from adopting IT and "that inflation targeters even suffered bigger losses during disinflation when compared to non-targeters" (p.1686).

7.2.3 Considerations for Developing Countries

For many countries, an oblique and/or nonlinear LR-PC has serious ramifications for monetary policy; more-so for developing countries. There is no doubt that inflation is undesirable but the degree of inflation aversion should depend on the source of inflation and the level of development of a particular country. A number of studies have documented the existence of some country specific level of inflation, consistent with sustainable rates of growth and unemployment. For developed countries, an optimal inflation rate of 1.0-3.4 per cent is estimated to maintain the lowest sustainable rate of unemployment, while for developing countries a range of 11-18 per cent is suggested (see Akerlof *et al*., 2000; Khan and Senhadji, 2001; and Pollin and Zhu, 2006). These studies show that the level is lower for industrialised than developing countries. Hence, attempts to adopt advanced countries' view of optimal inflation and subsequent disinflation would increase the loss for developing countries irrespective of the nature of the PC. This further diminishes the justification of an NCM framework in developing countries which experience moderate levels of inflation. Hence, Fontana (2009a) observed that "the NCM is...a *fair weather* model, which may have some application in low and stable inflation environment, but is increasingly...less relevant in the current economic climate of highly unstable inflation, deep financial crisis and serious economic recession" (p.197). Given the inflation volatility and dislocated financial system that characterise most developing countries, the applicability of the NCM model in these countries becomes even more impractical and contentious.

If monetary policy is to enhance overall welfare then developing countries' CBs should choose a framework that maximises welfare. Cukierman (2002) and Feldstein (1997) conducted a welfare analysis of disinflation under an IT framework and showed that inflation and inflation expectations lower welfare. They thus argued that disinflation is less costly since CB's independence would increase welfare (Cukierman, *op.cit*) and the resultant unemployment is transitory (Feldstein, *op.cit*). Since inflation or unemployment can result in reduced welfare in the long-run, the question should be: which one of these is the cheaper option (in the presence of trade-off)? In a recent paper, Blanchflower (2007) applied the concept of happiness economics in studying the social welfare impact of inflation and unemployment in both developed and developed countries. He found that unemployment generally lowered happiness more than inflation and that the least educated and the old were more concerned with unemployment, while young and educated people are happier with low inflation. However, rather than suffer unemployment jointly with lower inflation, people may prefer employment with higher inflation. Therefore, analysing, the cost-benefit implications of monetary policy, Blanchflower concluded that unemployment depresses wellbeing more and is thus costlier than inflation. Comparing industrialised and developing countries, he found support for the *Easterlin hypothesis* that faster growth increased wellbeing in developing countries more than it does in developed ones. Thus, the general implication is that, disinflation is not only costly, but may even be costlier for developing countries.

A key feature of developing countries is the existence of allocative and cost inefficiencies which are overlooked in NCM analysis. Nonetheless, assuming an efficiently functioning economy, social welfare can be analysed using either the Pareto optimality or the Kaldor (1939) compensation principle. The former states that policies are desirable if no one is made worse-off while the other chooses policies that provide huge gains for the better-off which more than offsets the loses by the worse-off. Under the Pareto principle expansionary policy is optimal if it can increase output without causing inflation; hence, no inflation-output trade-off. These would be the case if inflation is supply-side driven as envisaged for many developing countries. However, in the Kaldor criterion a trade-off exists. Higher welfare is attained if gainers are hypothetically able to compensate losers costlessly such that everyone is better-off. In essence, the net benefit of policy should be positive for it to increase social welfare. The inflation-output trade-off produces both gainers and losers notwithstanding the level of inflation aversion. Given that welfare loss from inflation affects everyone while that from unemployment is limited to a group, it would seem appealing for governments to limit the loss to a group of unemployed while redistributing the gain via social/unemployment allowances.

A segment of the literature argued that such unemployment benefits can reinforce hysteresis effect and increase long-term unemployment permanently. For instance, Ball (1997) analysed the impact of disinflation on the NAIRU and found that not only is disinflation very costly in the long-run, the costs increases with unemployment allowances. This is because the unemployed may accept the lifestyle of receiving benefit, lose motivation to search for job, lose their skills and disconnect permanently from the workforce. From Ball's findings it can be deduced that as long as benefits are transient and do not discourage search for employment, the redistribution would make IT less costly. Even if one was willing to accept these deductions, it may be untenable for developing countries since most lack the institutional framework to collect and/or distribute taxes or benefits. Besides these economies do not function efficiently and inflation may be due to productivity slack. The resultant disappearance of the inflation-output trade-off effectively implies that expansionary policy is Pareto optimal creating no welfare losses.

One reason why disinflation would be costlier in developing than developed countries is due to the fact that these countries may have slack capacities (as opposed to capacity constraint in more advanced countries). This is coupled also with the fact that supply shocks may be more prominent than demand shocks in these countries. Again, given the evidence in some studies that the gap between richer and poorer countries is in many cases widening (see Parkin *et al*., 2012, p.511), the need for developing countries to adopt pro-growth policies is even more warranted. Hence, disinflationary policies that lower employment and output (and its growth rate) would depress income and further leave these countries behind. Besides, the existence of slack capacity imply that there is no over production or over employment but the converse so that inflation would definitely in most cases not be due to excess demand. Thus, the parameter (β) in equation 7.3 may be expected to be less significant in developing countries than developed ones.

7.3 The Case of Nigeria

Like in many developing countries, the inflation-output relationship in Nigeria may differ from those assumed under the NCM. The Nigerian economy is largely dependent on the agricultural sector and imports for consumption and the oil sector for government revenue and investment. These are, by-and-large, supply-related factors. Food constitutes over 60 per cent of the CPI basket, while food and energy (non-core CPI) comprise almost 70 per cent of the basket. In addition, the exchange rate and import prices are deemed important drivers of the inflationary process in Nigeria (Aliyu *et al*., 2010; Oyinlola and Egwaikhide, 2011). Data from the CBN also suggest that capacity utilisation was 54.5 per cent in 2011 and averaged 43.5 between 1985 and 2011. These figures suggest that AS, rather than demand, is dominant in the inflationary process, so that AD management may not be the ideal policy. [60]

The emphasis of the NCM on the natural rate hypothesis, the supply-determined equilibrium and the resultant long-run neutrality of monetary policy can lead to policy misdiagnosis. Stiglitz (1997) observed that the natural rate hypothesises implies that inflation is essentially a labour market phenomenon, so that inflationary changes is well predicted by unemployment which explains substantial amount of its variation.[61] Hence, during economic expansion when unemployment is low (and below the NAIRU), real wages are higher than equilibrium, and inflationary pressure emerges. The converse holds during recession. This implies that the solution for rising inflation is to deflate the economy and reduce employment. But how does one justify this assertion in a developing country particularly those afflicted with considerable levels of unemployment as well as moderately high levels of inflation. For instance, in Nigeria, the NBS (2011) reported that the unemployment rate was 19.7, 21.1 and 23.9 per cent in 2009, 2010 and 2011, respectively. The corresponding GDP growth rates were 6.9, 7.9, and 7.3 per cent while relatively moderate inflation rates of 13.9, 11.8 and 10.3 per cent were recorded, respectively. With such high levels of unemployment what is the justification for disinflation. Given these data, anti-inflationary policy of the NCM model may suggest an unacceptable NAIRU of about 25 per cent or more for Nigeria. Inflation in this case may not be due to excess demand but rather to under-production and under-employment; thereby reinforcing the view that inflation is supply rather than demand determined in Nigeria.

Furthermore, the NBS Report indicate that most of the unemployed were young, showing rates of 22.4-37.7 per cent and 18.0-21.4 per cent for age groups below 44 years and those above it, respectively. The increasing unemployment was attributed to the rising number of new entrant into the labour force; indicating a widening between the growth in the economies' human capital capacity and the actual utilisation of human capital. The question then is: why are firms not hiring given that the economy

[60] It may also suggest that 'potential output' in Nigeria would correspond to capacity utilisation of around 50 per cent, and hence 'potential output' does not have any connotation of corresponding to productive potential/capacity

[61] The original Phillips curve formulation as well as the Friedman version did identify inflation with labour market; but the new-Keynesian version and the NCM version are product market based.

is expanding? An answer, consistent with mainstream economists view, would be: due to the high cost of production. However, contrary to the mainstream view, this high cost is not attributable to wages, but to the high cost of infrastructures and amenities. In Nigeria, erratic and inadequate supply of basic amenities like electricity, water and security means that firms provide these in-house. While the cost of providing water and security is moderate depending on the kind of firm, the cost of generating electricity is high. For instance, firms would incur a lump-sum cost of acquiring high capacity generators; then would incur the recurrent costs of fuelling, servicing, and repairing these generators. These recurrent costs are usually higher and transmitted to goods' prices to ensure that firms at least break-even. In many cases, this limits firms' competitiveness vis-à-vis cheaper imported substitute. To minimise their losses while staying competitive, firms run their generators intermittently and rely on the erratic power supplied at much lower rate. This, thus, makes firms (and the economy in general) to operate with slack human and physical capital capacity, which explains the high unemployment and low capacity utilisation in Nigeria.

Nonetheless, the concurrence of high growth rate and very high unemployment rate may be due to increasing productivity in some non-labour intensive sectors like the oil sector. It may also be indicative of the large inequality between the few rich and multitude poor; where the high lifestyle of the rich obscures deprivation. However, and more importantly, it is reflective of the large and widening difference between realised output and the *true* potential output. Due to past shocks or policies, growth may have been repressed over time so that the long-run path of growth is depressed permanently. In this regard, application of the Lucas wedge would show an astronomical and permanent loss of output and social welfare.[62] This would mean that while the economy is expanding the *true* potential is growing even faster so that the output gap is widening and unemployment rising. If we measure the economy's potential in terms of its human and physical capital, and noting the rising levels of entrants into the labour market, the economy's potential is clearly ascending. Given that these new entrants are not absorbed as quickly as they emerge, the economy's output would expand more slowly than its potential. Thus, eliminating the currently

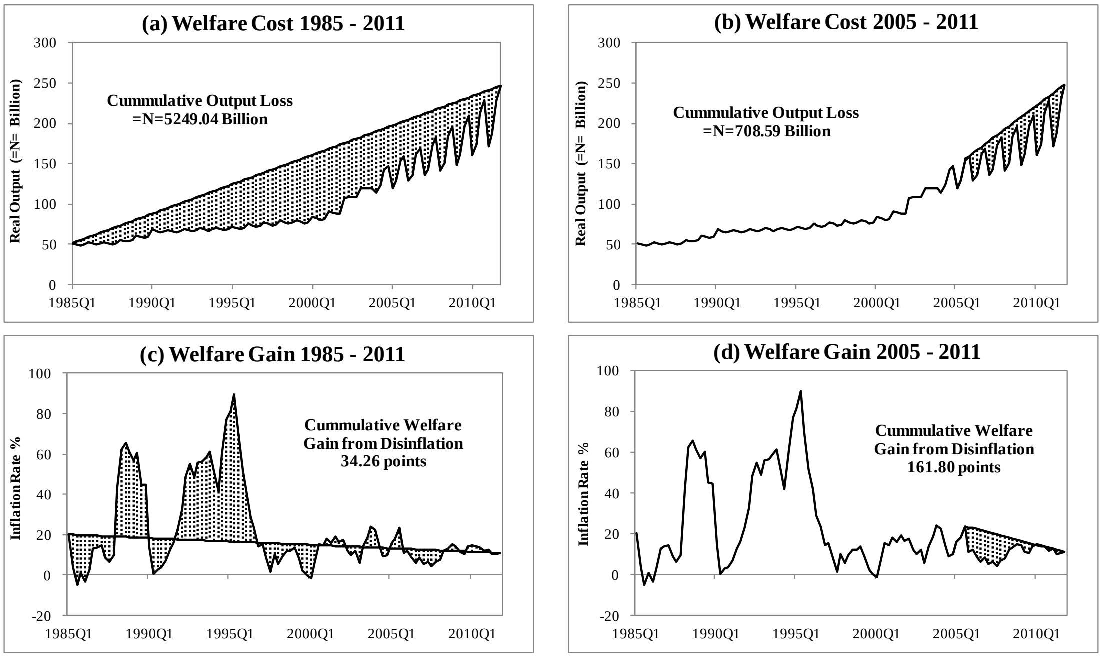
[62] The Lucas wedge is a graphical illustration of the cumulative loss in an economies' output following a slowdown in the real GDP growth rate; thus showing where the economy would have been without the deceleration.

high unemployment rate would require significant absorption of the new entrant, leading to a soaring GDP growth.

Welfare analysis of the inflation-output trade-off and its implication for the overall wellbeing is important for any macroeconomic policy. The Lucas wedge (in figure 7.1) contains a welfare analysis of disinflation. In 1985:Q1 Nigeria's real GDP was about ₦51 billion while inflation rate was 20.0 per cent. By 2011:Q4, real GDP had risen five-fold to ₦246 billion while inflation had halved. During this period both real GDP and inflation showed some fluctuations. However, holding all things constant, we may insert a hypothetical projection of these variables which shows a fluctuation-free path from their initial levels to the final levels. This projection line would thus represent the Lucas wedge potential levels of real GDP and inflation rate. Assuming that at the beginning of 1985 the government could correctly forecast/determine the level of real GDP in 2011:Q4, then it is optimal to choose policies which maintained the projection. GDP levels above the forecast trajectory would increase welfare while those below would lower welfare. To achieve this, the government can also reduce inflation at a constant speed from its 1985 level to its 2011 level. Inflation rates below the trajectory are considered extra achievements and welfare gains while rates above are welfare losses.

The wedge in panel (*a*) shows a cumulative welfare loss of ₦5,249 billion in real GDP, while panel (*c*) indicates a modest cumulative welfare gain of 34.26 percentage points. These suggest an enormous loss of ₦153 billion per percentage point reduction in inflation rate. Given the considerable economic and political upheavals of the 1987-1997 period, the ensuing lower growth *cum* higher inflation rates during this period can undermine the gains from disinflation and amplify output loss. So another set of wedges is produced for a more recent period of 2005-2011 characterised by lower inflation and faster growth. Panels (*b*) and (*d*) present the wedges for this period with a cumulative output loss of ₦709 billion and disinflationary benefits of 161.80 percentage points implying a loss of ₦4.4 billion per percentage point of disinflation. This thus connotes that with a constant disinflation of 0.51 percentage points per quarter the hypothetical cost is ₦8.9 billion annually; an enormous cost to bear if anti-inflationary policies are effective.

Figure 7.1: A Lucas Wedge Analysis of the Welfare Effect of Disinflation



Data Source: CBN and NBS

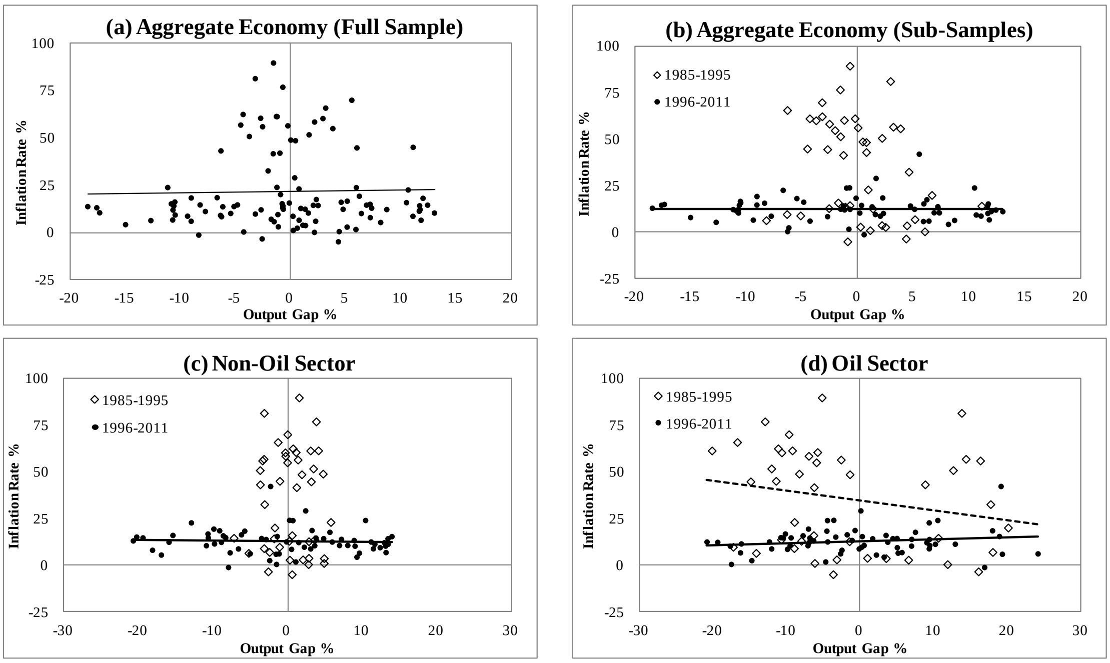
However, the dynamics of inflation may not be due to demand but to other factors. A visual inspection of figure 7.1 does not elucidate the inflation-output relationship in Nigeria. What is nonetheless apparent is that there seem to be structural breaks in both variables during the mid/late-1990s preceded by slow growth and high inflation (and inflation volatility) which ameliorated thereafter. To gain some insight into the inflation-output relationship, the Nigerian PC is plotted in figure 7.2 for output gap and inflation rate.[63] This is illustrated for full- and sub-samples to determine the possible existence of structural breaks in the relationship and also presented for aggregate, non-oil and oil output. Ideally if inflation is demand-pushed then the PC should generally be upward sloping, indicating $0 < \beta < \infty$.

In panel (*a*) the full sample aggregate relationship is presented with a trend line, which showed a flat PC indicating that inflation is on the average irresponsive to changes in the output gap. When the data are broken into sub-samples of 1985-1995 and 1996-2011, the result presented in panel (*b*) indicated transition from a somewhat vertical PC in the earlier period to a horizontal curve in the latter period. This would suggest that the cost of disinflation has increased over the two sample periods. While the deductions for the non-oil sector in panel (*c*) mimics the aggregate, the oil sector – panel (*d*) – showed a slightly inverse relationship initially which became horizontal in

[63] The output gap is derived from the Hodrick-Prescott filter with $\lambda = 1600$.

the latter period. Overall, figure 7.2 indicate that the PC may be more-or-less horizontal both at aggregate and sectoral levels, in recent times. The flattening coincided with the CBN autonomy conferred in the late-1990s and the subsequent active use of the interest rate for monetary policy; thus, indicating increased costs of an NCM-type monetary policy in Nigeria.

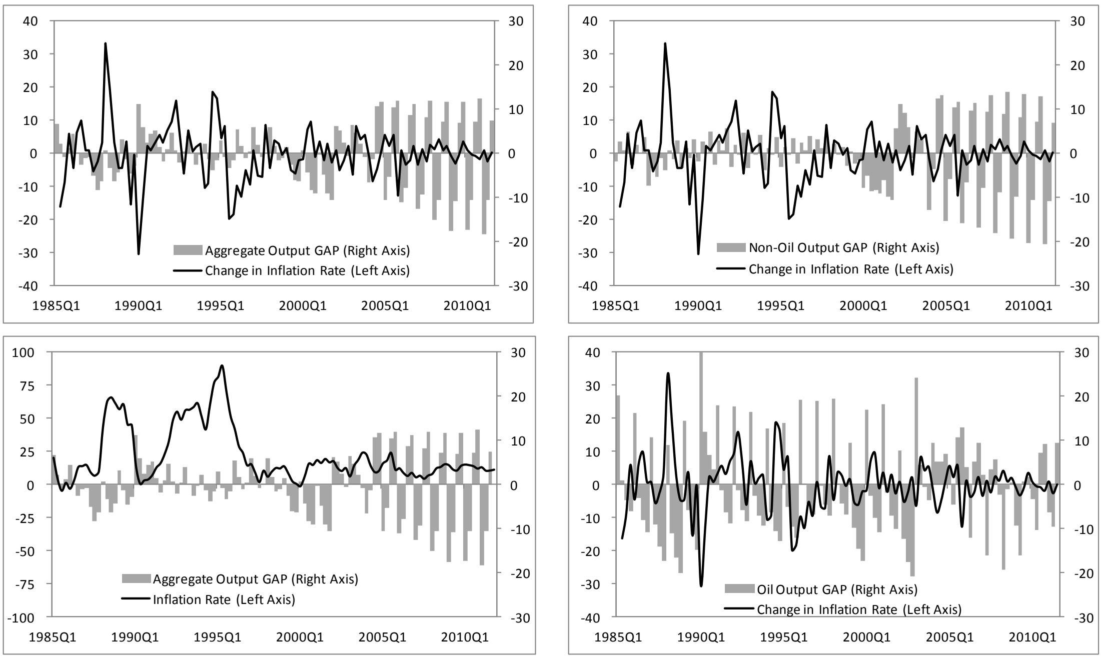
Figure 7.2: The Phillips Curve: Nigeria's Inflation and Output Gap



Data Source: CBN and NBS

To further highlight the relationship between inflation and output, and given the assumption of the NAIRU that positive output gaps accelerates inflation, figure 7.3 plots the relationship between changes in inflation and output gap. If the assumptions of the NAIRU and NCM are correct, we expect to see positive inflation changes per positive output gap. However, especially for aggregate and non-oil sector, the figures tended to show an inverse relationship in most cases. This further illustrates that inflation in Nigeria is not demand but supply-driven. Thus when production is increased, more are supplied to the market causing price to fall, but when less are produced scarcity drives prices up.

Figure 7.3: Price Acceleration and Output Gap



Data Source: CBN and NBS

Two recent studies commissioned by the CBN provided evidence supporting this view. First, studying *The Dynamics of Inflation in Nigeria*, Mordi *et al*. (2007) found that output gap was insignificant and negatively signed while exchange rate and foreign prices were key determinants of inflation. Similarly, the second study on *Inflation Forecasting Models for Nigeria* by Adebiyi *et al*. (2010) documented the exchange rate rather than demand as significant in explaining and forecasting inflation. These thus suggest that attempts to dampen AD in order to combat inflation can be counter-productive and very costly, since it would lead to unnecessary increase in unemployment, suppressed supply and heighten inflationary pressure.

7.4 Model Specification, Methodology and Data [64]

7.4.1 The Models

In line with recent literature, this chapter investigates the inflation-output nexus and the costs of inflation using a PC analysis. This conventionally shows the relationship between AD and inflation in an economy. However, inflation may be determined by many other non-demand factors. Though the proponents of the NCM and the natural rate hypothesis do not dispute these, they nonetheless suggest that while demand effects are permanent those of supply are transitory. Given that a number of studies

[64] This chapter relies heavily on earlier discussions in chapters five and six.

have shown that supply factors are significant and non-transitory, our interest in this chapter is to model the PC in a way that incorporates supply factors (while also providing information for both the short- and long-run). Dupasquier and Ricketts (1998) showed that the inclusion of supply shock variables significantly reduces the standard errors of the regression and enhances the precision of the estimated parameters. To capture the possible nonlinearity in the inflation-output nexus, we consider both symmetric and asymmetric specifications of the PC. From equation 7.3, the linear LR-PC is thus specific as

$$\pi_t = \Phi + \beta\tilde{y}_t + \mathbf{\Gamma}\boldsymbol{Z_t} + \varepsilon_t \tag{7.4}$$

$$\tilde{y}_t \equiv y_t - \bar{y}_t$$

where π_t is the annualised inflation rate, $\tilde{y}_t$ measures the deviation of log real GDP from its trend, $\boldsymbol{Z}_t$ is a $k \times 1$ vector of k supply factors and ε_t is the stochastic error term which is assumedly $iid(0, \sigma_\varepsilon^2)$. The subscript t indicates that the variables are time-series while $\Phi, \beta,$ and $\mathbf{\Gamma}$ are the (conforming vector of) long-run parameters to be estimated. Our objective is to determine the characteristics of β and its relative importance vis-à-vis $\mathbf{\Gamma}$ in the inflationary process.

From the preceding chapters, we noted that non-stationarity of most economic variables affects the validity of inferences made with such variables. Hence, to avert the problem of spurious regression as well as enable us capture both long-run relationships and short-run dynamics we, again, conduct a cointegration analysis using the ARDL model *à la* Pesaran and Shin (1998) discussed earlier. Consequently, equation 7.4 is re-specified to derive our benchmark linear-ARDL model as

$$\Delta\pi_t = \mu + \alpha\pi_{t-1} + \delta\tilde{y}_{t-1} + \mathbf{\Xi}\boldsymbol{Z}_{t-1} + \phi(L)\Delta\pi_t + \theta(L)\Delta\tilde{y}_t + \boldsymbol{\gamma}(L)\Delta\boldsymbol{Z}_t + \eta_t \tag{7.5}$$

where μ is the intercept, α is the error correction parameter which measures the speed of adjustment to the long-run equilibrium following a shock and satisfies $-1 < \alpha < 0$. The parameter δ nests the long-run partial elasticity of demand, $\mathbf{\Xi}$ is a vector which embeds the long-run parameters of supply determinants and $\eta_t \sim iid\left(0, \sigma_\eta^2\right)$ is the error term. Long-run parameters are extracted as $\beta = \delta/-\alpha$ and $\mathbf{\Gamma} = \mathbf{\Xi}/-\alpha$ (see chapters five and six). The terms $\phi(L)$, $\theta(L)$ and $\boldsymbol{\gamma}(L)$ are lag polynomials in the short-run variables with ϕ, θ and $\boldsymbol{\gamma}$ as short-run dynamic parameters. This specification enabled the concurrent estimation of the short- and long-run dynamics of inflation. The lag augmentation in the model captures price stickiness and the short-run impact of demand and supply factors.

To investigate the possibility of asymmetry and nonlinearity, equation 7.5 is modified in line with discussions in preceding chapters. First, we investigate the possibility of asymmetric effect with output gap as the transition variable (i.e. the hypothesis that inflation responds differently to negative vis-à-vis positive gaps). From the asymmetric ARDL model of Shin *et al*. (2009) discussed earlier, this requires splitting the output gap about a zero threshold. The asymmetric regressor is thus generated as

$$\tilde{y}_t = \tilde{y}_0 + \tilde{y}_t^{(+)} + \tilde{y}_t^{(-)} \qquad (7.6)$$

where the constant $\tilde{y}_0$ is any real number, while $\tilde{y}_t^{(+)}$ and $\tilde{y}_t^{(-)}$ constitute the partial sum processes of the positive and negative changes in $\tilde{y}_t$ derived as

$$\tilde{y}_t^{(+)} = \sum_{h=1}^{t} \Delta\, \tilde{y}_t \cdot \mathrm{I}_{\{\tilde{y}_t \geq 0\}} \qquad (7.7)$$

$$\tilde{y}_t^{(-)} = \sum_{h=1}^{t} \Delta\, \tilde{y}_t \cdot \mathrm{I}_{\{\tilde{y}_t \leq 0\}} \qquad (7.8)$$

which breaks the variables into two regimes *viz*: regime_1 (i.e. $\tilde{y}_t \geq 0$) for positive gaps and regime_2 (i.e. $\tilde{y}_t \leq 0$) for negative gaps. $\mathrm{I}_{\{\tilde{y}_t,0\}}$ is an indicator function that equalled unity when the argument is true and zero otherwise. By substituting for $\tilde{y}_t$ in equation 7.5 the asymmetric ARDL becomes

$$\begin{aligned} \Delta\pi_t &= \mu + \alpha\pi_{t-1} + \delta^{(+)}\tilde{y}_{t-1}^{(+)} + \delta^{(-)}\tilde{y}_{t-1}^{(-)} + \boldsymbol{\Xi Z}_{t-1} + \\ &+\phi(L)\Delta\pi_t + \theta^{(+)}(L)\Delta\tilde{y}_t^{(+)} + \theta^{(-)}(L)\Delta\tilde{y}_t^{(-)} + \boldsymbol{\gamma}(L)\Delta\boldsymbol{Z}_t + \eta_t \end{aligned} \qquad (7.9)$$

where $\delta^{(+)}$ and $\delta^{(-)}$ are asymmetric parameters which nest the asymmetric long-run elasticities of demand (i.e. $\beta^{(+)}$ and $\beta^{(-)}$) derived as $\delta^{(+)}/-\alpha$ and $\delta^{(-)}/-\alpha$, respectively, while $\theta^{(+)}$ and $\theta^{(-)}$ are the short-run parameters in regimes_1 and_2. Asymmetry is then tested via the *Wald*-test under $H_0: \beta^{(+)} = \beta^{(-)}$ and $H_0: \theta^{(+)} = \theta^{(-)}$ for the long- and short-run, respectively.

Next, we investigate nonlinearity in the inflation-output nexus to determine if the relationship changes at some levels of output gaps. Filardo (1998) and Greenwood-Nimmo *et al.* (2011) showed that this nonlinearity can be complex since there may be one or more thresholds. Following these studies, we assume a maximum of two thresholds and thus specify a T-ARDL[1] and T-ARDL[2] models for single or double thresholds, respectively. For the two-regime T-ARDL[1], the threshold is defined as $\tau = \tilde{y}_{t-d}$; where τ and $d \geq 0$ are unknown threshold and delay parameters to be estimated. By redefining equation 7.6 accordingly, the asymmetric regressor can now be disaggregated as

$$\tilde{y}_t = \tilde{y}_0 + \tilde{y}_t^{(1)} + \tilde{y}_t^{(2)} \tag{7.10}$$

where $\tilde{y}_t^{(1)}$ and $\tilde{y}_t^{(2)}$ are the partial sum processes of the changes in $\tilde{y}_t$ in regime_1 $(\tilde{y}_t > \tau)$ and regime_2 $(\tilde{y}_t \leq \tau)$, respectively, derived as

$$\tilde{y}_t^{(1)} = \sum_{h=1}^{t} \Delta\, \tilde{y}_h \cdot \mathrm{I}_{\{\tilde{y}_{t-d} > \tau\}}\ ;$$

$$\tilde{y}_t^{(2)} = \sum_{h=1}^{t} \Delta\, \tilde{y}_h \cdot \mathrm{I}_{\{\tilde{y}_{t-d} \leq \tau\}} \tag{7.11}$$

where $\mathrm{I}_{\{\tilde{y}_{t-d},\tau\}}$ is the indicator. Substituting equation 7.10 into 7.5 the T-ARDL[1] model is derived as

$$\begin{aligned}\Delta\pi_t = \mu + \alpha\pi_{t-1} + \delta^{(1)}\tilde{y}_{t-1}^{(1)} + \delta^{(2)}\tilde{y}_{t-1}^{(2)} + \boldsymbol{\Xi}\boldsymbol{Z}_{t-1} + \\ + \phi(L)\Delta\pi_t + \theta^{(1)}(L)\Delta\tilde{y}_t^{(1)} + \theta^{(2)}(L)\Delta\tilde{y}_t^{(2)} + \boldsymbol{\gamma}(L)\Delta\boldsymbol{Z}_t + \eta_t\end{aligned} \tag{7.12}$$

where, as previously defined, $\delta^{(1)}$ and $\delta^{(2)}$ are asymmetric parameters nesting the nonlinear long-run effects of demand $\beta^{(1)}$ and $\beta^{(2)}$ derived as $\delta^{(1)}/{-\alpha}$ and $\delta^{(2)}/{-\alpha}$, respectively, while $\theta^{(1)}$ and $\theta^{(2)}$ are the short-run parameters in both regimes. A *Wald*-test is, again, performed for $H_0\!: \beta^{(1)} = \beta^{(2)}$ and $H_0\!: \theta^{(1)} = \theta^{(2)}$ to test long- and short-run nonlinearity, respectively.

For the T-ARDL[2], two unknown thresholds are specified leading to three possible regimes. The first threshold $\left(\tau^{(1)}\right)$ defined the upper regime for large positive gaps while the other $\left(\tau^{(2)}\right)$ bounds the lower regime for large negative gaps. The middle regime contains moderate gaps. In this case, $\tilde{y}_t$ is discomposed as

$$\tilde{y}_t = \tilde{y}_0 + \tilde{y}_t^{(1)} + \tilde{y}_t^{(2)} + \tilde{y}_t^{(3)} \tag{7.13}$$

where $\tilde{y}_t^{(j)}$ is the partial sum process for the changes in $\tilde{y}_t$ in the j^{th} regime defined as

$$\begin{aligned} \tilde{y}_t^{(1)} &= \textstyle\sum_{h=1}^{t} \Delta\, \tilde{y}_h \cdot \mathrm{I}_{\{\tilde{y}_{t-d} \geq \tau^{(1)}\}} \\ \tilde{y}_t^{(2)} &= \textstyle\sum_{h=1}^{t} \Delta\, \tilde{y}_h \cdot \mathrm{I}_{\{\tau^{(1)} > \tilde{y}_{t-d} > \tau^{(2)}\}} \\ \tilde{y}_t^{(3)} &= \textstyle\sum_{h=1}^{t} \Delta\, \tilde{y}_h \cdot \mathrm{I}_{\{\tilde{y}_{t-d} \leq \tau^{(2)}\}} \end{aligned} \tag{7.14}$$

where $\mathrm{I}_{\{\tilde{y}_{t-d}, \tau^{(\cdot)}\}}$ is again the indicator function. Substituting equation 7.13 into 7.5 yields the T-ARDL[2] as

$$\begin{aligned} \Delta\pi_t = \mu + \alpha\pi_{t-1} + \textstyle\sum \delta^{(j)} \tilde{y}_{t-1}^{(j)} + \boldsymbol{\Xi}\boldsymbol{Z}_{t-1} + \\ + \phi(L)\Delta\pi_t + \textstyle\sum \theta^{(j)}(L)\Delta\tilde{y}_t^{(j)} + \boldsymbol{\gamma}(L)\Delta\boldsymbol{Z}_t + \eta_t \end{aligned} \tag{7.15}$$

where $j \in [1,2,3]$ represents the respective regimes. Again, $\delta^{(j)}$ contains the nonlinear long-run parameter $\left(\beta^{(j)}\right)$ while $\theta^{(j)}$ represents the short-run nonlinear parameters. Once more, test of nonlinearity is based on the *Wald*-test for $H_0\colon \beta^{(1)} = \cdots = \beta^{(j)};\ \forall j$, and $H_0\colon \theta^{(1)} = \cdots = \theta^{(j)};\ \forall j$, in the long- and short-run, respectively.

For both the T-ARDL[1] and T-ARDL[2], the stochastic and unknown thresholds are estimated by conducting a grid search and selecting the pair (τ, d) that minimised the RSS as follows

$$\hat{\tau} = \underset{\tau, d \in [0.15Q, 0.85Q]}{\operatorname{argmin}} RSS(\tau, d) \tag{7.16}$$

where RSS is derived from OLS regressions of equations 7.12 and 7.15, respectively, for different values of $\tau, d \in Q$, and Q is the set of all possible values of the transition variable after removing non-zero observations in the top and bottom 15th-percentile. This is to ensure that there are at least 15 per cent of non-zero values in each regime. The search is conducted sequentially in increments of 0.25 per cent in the gap while the estimation of the delay parameter is limited to $0 \leq d \leq 4$ given the quarterly frequency of our data.[65] Following Hansen (2000), a likelihood-ratio test, is then conducted for the T-ARDL[1] to test the null hypothesis of no threshold versus the

[65] The sequence for τ, d were chosen conveniently, this nonetheless produced a total of about 1000 equations for the grid search.

alternative of single threshold, while for the T-ARDL[2] the null of single threshold is tested against the alternative of double threshold. The likelihood-ratio test enables to investigate the robustness of the threshold models and thus, ascertain that our results are not due to outliers.

The linear and nonlinear equations 7.5, 7.9, 7.12 and 7.15 represent the different PCs to be investigated. In the literature, the $k \times 1$ vector of supply determinants $\boldsymbol{Z}_t$ included factors like indirect taxes (see Dupasquier and Ricketts, 1998), exchange rate and import prices (see Adebiyi *et al*., 2010; Dwyer *et al*. 2009; and Mordi *et al*., 2007), and oil prices (see Rumler and Valderrama, 2008; Dupasquier and Ricketts, 1998; and Kromphardt and Logeay, 2011) which represent domestic and foreign factors. Consequently, we define $\boldsymbol{Z}_t$ to include exchange rate changes (E_t), import prices changes $\left(\pi_t^{imp}\right)$, oil price changes $\left(\pi_t^{oil}\right)$ and domestic spare capacity (Λ_t), to capture foreign and domestic shocks. Cumulative dynamic multipliers in these models are computed, as discussed in chapter 6, to analyse adjustment path to steady-state equilibrium after an impulse to regressors.

7.4.2 Methodology

Parameters in the above equations are estimated by the applying the OLS procedure to the various ARDL models. Given its time-series nature, and the fact that inflation is affected by an array of factors, all of which may not enter any specific model, OLS estimation of a model of inflation can be subjected to a number of problems like endogeneity bias, autocorrelation, and non-stationary of variables (as explained in earlier chapters). Nonetheless, according to Pesaran and Shin (1998), the ARDL modelling approach has the advantage of producing consistent parameters estimate even in the presence of these problems. Adequate lag augmentation, using an appropriate information criterion, concurrently eliminates the problems of autocorrelation and endogeneity bias.

Pesaran and Shin (*op.cit*) also indicated that the OLS estimators of the cointegrating parameters of the ARDL are Gaussian and efficient. As in the previous chapters, test of cointegration is conducted using the PSS bounds *F*-test which is performed under the (joint) null of no cointegration as

$$H_0: \alpha = \delta^{(n)} = \boldsymbol{\Xi} = 0 \tag{7.17}$$

where $n \in [1,2,3]$ is the respective regimes in appropriate ARDL models. The *F*-statistic is compared with the asymptotic critical values provided in Pesaran *et al*. (2001) as discussed in the preceding chapters. Again robust OLS estimators are derived using the Newey-West method to produce HAC standard errors which ensure the validity of our inferences even in the presence of the classical problems. All restrictions and models evaluations are conducted at the 5 per cent level of significance.

Empirical investigation follows a general to specific approach where eight lags of the all variables are initially included in the over-parameterised equation. To determine the optimal lag length we conduct a sequential search between one-to-eight lags by estimating various versions of the benchmark equation 7.5 and selecting the lag with the lowest AIC. The appropriate lag-length is then applied to all the variants of the ARDL model. A parsimonious model is thereafter obtained in each model by deleting insignificant dynamic regressors from the model while being mindful of the fit and the AIC criterion. For any set of potential parsimonious models, that with the least AIC is preferred. Where variables emerge insignificant both in the long- and short-run, they are expunged from the model. Coefficients of the remaining significant short-run variables in the models are then summed-up to derive the short-run dynamic parameter for the respective variables. We further evaluate the correctness of our model specification using Ramsey's *RESET* with the null of no specification error. This is an *F*-statistic specification error test using the squares of fitted residuals.

For the variables $\tilde{y}_t, E_t, \pi_t^{imp}, \Lambda_t$ we expect positive signs *a priori*, implying that these are inflationary while for π_t^{oil} in Nigeria, we have no priors. The ambiguity of π_t^{oil} is because rising oil prices can raise the cost of production while concurrently enhancing government subsidies, which lower domestic costs and inflation. However, oil prices can also have demand effect via its effect on government expenditure though this would already be captured by $\tilde{y}_t$.

7.4.3 The Data

Analysis in this chapter is conducted using quarterly data spanning 1985:Q1-2011:Q4. The dataset include the log of real GDP (y_t) defined as the gross domestic product at 1990 constant basic prices, which is subdivided into non-oil and oil sector to capture the structure of the Nigerian economy. Using the Hodrick-Prescott filter with a smoothing parameter $\lambda = 1600$, potential output $(\bar{y}_t)$ is derived as the trend of log of real GDP. Inflation rate (π_t) is defined as the annualised change in the log of headline CPI while exchange rate changes (E_t) is the annualised change in log of nominal exchange rate defined as naira per dollar rate. We derive domestic spare capacity (Λ_t) as

$$\Lambda_t = 1 - \frac{capacity\ utilisation}{100}$$

where capacity utilisation is the percentage of installed capacity of the manufacturing sector used during the period. Oil price change $\left(\pi_t^{oil}\right)$ is the annualised difference in log of quarterly average of the dollar per barrel price of bonny light (Nigeria's reference crude petroleum). Imported inflation $\left(\pi_t^{imp}\right)$ is the annualised change in log of import commodity price index. Since according to the CBN (2009a) majority of Nigeria's import originate from industrials countries, the OECD producer price index is used as proxy for import prices. All domestic dataset are sourced from the CBN and the NBS while the OECD price index is obtained from the OECD database.

7.5 Empirical Analysis

Given the possibility of bi-directional relationships between some of the potential explanatory variables (e.g. output gap versus excess capacity and oil price versus exchange rate), a variance inflation factor (VIF) test of multicollinearity is conducted. The estimated VIF are all relatively low, ranging from 1.28-2.75; where excess capacity possessed the highest VIF. This result indicated the possible absence of multicollinearity problems among the regressors. Subsequently, we conducted stationarity tests to examine the time-series properties of the variables. The tests are conducted using both the ADF test with the null hypothesis of a unit root and the KPSS test with a null hypothesis of stationarity. The results contained in table 7.1, showed a mixture of $I(1)$ and $I(0)$ properties among the variables. While total and non-oil gaps as well as excess capacity are $I(1)$, all other variables are $I(0)$. However, as observed earlier, the combination of $I(0)$ and $I(1)$ variables in the model would not affect the validity of our analysis based on the ARDL model and the PSS F-test.

Table 7.1: Times-Series Property of Variables

	ADF			KPSS		
	Levels	1st-Diff.	Decision	Levels	1st-Diff.	Decision
Domestic Inflation ($\boldsymbol{\pi}$)	-3.06**	-7.27***	$I(0)$	0.33	0.03	$I(0)$
Output Gap ($\tilde{y}$_**W**)	-0.63	-15.94***	$I(1)$	0.95***	0.14	$I(1)$
Non-Oil ($\tilde{y}$_**N**)	-0.45	-17.41***	$I(1)$	0.96***	0.12	$I(1)$
Oil ($\tilde{y}$_**O**)	-4.43***	-7.51***	$I(0)$	0.44*	0.12	$I(0)$
Exchange Rate Changes ($\boldsymbol{E}$)	-2.89**	-8.84***	$I(0)$	0.43*	0.35*	$I(0)$
Excess Capacity ($\boldsymbol{\Lambda}$)	-1.33	-3.60***	$I(1)$	0.65**	0.20	$I(1)$
Oil Price Changes ($\boldsymbol{\pi^{oil}}$)	-3.58***	-6.87***	$I(0)$	0.44*	0.35*	$I(0)$
Import Price Inflation ($\boldsymbol{\pi^{imp}}$)	-5.54***	-8.06***	$I(0)$	0.31	0.20	$I(0)$

Source: Author's computations based on data from the CBN, NBS and OECD database.

Note: Tests of stationarity were conducted with intercept but no trend. The ADF test was conducted under the null hypothesis of unit root using MacKinnon critical values of –3.49,–2.88 and –2.58 for the 1%, 5% and 10% significance level, respectively, while the KPSS test was performed under the null hypothesis of stationarity with asymptotic critical values of 0.73,0.46 and 0.34 for the 1%, 5% and 10% significance level, respectively.

For the empirical analysis, the various ARDL models are estimated for total ($\tilde{y}\_W$), non-oil ($\tilde{y}\_N$) and oil ($\tilde{y}\_O$) output gaps adopting a general to specific approach. Using the AIC criterion, and searching between one-to-eight lags, we found the optimal lag length at eight. This search is conducted basically for the linear $\tilde{y}\_W$ model and the outcome is adopted for other models. Hence, we specified an over-parameterisation with a lag-order of eight in all cases and derive parsimony by deleting insignificant short-run regressors from the model, complemented with the AIC criterion.

7.5.1 The Linear-ARDL Model

Standard specification of the PC as contained in the NCM do not contain supply factors, which are usually subsumed into the error term and are assumed to have no long-run relevance. Hence, the linear model in equation 7.5 is estimated initially under this assumption. This required the necessary imposition of zero value on all the k elements of the $\boldsymbol{Z}_t$ vector. Thus, a simple linear-PC is estimated without supply factors, the result of which is contained in panel (A) of table 7.2 below.[66] The results indicated an inverse and somewhat insignificant relationship between inflation and the output gap both in the long- and short-run. The inverse relationship is indicative of the

[66] Given the length of the original tables abridged versions are presented in the main text showing the relationships of interest. The complete tables are contained in the appendices.

dominant effect supply shocks since these would reduce equilibrium output and raise prices simultaneously. In this specification, inflation is driven mostly by inertia in the short-run, and by non-demand factors in the long-run. This is contrary to the underlying assumptions of the NCM-PC. Diagnostic and summary statistics, however, suggest that this specification is inadequate. While the *RESET* rejected the null hypothesis of no specification error, the PSS F-test could not reject the null of no cointegration. The $\bar{R}^2$ is also low and accompanied by relatively high RSS.

Table 7.2: Results of the Linear-ARDL Phillips Curve Models

	(A) Simple PC			(B) Supply-Augmented PC		
	Whole Economy	***Non-Oil Sector***	***Oil Sector***	***Whole Economy***	***Non-Oil Sector***	***Oil Sector***
Regressors	(1)	(2)	(3)	(4)	(5)	(6)
$\boldsymbol{\mu}$	0.03** (0.01)	0.03 (0.02)	0.02** (0.01)	0.06 (0.05)	0.12*** (0.05)	0.08** (0.03)
$\boldsymbol{\alpha}$	-0.09** (0.04)	-0.09* (0.05)	-0.06 (0.04)	-0.09* (0.05)	-0.09* (0.05)	-0.08** (0.04)
$\boldsymbol{\beta}$	-2.40* (1.43)	-1.93 (1.50)	-0.86 (2.98)	0.27 (2.06)	-1.32 (1.62)	4.51* (2.47)
$\boldsymbol{\Gamma}^{[E_{t-1}]}$				1.41* (0.80)	1.50* (0.81)	1.59* (0.91)
$\boldsymbol{\Gamma}^{[\Lambda_{t-1}]}$				1.03 (1.44)	1.88* (1.05)	1.61 (1.42)
$\boldsymbol{\Gamma}^{[\pi_{t-1}^{oil}]}$				-0.44 (0.30)	-0.50 (0.33)	-0.37 (0.37)
$\boldsymbol{\Gamma}^{[\pi_{t-1}^{imp}]}$				-2.59 (4.09)	-3.72 (4.15)	-12.40 (7.82)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}$	0.57*** (0.10)	0.41** (0.21)	0.35* (0.18)	0.49* (0.28)	0.58** (0.23)	0.61*** (0.19)
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}_{t-s}$	-0.30 (0.22)	-0.40* (0.21)	-0.09 (0.11)	-1.76*** (0.59)	-0.34* (0.20)	-0.34** (0.14)
$\sum_{s=0}^{8} \Delta\boldsymbol{E}_{t-s}$				-0.90*** (0.17)	-0.93*** (0.16)	-0.96*** (0.13)
$\sum_{s=0}^{8} \Delta\boldsymbol{\Lambda}_{t-s}$				2.37*** (0.71)	2.35*** (0.68)	3.28*** (0.83)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}^{oil}$				-0.33*** (0.13)	-0.37*** (0.12)	-0.38*** (0.12)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}^{imp}$				6.08*** (1.63)	6.55*** (1.64)	7.50*** (2.16)
$\bar{\boldsymbol{R}}^2$	0.27	0.25	0.29	0.56	0.54	0.60
RSS	0.45	0.45	0.42	0.20	0.21	0.17
AIC	-2.40	-2.36	-2.42	-2.73	-2.71	-2.81
F-Test$_{(PSS)}$	2.66	1.36	1.76	8.15**	7.92**	8.56**
RESET	4.21** [0.03]	5.34** [0.01]	3.05** [0.04]	0.06 [0.80]	0.01 [0.97]	0.27 [0.59]

Source: Author's computations based on data from the CBN, NBS and OECD database.

Note: Econometric estimation was conducted with *EViews 7.0* software using data are from 1985:Q1 to 2011:Q4. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *RSS* denotes residual sum of squares while *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F-test*($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using 5% asymptotic critical values from Pesaran *et al*. (2001). *RESET* is the *F*-statistic of Ramsey's specification error test using the squares of fitted residuals; *p*-values are in [ ].

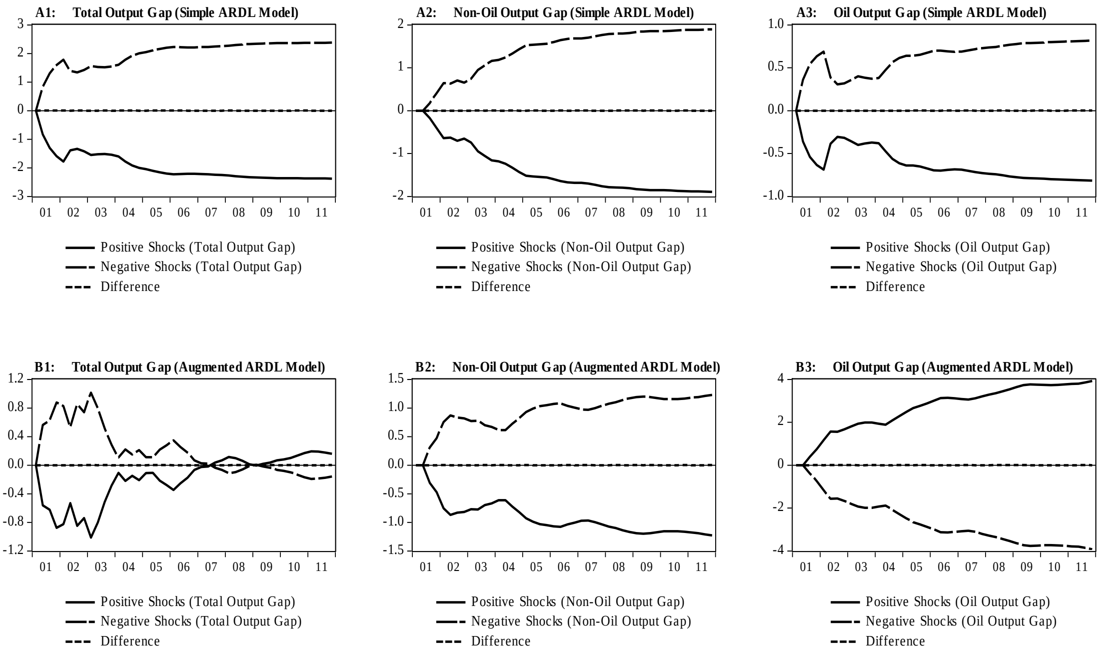
Given the poor performance of the simple-PC, the restriction on the $\boldsymbol{Z}_t$ vector is relaxed and equation 7.5 is re-estimated with supply-factors augmentation. The results of the supply-augmented PC are shown in panel (B). As in the preceding model, the error correction parameter (α) is correctly sized and signed in all equations, although slightly larger in the augmented-PC. Again, in most cases the coefficient of output gap is negatively signed and/or insignificant both in the long- and short-run. The only exception is for the oil gap where it is significantly positive in the long-run. However, exchange rate changes are consistently found to be a significantly positive determinant of inflation while excess capacity is only significant in the non-oil model. These findings are consistent with our prior expectations.

Import and oil price changes are, however, negatively signed. For import prices, this may indicate the effect of competition between domestic production and importation; hence, falling foreign prices makes import cheaper. Generally, the cost of production in Nigeria is high given that firms provide their own infrastructures, which sometimes makes importation a cheaper option for many tradables. Hence, rising import prices make local alternatives to be more attractive to consumers and encourage domestic production and supplies. Increased supply would thus reduce domestic inflation. The negative sign for oil price could reflect impact of oil-windfalls on the government's ability to subsidies domestic activities as well as the increased ability to finance long-term public investments.

In the short-run the drivers of inflation are found to be excess capacity, import price and inflation inertia. Output gap, oil prices and exchange rate changes are negatively signed in the short-run. Overall, excess capacity increased inflation both in the long- and short-run which again suggests that inadequate supply, rather than excess demand is the more important determinant of inflation. Compared with the previous specification, model evaluation based on the $\bar{R}^2$, RSS and AIC indicated a better fit. The *RESET* also could not reject the null of no mis-specification even as the PSS *F*-test confirmed cointegration among the variables.

The results from both versions of the linear model suggest that the LR-PC may not be vertical but somewhat flat (with a slightly negative slope). In the short-run, the PC is mostly downward sloping. These do not only suggest that inflation is supply-driven but also dismantles the notion of long-run neutrality. This conclusion is further highlighted in figure 7.4 which presents the cumulative dynamic multipliers for the linear models. The figure illustrates the adjustment paths from short-run disequilibrium to long-run equilibrium following output gap shocks.

Figure 7.4: Dynamic Multipliers of the Linear Models



The paths of the simple-PC are shown in row (A) while row (B) illustrates the traverse of the augmented-PC for total, non-oil and oil gap models in columns 1, 2, and 3, respectively. These charts depict symmetry in response following positive or negative shocks to the output gap. In the simple-PC, following a positive shock which increases GDP above potential, the multipliers are entirely negative through-out its lifespan. This negative-side adjustment is replicated for $\tilde{y}\_N$ in the augmented-PC while for $\tilde{y}\_O$, it is positive. For $\tilde{y}\_W$, the initial adjustments were considerably negative. This diminished after three years becoming positive after eight years. In all these, the adjustment pattern is symmetric over the life of the shock, generally sluggish and somewhat long-lived. It can be seen that it takes over a decade, in most cases, to correct short-run disequilibrium and attain the long-run steady-state of the model. This thus supports non-neutrality of real variables in the long-run.

7.5.2 The Nonlinear-ARDL Models

The results of nonlinear and asymmetric ARDL models of equations 7.9, 7.12 and 7.15 are presented in table 7.3 below. Panel (A) contains the results of the asymmetric ARDL which tests the hypothesis that positive gaps behave differently from negative gaps. *A priori*, we expect coefficients of both positive and negative gaps to be positively signed. Equality of these would indicate symmetry in the relationship. In panel (B) is the result of the single (unknown) threshold. If the threshold is estimated to be zero then results in panels (A) and (B) would coincide. The results of the double (unknown) thresholds are tabulated in panel (C). This contains the inflation-output relationship in three regimes: large positive, moderate level, and large negative gaps. Again, our *a priori* expectation in both threshold models is that all coefficients of outputs gaps are positively signed; where equality of these would imply linearity in the relationship.

7.5.2.1 The Asymmetric NARDL Model

The coefficients of the positive and negative gaps are all significant in all cases for $\tilde{y}\_W$, $\tilde{y}\_N$ and $\tilde{y}\_O$ but are considerably larger for $\tilde{y}\_W$. However, these are perversely signed in some cases. For $\tilde{y}\_W$ and $\tilde{y}\_N$, both positive and negative gaps are inflationary, while for $\tilde{y}\_O$ both gaps are deflationary. This suggests a "V-shaped" LR-PC for $\tilde{y}\_W$ and $\tilde{y}\_N$, and "Λ-shaped" LR-PC for $\tilde{y}\_O$. Thus, irrespective of whether output is above or below potential, inflation dynamics are unaffected. Other factors rather than demand would thus be responsible for inflation in Nigeria. Given the more-or-less equality in the absolute values of the coefficient, the overall effect of AD on inflation would be approximately zero (or insignificantly negative). This explains the findings in the preceding linear models and those of Mordi *et al*. (2007) and Adebiyi *et al*. (2010) for Nigeria. As in the linear models, exchange rate changes and spare capacity are found to be the significant inflationary factors while import prices maintained an inverse effect. However, oil price coefficient in the $\tilde{y}\_N$ and $\tilde{y}\_O$ equations now became inflationary while for $\tilde{y}\_W$ it remained negative.

In the short-run, output gaps are deflationary for $\tilde{y}\_W$ and $\tilde{y}\_N$ but inflationary for $\tilde{y}\_O$. The significant drivers of inflation in the short-run are spare capacity, import prices and inertia, while exchange rate and oil prices dampened inflation. Analysis of the model diagnostics generally indicated no specification error and confirmed long-run relationship among the variables. The $\bar{R}^2$, RSS and AIC are slightly better than those in the linear model. *Wald*-tests of symmetry that $H_0: \beta^{(+)} = \beta^{(-)}$ and $H_0: \theta^{(+)} = \theta^{(-)}$ rejected the null both in the long- and short-run. However, a slightly modified test of $H_0: |\beta^{(+)}| = |\beta^{(-)}|$ and $H_0: |\theta^{(+)}| = |\theta^{(-)}|$ could not reject the null of symmetry in the long-run absolute values of the coefficients but reject the null in the short-run. This indicated a basically horizontal LR-PC and an oblique SR-PC. These findings are also supported by the plots of the dynamic multipliers in row (A) of figure 7.5 below. This showed coincidence in adjustment paths for positive and negative demand shocks, both of which are inflationary. Inflationary pressures, by implication, subsist regardless of whether the economy is contracting or expanding, so that inflation may basically not be an AD phenomenon. Hence, the net impacts of these as shown are more-or-less zero, indicative of a flat PC. Inflation is, thus, due to other factors, so that expansionary policy may be conducted undaunted of inflationary pressures since the inflation-output trade-off disappears.

7.5.2.2 The Nonlinear T-ARDL[1] Model

Moving away from the assumption of a known threshold around zero output gap, the two-regime T-ARDL[1] model is estimated by first deriving the threshold ($\tau = \tilde{y}_{t-d}$; where $d \geq 0$). For $\tilde{y}\_W$ and $\tilde{y}\_N$ we found the *infimum-RSS* at $\tau =$2.5 and 5.5 per cent, respectively, with $d = 0$, while for $\tilde{y}\_O$ we found $\tau = -1.25$ per cent and $d = 3$. The likelihood ratio test validated these thresholds at the 5 per cent significance level. Results of the T-ARDL[1] model presented in panel (B) are somewhat similar to that of the NARDL in panel (A). Though, the coefficients of the output gap are smaller than in the preceding model, the inferences therefrom are somewhat identical. First, the coefficient for $\tilde{y}\_W$ is considerably larger than those of $\tilde{y}\_N$ and $\tilde{y}\_O$. For each sector, the absolute values of the coefficients were identical while they bore opposite signs which imply that the overall effects are approximately zero. Again, this would imply a horizontal LR-PC. As in the preceding model, the significant inflationary factors in the long-run are the exchange rate changes and excess capacity. Oil prices are again inflationary for $\tilde{y}\_N$ and $\tilde{y}\_O$ but not $\tilde{y}\_W$ while import prices reduced inflation in the long-run.

Table 7.3: Results of the Nonlinear-ARDL Phillips Curve Models

	(A) NARDL Model			(B) T-ARDL[1] Model			(C) T-ARDL[2] Model		
	Whole Economy	***Non-Oil Sector***	***Oil Sector***	***Whole Economy***	***Non-Oil Sector***	***Oil Sector***	***Whole Economy***	***Non-Oil Sector***	***Oil Sector***
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\mu}$	-0.34**	-0.30***	0.78***	-0.38***	-0.20**	0.18***	-0.50***	-0.51***	0.26***
	(0.14)	(0.09)	(0.09)	(0.13)	(0.09)	(0.06)	(0.11)	(0.08)	(0.06)
$\boldsymbol{\alpha}$	-0.15***	-0.21***	-0.62***	-0.16***	-0.22***	-0.21***	-0.14***	-0.18***	-0.11***
	(0.05)	(0.03)	(0.07)	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)	(0.03)
$\boldsymbol{\beta}^{(\mathbf{1})/(+)}$	28.82**	6.38**	-2.67***	16.47***	6.54***	-1.34**	17.93***	5.76***	-0.32
	(12.49)	(3.05)	(0.39)	(5.63)	(1.82)	(0.52)	(6.18)	(1.58)	(0.22)
$\boldsymbol{\beta}^{(\mathbf{2})/(-)}$	-28.82**	-7.23**	2.47***	-16.34***	-6.75***	1.07**	10.99***	-2.47***	0.96*
	(12.39)	(2.98)	(0.37)	(5.59)	(1.84)	(0.51)	(3.95)	(0.71)	(0.53)
$\boldsymbol{\beta}^{(\mathbf{3})}$							-17.14***	-6.56***	-0.51
							(5.91)	(1.77)	(0.52)
$\boldsymbol{\Gamma}^{[\boldsymbol{E}_{t-1}]}$	1.29*	0.74**	0.37***	1.26***	0.81***	0.50**	1.61**	2.12***	0.65
	(0.68)	(0.31)	(0.04)	(0.39)	(0.22)	(0.23)	(0.61)	(0.64)	(0.56)
$\boldsymbol{\Gamma}^{[\boldsymbol{\Lambda}_{t-1}]}$	3.33**	3.11***	-0.02	3.58**	1.96**	-0.09	4.27**	1.25*	-0.55
	(1.71)	(0.76)	(0.14)	(1.66)	(0.01)	(0.43)	(1.89)	(0.67)	(0.96)
$\boldsymbol{\Gamma}^{[\boldsymbol{\pi}^{oil}_{t-1}]}$	-1.27***	0.70**	0.52***	-0.46**	0.01	0.01	-1.85**	-1.14***	-0.24
	(0.39)	(0.28)	(0.07)	(0.22)	(0.15)	(0.15)	(0.73)	(0.39)	(0.35)
$\boldsymbol{\Gamma}^{[\boldsymbol{\pi}^{imp}_{t-1}]}$	-4.60	-15.62***	-10.92***	-1.97	-6.81***	-11.90***	-3.67	-13.64***	-20.56***
	(4.00)	(4.58)	(1.44)	(1.94)	(2.29)	(3.30)	(2.74)	(4.78)	(6.88)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}$	0.58***	0.75***	0.90***	0.55***	0.68***	0.72***	0.64**	0.78***	0.84***
	(0.12)	(0.15)	(0.23)	(0.08)	(0.07)	(0.10)	(0.25)	(0.18)	(0.12)
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}^{(\mathbf{1})/(+)}_{t-s}$	-16.78***	-2.51	0.91***	-9.58***	-0.35	-0.57**	-6.69***	0.98	-0.97***
	(3.78)	(2.28)	(0.17)	(2.01)	(0.84)	(0.27)	(0.88)	(0.79)	(0.24)
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}^{(\mathbf{2})/(-)}_{t-s}$	20.35***	12.06***	-0.63*	12.04***	3.51**	-0.13	-5.04***	-7.25***	0.55***
	(4.97)	(2.70)	(0.33)	(2.65)	(1.53)	(0.08)	(1.24)	(1.36)	(0.23)
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}^{(\mathbf{3})}_{t-s}$							9.52***	6.10***	-0.03
							(1.20)	(1.19)	(0.06)
$\sum_{s=0}^{8} \Delta\boldsymbol{E}_{t-s}$	-2.16***	-1.43***	-0.30**	-2.00***	-1.47***	-0.93***	-1.67***	-2.77***	-0.90***
	(0.24)	(0.26)	(0.11)	(0.25)	(0.29)	(0.15)	(0.21)	(0.34)	(0.13)
$\sum_{s=0}^{8} \Delta\boldsymbol{\Lambda}_{t-s}$	3.94*	8.27***	8.91***	3.15***	2.94**	4.25***	4.51***	5.30***	4.75***
	(2.13)	(2.90)	(1.06)	(1.26)	(1.10)	(0.94)	(1.06)	(1.36)	(1.34)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}^{oil}_{t-s}$	0.87*	-0.73***	-0.35*	0.02	-0.09	-0.49***	-1.26***	0.79***	-0.46***
	(0.48)	(0.23)	(0.19)	(0.17)	(0.12)	(0.13)	(0.18)	(0.21)	(0.09)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}^{imp}_{t-s}$	5.73***	6.63***	7.98***	6.05***	8.19***	14.40***	5.52***	7.17***	14.22***
	(1.92)	(1.52)	(1.68)	(1.42)	(2.11)	(3.43)	(0.72)	(1.91)	(2.55)
$\bar{\boldsymbol{R}}^{\mathbf{2}}$	0.52	0.60	0.62	0.58	0.65	0.61	0.68	0.72	0.63
RSS	0.12	0.11	0.12	0.13	0.11	0.14	0.10	0.07	0.12
AIC	-2.61	-2.78	-2.82	-2.72	-2.90	-2.82	-2.99	-3.17	-2.89
F-Test$_{(PSS)}$	12.86**	9.25**	16.70**	16.00**	7.96**	7.37**	20.92**	17.64**	8.55**
RESET	0.08	0.62	0.01	0.61	0.31	0.61	0.43	2.42	0.52
	[0.77]	[0.43]	[0.90]	[0.43]	[0.57]	[0.43]	[0.40]	[0.12]	[0.46]

Source: Author's computations based on data from the CBN, NBS and OECD database..

Note: Econometric estimation was conducted with *EViews 7.0* software using data are from 1985:Q1 to 2011:Q4. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *RSS* denotes residual sum of squares while *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F-test*($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using 5% asymptotic critical values from Pesaran *et al*. (2001). *RESET* is the *F*-statistic of Ramsey's specification error test using the squares of fitted residuals; *p*-values are in [ ].

In the short-run, declining positive gaps are perversely inflationary until it reaches 2.5 or 5.5 percents for $\tilde{y}\_W$ and $\tilde{y}\_N$, respectively, beyond which further declines become deflationary. For $\tilde{y}\_O$, declining gaps are also inflationary until output is 1.25 per cent below potential after which the gap-effect becomes insignificant. The results of the other short-run factors are also similar to those found in the preceding NARDL model. Nonetheless, the models diagnostics showed a slightly better fit for the T-ARDL[1] vis-à-vis the NARDL and ARDL models. Existence of long-run relationship is confirmed by the PSS F-test while the $RESET$ indicated no mis-specification. The $\bar{R}^2$, RSS and AIC also showed marginal improvement on the average. Tests of linearity, once more, rejected the null hypothesis both in the long- and the short-run; but could not reject the null of linearity in the long-run absolute values of the coefficients. This again suggested that the LR-PC is more-or-less horizontal though the SR-PC is positively sloped especially for $\tilde{y}\_W$ and $\tilde{y}\_N$. Row (B) of figure 7.5 illustrates the adjustment pattern following positive and negative shocks to output gap. Again, the plots of the dynamic multipliers supported the symmetry found in absolute values and the zero overall effect of AD on inflation. As in the NARDL, it takes over ten years for short-run disequilibrium to be fully adjusted.

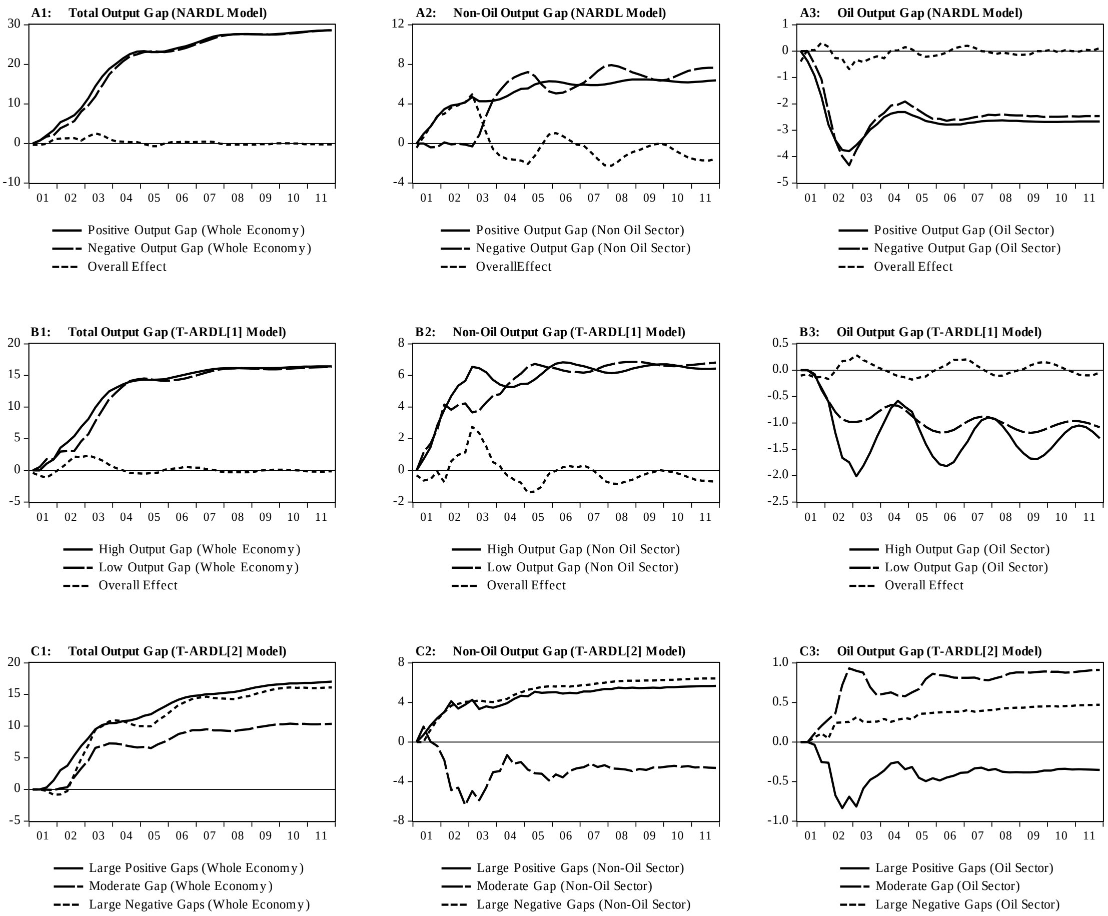
7.5.2.3 The Nonlinear T-ARDL[2] Model

The T-ARDL[2] comprised two unknown thresholds $\left(\tau^{(1)} > 0 > \tau^{(2)}\right)$ which are estimated sequentially. First, the positive threshold $\tau^{(1)}$ is obtained. Then, holding this constant, $\tau^{(2)}$ is estimated, after which $\tau^{(1)}$ is re-estimated. The thresholds $\left(\tau^{(\cdot)}\right)$ and the delay parameter (d) are estimated concurrently. Results of the grid search suggested that $\tau^{(1)} = 2.75; 5.50; 0.75$, and $\tau^{(2)} = -3.00; -0.75; -1.50$ for $\tilde{y}\_W$, $\tilde{y}\_N$ and $\tilde{y}\_O$, respectively, with $d = 0$. These are again validated with a likelihood ratio test.

Panel (C) presents the result of the T-ARDL[2] models. As in the NARDL and T-ARDL[1], the speed of adjustment (α) is significant with correct size and sign in all equations though marginally lower in the T-ARDL[2]. The long-run coefficients of $\tilde{y}$ are larger, in absolute terms, for the extreme regimes than the middle regime in all cases. Again, the coefficient are considerably larger for $\tilde{y}\_W$ than for $\tilde{y}\_N$ and $\tilde{y}\_O$. Furthermore, in the two extreme regimes, the absolute values of the coefficients, $\beta^{(1)}$

and $\beta^{(3)}$, are identical but with different signs. These suggested that large gaps are inflationary for $\tilde{y}\_W$ and $\tilde{y}\_N$, but deflationary for $\tilde{y}\_O$, irrespective of whether they are positive or negative gaps.

Figure 7.5: Dynamic Multipliers of the Nonlinear Models



In the middle regime, increasing output gaps are inflationary while falling gaps are deflationary for $\tilde{y}\_W$ and $\tilde{y}\_O$. The converse holds for $\tilde{y}\_N$. Hence for the whole economy, contractionary policy would moderate inflation only when output gap is above -3.00 per cent. If output gap falls below this threshold, then contractionary policy becomes inflationary. This is also the case for oil output gaps with an inflationary threshold of -1.50 per cent. For the non-oil sector, however, the implication is dire. Contractionary policy would reduce inflation only if output gaps are above 5.50 per cent. When output gaps are below this threshold contractionary policy would be counter-productive; policymakers should, thus, only react if non-oil output gap is excessively positive. Given the susceptibility of the non-oil sector to domestic policies, it means that effort should be made to maintain a mildly positive level of output gaps in the non-oil sector in order to rein-in inflation.

Nonetheless, the converse signs of the coefficients, $\beta^{(1)}$ and $\beta^{(3)}$, in the all three sectors, suggests that long-run inflation dynamics is essentially impervious to the scale and direction of output gap and that other factors may be more apt in the inflation process. As in the preceding models, the significant inflationary factors in the long-run are the exchange rate changes and excess capacity while oil prices and import prices dampen inflation. In the short-run, import price, excess capacity and inertia drive inflation while exchange rate and oil prices moderate inflation. Contractionary policies would be inflationary in $\tilde{y}\_W$ and $\tilde{y}\_N$ models when gaps are above -3.00 and -0.75 per cent, respectively.

The model diagnostics generally suggested a better fit than the preceding model. However, while the *Wald*-test suggested long-run asymmetry for $\tilde{y}\_W$ and $\tilde{y}\_N$, it could not reject the null for $\tilde{y}\_O$. In the short-run, the null hypothesis is not rejected in all models. Again, absolute value symmetry was found in the extreme regimes of $\tilde{y}\_W$ and $\tilde{y}\_N$. These findings are confirmed in the row (C) of figure 7.5 which showed somewhat symmetry in the adjustment path following shocks to $\tilde{y}\_O$, although these are perversely signed. For $\tilde{y}\_W$ and $\tilde{y}\_N$, positive and negative shocks are generally inflationary, however, for $\tilde{y}\_N$ it is deflationary in the middle regime. Hence, when non-oil output gap is moderate, negative shocks would increase inflation permanently. The effect would be largest in the first three years and would moderate in the fourth year.

7.6 Analysis of Findings

Based on the NCM principle that inflation is an AD phenomenon our prior expectation is that the coefficient of output gap is positive and significant both in the linear and the nonlinear cases. Concurrently, demand is expected to be the most prominent determinant of inflation. Given that macroeconomic policies are usually directed at the non-oil sector in Nigeria, since the oil sector is largely assumed to follow international factors, our analysis focus basically on the total and non-oil economy. The coefficients, in the total and the non-oil models are mostly found to be negative and in some cases zero. This is indicative of a slightly horizontal LR-PC similar to that found by

Kromphardt and Logeay (2011) for some industrialised economies. Our results nonetheless show that the inflation-output relationship is inverse and thus, perverse. This implied that economic expansions are not necessarily inflationary in a developing country like Nigeria.

Inflation is thus not an AD phenomenon but attributable to other factors. Exchange rate changes and slack capacity are consistently found to be the significant drivers of inflation in the long-run, while import prices and slack capacity determined inflation significantly in the short-run. These suggest that supply factors are the significant source of inflationary pressures and somewhat explains the negative coefficient found for output gap. Basically, supply shocks are more prominent than demand shocks, so that the supply curve is shifted to the left causing prices to rise while aggregate output declines. From the results above, the effects of these shocks are not transient as usually assumed but persist for more than a decade before disequilibrium is fully corrected.

The finding is not entirely surprising given the features of the Nigerian economy, which included high incidence of poverty. Food and other basic necessities constitute the bulk of the budget in an average Nigerian household. Besides, food constitutes over 60 per cent of the CPI basket. With poverty, demand for basic necessities (like food) would be inelastic to contractionary policies while supply-induced scarcity would fuel inflation. Contractionary policies would thus worsen domestic production and heighten inflation. The combination of poverty and the high weights of food in household budget and the CPI basket, thus, ensure that prices are supply rather than demand shock driven.

The results so far do not show the relative importance of the different variables. These are highlighted by the scaled coefficients in tables 7.4 and 7.5 below. Scaled coefficients are standardised from point estimates of parameters (in tables 7.2 and 7.3) by multiplying the estimated coefficient of a regressor by the standard deviation of the regressand and scaling by the standard deviation of the regressor. The resulting parameters confirm that exchange rate and excess capacity are the most important drivers of inflation in the long-run. Basically, a one-per cent increase in the rate of change of the exchange rate, would increase inflation by over 2.0 per cent on the average, while a one-per cent increase in excess capacity causes inflation to rise by about 1.3 per cent. In the short-run, the exchange rate has the highest, though perverse, impact. The most important inflationary factor in the short-run is import prices which one-per cent shock induces a 1.2 per cent rise in inflation. In all, output gap have a comparatively modest contribution which usually cancelled out in the nonlinear models.

Table 7.4: Scaled Coefficients of the Linear Models

	(A) Simple PC			**(B) Supply-Augmented PC**		
	Whole Economy	***Non-Oil Sector***	***Oil Sector***	***Whole Economy***	***Non-Oil Sector***	***Oil Sector***
	(1)	(2)	(3)	(4)	(5)	(6)
$\boldsymbol{\beta}$	-0.50	-0.46	-0.25	0.05	-0.31	1.34
$\boldsymbol{\Gamma}^{[E_{t-1}]}$				2.34	2.49	2.64
$\boldsymbol{\Gamma}^{[\Lambda_{t-1}]}$				0.45	0.83	0.71
$\boldsymbol{\Gamma}^{[\pi_{t-1}^{oil}]}$				-0.64	-0.73	-0.54
$\boldsymbol{\Gamma}^{[\pi_{t-1}^{imp}]}$				-0.33	-0.47	-1.58
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}$	0.57	0.41	0.35	0.51	0.60	0.63
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}_{t-s}$	-0.14	0.20	-0.10	-0.77	-0.17	-0.36
$\sum_{s=0}^{8} \Delta\boldsymbol{E}_{t-s}$				-2.64	-2.72	-2.82
$\sum_{s=0}^{8} \Delta\boldsymbol{\Lambda}_{t-s}$				0.28	0.27	0.39
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}^{oil}$				-0.96	-1.07	-1.13
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}^{imp}$				1.19	1.28	1.47

Source: Author’s computations based on data from the CBN, NBS and OECD database.

However, results from the preceding section suggests that the T-ARDL[2] outperformed the others and that the overall impact across its regime is not necessarily zero. While the coefficients in the two outer regimes cancelled out that in the middle regime presented significant ramification for policy. For the whole economy, disinflationary policy would be effective for large positive gaps but would generally become counter-productive for gaps below -3.00 per cent. In this regard, as long as output gap is above this threshold, a one-per cent contraction in the economy would reduce inflation by 1.6 per cent which is less than the 2.7 per cent impact of exchange rate, and 1.8 per cent for excess capacity. However, much of the inflation-output connection observed for the aggregate economy may be due to the oil sector. Considering the non-oil sector, the nonlinearity in the relationship indicated that disinflationary policies are only effective when gaps are above 5.5 per cent. Policies that reduce gaps below this level would be inflationary. Examination of figure 7.2

shows that this threshold is in the eightieth percentile, which means that for 80 per cent of the data, contraction of non-oil output is inflationary.

Table 7.5: Scaled Coefficients of the Nonlinear Models

	(A) NARDL Model			(B) T-ARDL[1] Model			(C) T-ARDL[2] Model		
	Whole Economy	*Non-Oil Sector*	*Oil Sector*	*Whole Economy*	*Non-Oil Sector*	*Oil Sector*	*Whole Economy*	*Non-Oil Sector*	*Oil Sector*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\beta}^{(1)/(+)}$	1.56	1.07	-0.38	1.40	1.06	0.26	1.65	1.26	0.21
$\boldsymbol{\beta}^{(2)/(-)}$	-1.56	-1.07	0.38	-1.40	-1.06	0.21	1.61	-1.24	0.12
$\boldsymbol{\beta}^{(3)}$							-1.65	-1.26	0.10
$\boldsymbol{\Gamma}^{[E_{t-1}]}$	2.14	1.59	0.62	2.09	1.35	0.79	2.67	3.51	1.08
$\boldsymbol{\Gamma}^{[\Lambda_{t-1}]}$	1.47	1.37	-0.01	1.58	0.86	-0.03	1.88	0.55	-0.24
$\boldsymbol{\Gamma}^{[\pi_{t-1}^{oil}]}$	-1.85	1.03	0.76	-0.67	0.01	0.02	-2.70	-1.67	-0.36
$\boldsymbol{\Gamma}^{[\pi_{t-1}^{imp}]}$	-0.58	-1.99	-1.39	-0.25	-0.87	-1.44	-0.47	-1.74	-2.62
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}$	0.59	0.76	0.90	0.55	0.69	0.74	0.66	0.80	0.86
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}_{t-s}^{(1)/(+)}$	-1.05	-0.25	0.14	-0.55	-0.02	-0.05	-0.39	0.05	-0.15
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}_{t-s}^{(2)/(-)}$	1.69	1.24	-0.05	1.07	0.36	-0.01	-0.14	-0.16	0.02
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}_{t-s}^{(3)}$							0.82	0.60	-0.00
$\sum_{s=0}^{8} \Delta\boldsymbol{E}_{t-s}$	-6.38	-4.24	-0.95	-5.29	-4.33	-2.28	-4.94	-8.19	-2.03
$\sum_{s=0}^{8} \Delta\boldsymbol{\Lambda}_{t-s}$	0.47	0.99	1.05	0.37	0.34	0.50	0.53	0.63	0.56
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}^{oil}$	2.50	-2.13	-1.43	0.06	-0.28	-1.44	-3.65	2.25	-1.35
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}^{imp}$	1.12	1.32	1.56	1.18	1.60	2.82	1.08	1.40	2.78

Source: Author's computations based on data from the CBN, NBS and OECD database.

The implication of these for NCM-type monetary policy in Nigeria is that since inflation is not inherently an AD phenomenon, attempts to disinflate using contractionary measures would be counter-productive and would cause inflation to spiral probably out of control. Rather than contract, policy should aim to enhance AS. As noted earlier, data from the NBS suggested that unemployment is rising, while the economy is growing. This is indicative of inadequate supply and capacity underutilisation. Essentially, scarcity drives inflation, but these shortages are not due to excess demand. Part of the causes of slack capacity in the economy is the dearth of essential and basic public infrastructures like electricity, water and security, which makes firms to provide for these in-house. These firms have to procure large generators which are very expensive to purchase and maintain. The costs of providing own security and other amenities are also high. Therefore, these secondary factors heighten costs of locally produced commodities thereby making imports a cheaper option. When import prices rise local production, by increasing domestic supply, removes pressure from the exchange rate and causes inflation to fall.

Accordingly, the task of macroeconomic policy should be to boost local production and supply. Nigeria is an import dependent country mostly for the reason of poor infrastructure mentioned earlier. This import dependence explains to some extent the prominent role of exchange rate in the inflation process. While monetary policy cannot provide infrastructure it can boost local production by increasing the availability of long-term credit to the real sector and by lowering interest rate. This would dampen the cost of capital and provide more funds for investment. These cheap funds would translate into cheaper domestic prices and larger domestic supplies. Since, the central bank does not lend to the public, it can encourage lending to productive sectors by guaranteeing such loans provided that banks have done due-diligence with the credit appraisal. Increased local production would thus reduce slack capacity and would translate into lower unemployment.

Under the NCM, disinflationary policies are undertaken by contracting demand so that the cost of disinflation is seen as the amount of output sacrificed. In this case it can be computed as the reciprocal of the coefficient of the output gap to show the percentage sacrifice of output per percentage point decline in inflation. However, when this coefficient is negatively signed, the cost of disinflation becomes large and complicated. In this regard, disinflationary policies would contract output but rather than moderate inflation would accelerate inflation. Tables 7.6 present implied costs of disinflation. The figures in italics are derived from individual coefficients while those in bold-format are derived from the average of the coefficients in respective models.

For the entire economy, the coefficients are not consistently signed. In the T-ARDL[2] model, again due the effect of the oil sector, the table shows that a one-percentage point fall in inflation only requires the output gap to reduce by 0.25 per cent overall. During overheating, when output is above the threshold, however, the cost is even less, at 0.05 per cent. For the non-oil sector, the coefficients are mostly negative, which means that policy induced contractions in non-oil output will create further inflationary pressure. In the T-ARDL[2] model, for gaps above 5.5 per cent, contractionary policy required the sacrifice of 0.17 per cent in the growth rate for every one percentage point of disinflation. This does not seem too costly a sacrifice to make. However, output gap is mostly below this threshold. The average picture for the T-ARDL[2] non-oil model thus suggests that contractionary policy which slows demand by 0.92 per cent would also cause a one-per cent rise in inflation; therefore, causing more harm than good.

Table 7.6: Implied Costs of Disinflation

	Whole Economy	*Non-Oil Sector*	*Oil Sector*
Simple ARDL	**-0.41**	**-0.51**	**-1.16**
$1/\beta$	*-0.41*	*-0.51*	*-1.16*
Augmented ARDL	**3.68**	**-0.75**	**0.22**
$1/\beta$	*3.68*	*-0.75*	*0.22*
NARDL	**-30.70**	**-2.34**	**-9.92**
$1/\beta^{(+)}$	*0.03*	*0.15*	*-0.37*
$1/\beta^{(-)}$	*-0.03*	*-0.13*	*0.40*
T-ARDL[1]	**15.46**	**-9.60**	**-7.45**
$1/\beta^{(1)}$	*0.06*	*0.15*	*-0.74*
$1/\beta^{(2)}$	*-0.06*	*-0.14*	*0.92*
T-ARDL[2]	**0.25**	**-0.91**	**23.84**
$1/\beta^{(1)}$	*0.05*	*0.17*	*-3.07*
$1/\beta^{(2)}$	*0.09*	*-0.40*	*1.03*
$1/\beta^{(3)}$	*-0.05*	*-0.15*	*-1.93*

Source: Author's computations based on results in tables 7.2 and 7.3 above.

Overall, the analysis revealed that the LR-PC is not vertical but somewhat horizontal. This implies that irrespective of the level of output gap, inflationary pressures may persist or dissipate due to other non-demand factors. Hence, inflation in Nigeria is not an AD but rather an AS phenomenon. The negative sign found on most of the output gaps coefficients can be interpreted to mean that supply shocks are more prominent than demand shocks, thereby weakening the NCM assertion. Generally supply factors especially exchange rate and excess capacity are found to be the most important drivers in the long-run while import prices and excess capacity are the determinants in the short-run. The findings on the excess capacity, have very important ramification for policy. Macroeconomic policies should endeavour to boost capacity utilisation. Since, the low capacity utilisation may be traced to the inadequate supply of public infrastructure which has the attendant effect of increasing cost of production, monetary policy should aim to reduce cost by ensuring lower lending rates and increased availability of credits to the productive sector. This will not only increase supply but would also ensure that domestic products can compete with imported counterparts. The offshoot of this is the reduced unemployment and enhanced social welfare. Basically attainment of higher social welfare would be Pareto optimal since the inflation-output trade-off is inexistent from the results.

The policy implication of the NCM is that the central bank should focus on long-run price-stability and short-run output stabilisation. This implies an optimisation procedure with inflation minimisation as the objective function and output as the constraint. However, our findings suggests that for a developing countries like Nigeria, it may be more beneficial if the role is defined the other way round so that output growth maximisation becomes the long-run objective and inflation the short-run constraint. In this regard, the central bank role should be to encourage economic expansion and employment creation in the long-run while reducing inflation variability in the short-run.

7.7 Conclusion

In this chapter we investigated the inflation-GDP connection in Nigeria and its consequences for monetary policy using a PC. Recently, the CBN mandate was amended to designate inflation as the overriding objective of monetary policy. Consequently, the CBN began active use of the short-term interest rate as policy instrument. This is consistent with the tenets of the NCM with the underlying assumption that inflation is an AD phenomenon and AS effects are temporal. Based on the consequences of inflation for the economy, an NCM-type policy is actively anti-inflation and contractionary irrespective of the source of inflation. However, the cost of disinflation would be excruciating if output loss is permanent or if inflation is supply- rather than demand-driven in the long-run. In this case, NCM-type anti-inflationary policies would lower the growth path and economic capacity permanently. For many developing countries this may be the case given the prevalence of supply over demand shocks and the allocative inefficiencies which characterise these countries.

By estimating linear and nonlinear-ARDL models, we found that the LR-PC is not vertical but almost horizontal with a negative slope. This is due to the negative and sometimes insignificant coefficient found for the output gap in most cases. The finding of a slightly horizontal relationship resembles that of Kromphardt and Logeay (2011), although ours was perversely signed. Our results thus suggest, first, the absence of long-run neutrality assumed by the NCM and, second, that inflation is not due to domestic expansions of output but to non-demand factors. Basically the most important long-run drivers are exchange rate and domestic spare capacity while import prices and spare capacity are germane in the short-run. Results of the nonlinear analysis also indicated that inflation-output relationship changes with the level of output gap, although the overall impact is zero. The PC in this regard is generally found to be "V-shaped" both for the whole economy and the non-oil sector. Thus, for gaps above some threshold expansions are inflationary while for gaps below it contractions are inflationary. This implies that, inflationary pressures subsist irrespective of whether gaps are positive or negative, thereby confirming that inflations are not demand-push. Besides, it suggests that anti-inflation contractionary policies are not necessarily disinflationary in Nigeria but inflationary. This has important implications for monetary policy.

Even when gaps are above threshold so that expansions are inflationary, the estimated upper threshold (especially for the non-oil sector) at 5.5 per cent has dire ramifications. Above this threshold the relationship is positive but becomes negative below it. Hence, when non-oil gaps are above 5.5 per cent it pays to pursue contractionary policies but when it is below this threshold expansionary policies are beneficial. However, the data indicate that over 80 per cent of non-oil output gaps occur below this threshold. By implication 80 per cent of monetary policy decision should be expansionary as this would deliver both the desired lower inflation and the economic growth.

The finding is not entirely surprising given the features of the Nigerian economy, which included high incidence of poverty, spare capacity and inadequate productive infrastructures. Food and other basic necessities constitute the bulk of the budget in an average Nigerian household. Besides, food constitutes over 60 per cent of the CPI basket. With poverty, demand for necessities like food would be inelastic to contractionary policies while supply-induced scarcity would fuel inflation. Contractionary policies would thus worsen domestic production and heighten inflation. The combination of poverty and the high weight of food in budget and CPI basket thus ensure that prices are supply rather than demand shock driven. Besides, the inadequate provision of public infrastructures like electricity increases domestic cost, hampers competition with imported goods and reduces domestic capacity utilisation. This causes supply constraints which heightens inflation. While a lot of agricultural produce are imported in Nigeria, several locally consumed food are perishable and somewhat non-tradeable. This requires domestic production to fill the gap and dampen supply-induced inflation.

Accordingly, the task of macroeconomic policy should be to boost local production and supply. Nigeria is an import dependent country mostly for the reason of poor infrastructure mentioned earlier. This import dependence explains to some extent the prominent role of exchange rate in the inflation process. While monetary policy cannot provide infrastructure it can boost local production by increasing the availability of long-term credit to the real sector and by lowering interest rates. This would dampen the cost of capital and provide more funds for investment. These cheap funds would translate into cheaper domestic prices and larger domestic supplies. Since, the central bank does not lend to the public, it can encourage lending to productive sectors by guaranteeing such loans provided that banks have done due-diligence with the credit appraisal. Increased local production would thus reduce slack capacity and would translate into lower unemployment.

GENERAL CONCLUSIONS

For many countries – developing or developed – monetary policy remains a tool for macroeconomic management, the design of which has increasingly followed the propositions of the NCM; with the short-term nominal interest rate as the sole policy instrument and price-stability as its overriding objective. While this approach may be effective in combating inflation, the associated cost remains an area of concern, particularly for developing countries where the costs may be even be higher. According to its proponents, the cost of NCM-type policy is the momentary (and negligible) depression of aggregate demand and economic growth while the benefit is the permanent bliss of low and stable inflation (and the ensuing permanent economic growth). However, the costs may be enormous in terms of permanent loss of economic growth, entrenched unemployment, and financial fragility which may result from constant fine-tuning of the interest rate. Generally, an optimal policy should be both effective and achievable at minimal costs in terms of general economic wellbeing.

Standard discussions of this type of monetary policy do not distinguish between developed and developing countries (Huang and Wei, 2006); thus, implying that the cost-benefits are comparable across countries. Hence many developing countries have joined advanced ones in adopting an NCM-type monetary policy. However, developing countries are idiosyncratically different from advances ones and their institutional features do not support much of the underlying assumptions and conclusions of the NCM approach. For instance, the NCM subtly assumes that financial markets are developed enough to transmit policy impulses to the rest of the economy, and that the economy continually operates about full potential. Hence, supply constraints are assumed non-existent and equilibrium is supply-determined, so that supply shocks are transitory and inflation is exclusively a demand phenomenon. These are generally at variance with the realities of many developing countries. Again, the objective of price-stability usually defined as an inflation rate of about 2 per cent has been criticised especially for developing countries. While the proponents of this objective argue that this level of inflation is optimal since it simultaneously averts the adverse consequences of inflation and deflation, critiques like Khan and Senhadji (2001) and Pollin and Zhu (2006) argued that, for developing countries, moderate level of inflation are beneficial to growth since the adverse effects emerge when the rate exceeds 18 per cent. Generally, we argue that NCM-type policy is not only costly, but the costs are extremely dire for developing countries which need enhanced growth, lower unemployment and more financial stability.

In Nigeria, like many developing countries, what constitutes an optimal monetary policy is yet to be fully appreciated; although the prevailing practice is somewhat congruous with the NCM, where policy rates are hiked in the face of inflationary pressure. This is with a view to first and foremost affect components of aggregate demand. Although average inflation rate most recently hovered around 11-12 per cent, efforts are continually directed at lowering this further (irrespective of its associated costs) given that price-stability, in Nigeria, is defined as 0-9 per cent rate of inflation. In the medium term, the CBN (in order to achieve this rate) plans to migrate to a full-fledged IT framework which entrenches the interest rate and the inflation rate, respectively, as the sole instrument and objective of monetary policy. This would entail the announcement of a specific inflation target around which the effectiveness of the Bank's policy actions would be judged. Adopting IT entails credibility of the CBN, an adequate understanding of the transmission mechanism of monetary policy and the willingness to sacrifice other objectives (such as economic growth and employment) for the attainment of price-stability.

Generally, Nigeria is characterised by weak institutional features, underdeveloped financial sector, fiscal dominance, high incidence of poverty, high unemployment, low capacity utilisation, and a complexly dichotomised (according to oil versus non-oil, formal versus informal, etc.) economy. These, jointly and/or independently, debilitate the conduct of monetary policy, diminish its reliability and heighten its associated cost. Besides, inadequate knowledge of the economic system and uncertainty about the transmission mechanism constitutes a major challenge to monetary policy in Nigeria (Uchendu, 2009a). This incomplete understanding – exacerbated by the existence of a vibrant and underestimated informal sector – is both with respect to the effectiveness and costs of monetary policy. These are believed to contribute to the volatility and slow economic growth in Nigeria (Batini, 2004, Balogun, 2007).

Earlier studies on the design of monetary policy in Nigeria have generally tended to study the effectiveness assuming money supply as the policy instrument. In this regard, Feridun *et al*. (2005) found that monetary policy resulted in increased instability in inflation and exchange rate in Nigeria. However, Olubusoye and Oyaromade (2008), Adam and Goderis (2008) attributed this instability to the disrupting effect of crude oil price volatility on the CBN's efforts. Essentially, crude oil price volatility impacts on monetary policy through its impact on the fiscal revenue and monetary expansion. The dominance of the fiscal sector and the continued monetisation of crude oil receipts creates liquidity in the system and heats up the economy. Hence, in measuring the effects monetary policy in Nigeria, Chuku (2009) concluded that the monetary authority should place more emphasis on quantity-based anchors as against price-based ones. In a recent study, Dada (2011) investigated the suitability of an IT framework in Nigeria via a nonlinear IS-LM framework which assumes monetary growth as the CBN policy variable, and found that IT increases output variability. However, the reality is that the hitherto QTM approach which underlies these studies is obsolete, given the realisation that money cannot be exogenously controlled by the central bank. Hence, monetary policy is not synonymous with managing the level and growth money supply, and policy effectiveness does not depend on the ability to control money.

In this study, the effectiveness and costs of an NCM-type monetary policy in Nigeria is investigated using innovative econometric techniques. The thesis provides a systematic study of the effect of monetary policy in Nigeria paying attention to the peculiarities of the Nigerian economy. Consistent with the overall objectives of the thesis, effectiveness (investigated in two-folds) and costs of monetary policy are analysed in three empirical chapters; each of which was undertaken with a rigorous application of up to date techniques. The nonlinear techniques that we utilised enabled us to examine issues usually raised with respect to the asymmetric outcomes in the conduct of monetary policy. Compared with other studies (like Akerlof *et al.*, 2000; Beccarini, 2007; Dada, 2011; Filardo, 1998; Gropp *et al*., 2007; Hoffman and Mizen, 2004; Khan and Senhadji, 2001; Pollin and Zhu, 2006; and Sørensen and Werner, 2006) most of which employed a single threshold to determine either size or sign asymmetry in the long- or short-run, we model nonlinearity in way that allows for the possibility of multiple inflection points, the determination of size and sign asymmetry, as well as the concurrent modelling of long- and short-run relationships.

To determine policy effectiveness, first, the NCM assumption of a complete pass-through from policy rate to market rate (which is critical for the success of monetary policy) is examined. Here an array of market, retail deposit and lending rates are examined while attempt was made to also capture the role of financial market (under)development. Second, the effectiveness of monetary policy on aggregate demand is investigated given that it constitutes the intermediate target of policy. Given the high incidence of poverty in Nigeria and our associated assumption that consumption would, in this case, be inelastic to policy changes, the aggregate demand effect is limited to investigating the responsiveness of investment to monetary policy induced changes in interest rate. Here, a range of investment theories are examined with a view to determining the relative importance of monetary policy in the economy, using a rigorous framework. Finally, the cost and benefit analysis of monetary policy in Nigeria is investigated by estimating an NCM-PC. To understand the dynamics and source of inflation the standard NCM-PC is augmented with supply factors. The relative importance of demand vis-à-vis supply factors as well as the cost and benefits of disinflation are thereafter determined. The findings from these provide answers to the research questions of this study and are summarised as follows.

a) *Monetary policy generally does not effectively anchor interest rates in Nigeria; an ineffectiveness that has deteriorated with time*. Specifically, the findings reveal that while the interest rate pass-through overshot for lending rate it was incomplete for deposit rate. These inexact responses pose a dilemma for policymakers as the policy outcome may be indeterminate. Besides, the interbank market was found to provide a weak anchor between monetary policy rate and retail rates; thereby further diminishing the effectiveness of monetary policy which is designed to be transmitted via the interbank market. Analysis of the time-varying pass-through parameter indicated that the ability of monetary policy to influence market rates has dwindled over time; the most recent parameter being the weakest. These, suggest that monetary policy may not be exactly effective in Nigeria and could be attributable to the nature and structure of the financial market. The Nigerian financial market is oligopolistic and is dominated by few DMBs. These banks possess market power to administer prices and ration credit in ways that enable them to maximise profits.

Overall, the analysis indicated that pass-through was stronger from policy to retail rates. However, the size of pass-through both in the short- and long-run had diminished over time. Thus, monetary policy (in the form of interest rate policy) had become weaker with time and the response lag of policy is increasing. While the inability of the interbank to anchor retail rates may essentially pose no threat, the considerable market power of commercial banks in price determination had an adverse effect on the pass-through process. This may be reflective of the inadvertent exclusion of non-bank private sector from the money market and low substitutability to banks' products. In essence, for interest rate policy to be effective in Nigeria there is need to ensure that financial markets are deepened, so that all players and agents have considerable access to the market, and there is a wide array of instruments and securities to choose from. Secondly, the CBN may need to de-emphasise its focus on the interbank market as it is more-or-less redundant in the monetary policy transmission process.

b) *NCM-type monetary policy is ineffective for policy rates changes below 125 basis points.* Generally, the impact of interest rate policy on aggregate demand is targeted mainly at its private consumption and private investment components. The NCM-AD equation is derived from household time-optimised consumption behaviour while firms investment behaviour are suppressed (Arestis and Sawyer, 2008a; 2008b). However, with the high incidence of poverty in Nigeria, an NCM-type policy would not affect consumption, since this would mostly constitute necessities which are essentially inelastic. Hence, monetary policy adjustments would be ineffective for consumption, irrespective of the magnitude of change but may affect private sector investments. The effect of monetary policy on private investment differs for the oil vis-à-vis the non-oil sector. While oil sector decisions are driven largely by international developments, exogenous to monetary policy, the non-oil sector are the principal target of policy decision. Nonetheless, policy adjustments would only be effective if rates were altered considerably (e.g. between 100-150 basis points). Generally, the practice of monetary policy is to adjust interest rates gradually by about 25-50 basis points. Empirical analysis, however, indicated that such in changes would have no significant impact on private investment; and hence no effect on aggregate demand.

Basically, private investment in Nigeria is principally explained, in long-run, by other non-monetary factors especially public investments, which have complementary effects. Again, we found that the availability of credit had important implications for private investment. Lack of adequate long-term credit lowers investments in the long-run. However, in the short-run when short-term external financing options are available the relationship becomes positive. This is reflective of the notion of construction (initial) financing and investment (final) financing discussed in Davidson (1982), Graziani (2003) and Lavoie (2009), and may be underpinned by the fact that Nigerian banks are willing to provide short-term financing and reluctant to avail long-term credits.

Overall, the implications of the results for monetary policy in Nigeria are critical. The nonlinearity found in the investment-interest rate relationship suggests that policy may have perverse and undesirable impact on investment, aggregate demand and the economy in general; especially if the thresholds for this nonlinearity are ill understood. More importantly, while gradual policy rate adjustments would have ineffective impact, a 'cold-turkey'-type large adjustments can increase uncertainties, financial fragility and undesirable effects in other sectors of the economy; thereby constituting a dilemma for the central bank.

c) *The cost of an NCM-type policy can be considerably high for Nigeria.* Results from our three empirical chapters indicate that an interest rate based monetary policy aimed at curbing inflation via the AD can increases the challenges of the Nigerian economy rather than improve overall wellbeing.

First, analysis of the pass-through suggested long-run positive asymmetry in lending rates. This indicated that while policy rate hikes were more readily incorporated into lending rates, banks were reluctant to reflect rate cuts. Hence, if the policy adjustments were considerable, then aggregate demand is contracted to a larger degree than it is expanded. This has the prospect of keeping economic growth perpetually under per.

Second, related to this is the finding that policy rate hikes reduces private non-oil investment to a larger proportion than the bolstering effect of an equally sized rate cut. The result showed that the reducing effect of tight policies on non-oil investments were large and sustained while recovery due to easy policy were smaller and transitory. Though moderate rate changes would not affect non-oil investment, accelerated changes would have an overall reducing effect in the long-run. Hence, even if lending rate pass-through were symmetric, contractionary policy would depress aggregate demand permanently regardless of whether such policy is reversed immediately. The implication of this for monetary policy under the NCM is that, in aggressive drive to control inflation, the growth path of an economy might be lowered permanently. For a developing country like Nigeria, this would further retard the development prospect for any given investment multiplier.

Third, the finding that monetary policy rate is only effective at low levels of interest rate and/or when rate changes are considerably large has implications for financial stability. An effective policy may require that rates be doubled or halved; thus, creating distortions, uncertainties and speculations in the economy. This result as well as the tendency to frequently adjust interest rate would lead to the Minskyan-type financial fragility.

Finally, and more importantly, analysis of the Phillips curve showed a non-vertical long-run curve. In fact, the long-run Phillips curve was found to be slightly negatively sloped. The slanted nature of the Phillips curve implied that monetary policy is non-neutral in the long-run while the negative slope indicated that inflation is not necessarily a demand phenomenon. Indeed further analysis revealed that inflation in Nigeria is largely driven by supply-side factors like capacity underutilisation and exchange rate. Combined, these implied that using aggregate demand management measures to control inflation would not only have adverse consequences, but these would be permanent. Besides, it suggests that anti-inflation contractionary policies are not necessarily disinflationary in Nigeria but inflationary. An expansionary monetary policy would thus have an overall effect of increasing growth, employment, stability while reducing inflation in the long-run.

These findings and their policy implications are not entirely surprising given the institutional features of the Nigerian economy. They generally suggested that the use of interest rate policy tended to create more problems than it can solve. Hence, to avert the associated problems, there is need for other instruments which the central banks can control effectively. Moreover, monetary policy focus should be long-run output expansion and short-run price-stability, rather than the converse. This would have the benefit of lowering poverty and unemployment.

Accordingly, policy should be directed at boosting local production and supply. Nigeria is an import dependent country mostly for the reason of poor infrastructure mentioned earlier. This import dependence explains to some extent the prominent role of exchange rate in the inflation process. While monetary policy cannot provide infrastructure it can boost local production by increasing the availability of long-term credit to the real sector and by lowering interest rates. This would dampen the cost of capital and provide more funds for investment. These cheap funds would translate into cheaper domestic prices and larger domestic supplies. Since, the central bank does not lend to the public, it can encourage lending to productive sectors by guaranteeing such loans provided that banks have done due-diligence with the credit appraisal. Increased local production would thus reduce slack capacity and would translate into lower unemployment. Overall, given the numerous challenges confronting the Nigerian economy, an optimal policy design should follow a multi-instrument-multi-target approach rather than focusing exclusively on one-instrument-one-target approach of the NCM.

However, determining the set of variables that qualify for the multi-instrument-multi-target would require further analysis. Here, our analysis indicate that the interest rate is an ineffective instrument in Nigeria while inflation is a sub-optimal objective and we suggested credit policy and economic growth as preferred instrument and target, respectively. However, it would be beneficial to analyse in detail the effectiveness and implication of this approach. This may require some further estimation in addition to calibration and simulations of our results. In addition, the viability of other variables like exchange rate as an instrument may also need to be explored. In essence, future work can concentrate on the determination of optimal policy alternatives for the Nigerian economy.

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APPENDICES

Appendix 5.1: Kalman Filter and the State-space Models

The Kalman filter is a recursive algorithm for computing efficient estimate of a state vector conditioned on appropriate information set (in the form of the observed data). It obtains conditional forecasts of the state vector $\{a_t\}$ based on available or observed data at time $t-s$. Assuming that $s=1$ the minimum mean square error estimate of $\{a_t\}$, which is conditional expectation of $\{a_t\}$ based on information set available at $t-1$, is then provided as

$$a_{t|t-1} \equiv E(a_t|\Omega_{t-1}) \qquad \text{(A5.1)}$$

where the information set is

$$\Omega_{t-1} = (x_{t-1}, x_{t-2}, \cdots, x_1, \cdots, \boldsymbol{Z}_{t-1}, \boldsymbol{Z}_{t-2}, \cdots, \boldsymbol{Z}_1) \qquad \text{(A5.2)}$$

If the assumption of normality is violated $a_{t|t-1}$ then becomes the minimum mean square estimate of $\{a_t\}$. The mean square error (MSE) is obtained as

$$P_{t|t-1} \equiv E\big[(a_t - a_{t|t-1})(a_t - a_{t|t-1})'\big] \qquad \text{(A5.3)}$$

which is the conditional variance matrix of $\{a_t\}$ based on information set available at $t-1$.

The recursive process of the Kalman filter begins with specifying the initial values for the state $a_{1|0}$ and the variance matrix $P_{1|0}$ which are then used to predict the conditional mean and variances of the state vector in the next period. Even when these initial values are unknown, Koopman, Shephard and Doornik (1999) showed that it is optimal to set $a_{1|0} = 0$ and $P_{1|0} = 10^6$ where the high initial conditional variance accounts for uncertainty about the values. This process continues recursively for the sample span. The sequence of recursion can follow a basic filtering process or a fixed interval smoothing method. While the basic filter obtains $\{a_t\}$ based on information available at time *t*, the smoothing process uses information available for the entire *T* periods of the sample. Using this available information set, the predicted value of Δr_t can be derived as

$$\Delta r_{t|t-1} = E[\Delta r_t|\Omega_{t-1}] = x_t a_{t|t-1} + \boldsymbol{\Theta} \qquad \text{(A5.4)}$$

where $$\boldsymbol{\Theta} = \Phi + \boldsymbol{\Xi}'\boldsymbol{Z}_t \tag{A5.5}$$

so that the prediction error is

$$\epsilon_{t|t-1} = \Delta r_t - \Delta r_{t|t-1} \tag{A5.6}$$

and the prediction error variance is

$$\tilde{F}_t = F_{t|t-1} = E\left[\epsilon_{t|t-1}^2\right] = x_{t-1}P_{t|t-1}x_{t-1}' + R \tag{A5.7}$$

Having obtained the estimates of the parameters and with the knowledge of the hyperparameters, the model may then be evaluated using prediction error decomposition. This implies that if the observations are normally distributed, as long as the prediction error and the associated prediction error variance are known, the value of the log likelihood function can be easily derived (Kim and Nelson, 1999). If the distribution of $\{a_1\}$, $\{\eta_t\}$ and $\{v_t\}$ are Gaussian, then the conditional distribution $\Delta r_t|\Omega_{t-1}$ is also Gaussian so that

$$\Delta r_t|\Omega_{t-1} \sim N\left(\Delta r_{t|t-1}, \tilde{F}_t\right) \tag{A5.8}$$

Under this assumption the log likelihood function can be expressed as

$$\log L = -\frac{T}{2}\log 2\pi - \frac{1}{2}\sum_{t=1}^{T}\log\tilde{F}_t - \frac{1}{2}\sum_{t=1}^{T}\epsilon_{t|t-1}'\,\tilde{F}_t^{-1}\,\epsilon_{t|t-1} \tag{A5.9}$$

which is then evaluated by the Kalman filter and maximised iteratively with respect to the unknown parameters.

Appendix 5.2: Linear-ARDL Policy Rate Pass-through without Exogenous Variables

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	> 1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	0.12 (0.86)	0.09 (0.10)	0.02 (0.19)	0.18 (0.27)	0.49 (0.37)	0.23 (0.28)	0.32 (0.27)	0.40 (0.32)	0.67** (0.31)	0.80** (0.39)
$\boldsymbol{\alpha}$	-0.37*** (0.08)	-0.01 (0.00)	-0.05** (0.01)	-0.07*** (0.03)	-0.11*** (0.04)	-0.08** (0.03)	-0.09*** (0.03)	-0.12*** (0.03)	-0.08*** (0.02)	-0.07** (0.03)
$\boldsymbol{\delta}$	0.37*** (0.11)	0.001 (0.007)	0.01 (0.01)	0.05** (0.02)	0.06** (0.03)	0.06* (0.03)	0.06** (0.03)	0.09*** (0.03)	0.07** (0.03)	0.06 (0.04)
$\boldsymbol{\beta}$	1.00*** (0.16)	0.15 (0.76)	0.61 (0.42)	0.70*** (0.24)	0.61*** (0.19)	0.74*** (0.23)	0.68*** (0.19)	0.72*** (0.16)	0.84*** (0.20)	0.82*** (0.33)
$\boldsymbol{\gamma_0}$	0.61* (0.36)	0.25*** (0.06)	0.35*** (0.11)	0.38*** (0.14)	0.51*** (0.16)	0.45*** (0.12)	0.47*** (0.12)	0.60*** (0.15)	0.69*** (0.21)	0.79*** (0.26)
$\sum_{j=0}^{12} \boldsymbol{\gamma_j}$	2.46** (0.97)	0.32*** (0.06)	0.43*** (0.12)	0.55*** (0.13)	0.51*** (0.16)	0.61*** (0.12)	0.59*** (0.14)	0.74*** (0.18)	0.69*** (0.21)	0.89*** (0.25)
$\sum_{j=1}^{12} \boldsymbol{\psi_j}$	0.23*** (0.07)	0.09* (0.05)	0.09** (0.04)		0.21** (0.09)		0.15** (0.07)	0.15** (0.06)	0.12* (0.06)	0.05* (0.02)
$\bar{R}^2$	0.21	0.12	0.19	0.15	0.21	0.15	0.16	0.22	0.34	0.31
AIC	5.71	2.13	2.31	3.04	3.14	3.27	3.29	3.68	3.05	3.40
$F\text{-}Test_{(PSS)}$	9.48**	1.16	2.09	4.30	3.68	2.92	4.46	6.56**	4.61	3.06
$\boldsymbol{\beta = 1}$	YES	NO	NO	YES	NO	YES	YES	YES	YES	YES
M.A.L	1.0	70.5	27.4	8.5	4.6	6.7	6.2	3.2	3.5	2.8

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1985 to January 2011 except the interbank data which span January 1996 to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 5.3: Linear-ARDL Policy Rate Pass-through including 1996-Dummies

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	0.12	2.31**	0.85	1.08	1.37	0.33	0.59	0.50	-0.50	-1.12
	(0.86)	(0.96)	(0.55)	(0.67)	(0.97)	(0.88)	(0.83)	(0.72)	(0.68)	(0.80)
$\boldsymbol{\alpha}$	-0.37***	-0.43***	-0.47***	-0.65***	-0.61***	-0.66***	-0.65***	-0.78***	-0.27***	-0.40***
	(0.08)	(0.16)	(0.12)	(0.11)	(0.11)	(0.15)	(0.10)	(0.08)	(0.07)	(0.09)
$\boldsymbol{\delta}$	0.37***	0.23**	0.38***	0.57***	0.53***	0.68***	0.67***	0.83***	0.39***	0.65***
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.15)	(0.14)	(0.11)	(0.11)	(0.16)
$\boldsymbol{\beta}$	1.00***	0.54***	0.80***	0.88***	0.87***	1.03***	1.02***	1.06***	1.46***	1.59***
	(0.16)	(0.13)	(0.07)	(0.07)	(0.10)	(0.09)	(0.08)	(0.05)	(0.16)	(0.11)
$\boldsymbol{\gamma_0}$	0.61*	0.35***	0.49***	0.63***	0.71***	0.81***	0.79***	0.85***	0.85***	1.02***
	(0.36)	(0.06)	(0.09)	(0.09)	(0.10)	(0.08)	(0.07)	(0.73)	(0.21)	(0.22)
$\sum_{j=0}^{12}\boldsymbol{\gamma_j}$	2.46**	0.50***	0.49***	1.05***	1.02***	1.03***	1.14***	1.17***	0.85***	1.02***
	(0.97)	(0.06)	(0.09)	(0.11)	(0.10)	(0.10)	(0.09)	(0.08)	(0.21)	(0.22)
$\sum_{j=1}^{12}\boldsymbol{\psi_j}$	0.23***	0.20**	0.09**		0.33***	0.34***	0.08**	0.04**	0.08	
	(0.07)	(0.09)	(0.04)		(0.11)	(0.10)	(0.03)	(0.02)	(0.08)	
Φ-Dummy		-2.27**	-0.95*	-1.09*	-1.25	-0.31	-0.69	-0.65	-0.08	0.81
		(0.96)	(0.55)	(0.66)	(0.88)	(0.91)	(0.85)	(0.75)	(0.72)	(0.86)
α-Dummy		0.44***	0.50***	0.66***	0.63***	0.68***	0.70***	0.83***	0.31***	0.43***
		(0.16)	(0.12)	(0.10)	(0.10)	(0.10)	(0.09)	(0.07)	(0.07)	(0.09)
δ-Dummy		-0.24**	-0.39***	-0.58***	-0.55***	-0.70***	-0.70***	-0.86***	-0.41***	-0.67***
		(0.11)	(0.10)	(0.11)	(0.11)	(0.15)	(0.13)	(0.10)	(0.11)	(0.16)
$\boldsymbol{\bar{R}^2}$	0.21	0.44	0.52	0.62	0.59	0.64	0.65	0.80	0.44	0.50
AIC	5.71	1.75	1.78	2.29	2.52	2.48	2.44	2.36	2.90	3.05
F-Test$_{(PSS)}$	9.48**	3.60	7.36**	15.78**	15.00**	16.34**	19.84***	42.02**	6.23**	9.95**
$\boldsymbol{\beta = 1}$	YES	NO	NO	YES	YES	YES	YES	YES	NO	NO
M.A.L	1.0	1.5	1.1	0.6	0.5	0.3	0.3	0.2	0.5	-0.1

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1985 to January 2011 except the interbank data which span January 1996 to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F*-test$_{(PSS)}$ is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 5.4: Linear-ARDL Policy Rate Pass-through Including 1996-Dummies and M2/GDP

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	-6.33** (3.05)	3.00*** (0.85)	1.61** (0.55)	2.09** (0.82)	2.46** (1.10)	1.39 (1.14)	1.59 (1.07)	1.37 (1.01)	0.52 (0.82)	0.62 (0.90)
$\boldsymbol{\alpha}$	-0.43*** (0.09)	-0.45*** (0.14)	-0.50*** (0.11)	-0.65*** (0.11)	-0.63*** (0.10)	-0.64*** (0.12)	-0.65*** (0.10)	-0.78*** (0.08)	-0.29*** (0.07)	-0.44*** (0.08)
$\boldsymbol{\delta}$	0.66*** (0.18)	0.24** (0.09)	0.39*** (0.10)	0.55*** (0.11)	0.53*** (0.11)	0.64*** (0.15)	0.65*** (0.13)	0.81*** (0.11)	0.42*** (0.10)	0.67*** (0.15)
$\boldsymbol{\beta}$	1.52*** (0.23)	0.53*** (0.10)	0.77*** (0.06)	0.84*** (0.06)	0.84*** (0.09)	0.99*** (0.09)	0.99*** (0.08)	1.03*** (0.05)	1.42*** (0.12)	1.51*** (0.10)
$\boldsymbol{\gamma_0}$	0.78* (0.45)	0.35*** (0.06)	0.48*** (0.09)	0.65*** (0.09)	0.73*** (0.09)	0.81*** (0.09)	0.77*** (0.07)	0.84*** (0.08)	0.86*** (0.18)	1.02*** (0.20)
$\sum_{j=0}^{12} \boldsymbol{\gamma_j}$	1.82** (0.88)	0.52*** (0.08)	0.52*** (0.08)	1.11*** (0.18)	1.30*** (0.17)	1.35*** (0.15)	1.26*** (0.09)	1.32*** (0.11)	0.86*** (0.18)	1.02*** (0.20)
$\sum_{j=1}^{12} \boldsymbol{\psi_j}$	0.21*** (0.08)	0.23** (0.10)	0.10** (0.04)	0.15** (0.06)	0.26*** (0.09)	0.13*** (0.05)	0.04** (0.02)	0.04** (0.02)		
Φ-Dummy		-2.14** (0.88)	-0.97* (0.54)	-1.12* (0.58)	-1.14 (0.78)	-0.33 (080)	-0.54 (0.73)	-0.59 (0.67)	-0.36 (0.84)	0.07 (0.88)
α-Dummy		0.43*** (0.14)	0.53*** (0.11)	0.71*** (010)	0.68*** (0.09)	0.71*** (0.10)	0.73*** (0.08)	0.85*** (0.06)	0.41*** (0.08)	0.55*** (0.08)
δ-Dummy		-0.26*** (0.09)	-0.42*** (0.09)	-0.62*** (0.09)	-0.61*** (0.09)	-0.73*** (0.14)	-0.74*** (0.11)	-0.88*** (0.09)	-0.53*** (0.11)	-0.84*** (0.15)
M2/GDP	13.99** (6.55)	-1.79** (0.72)	-1.67** (0.81)	-2.62* (1.47)	-3.12** (1.50)	-2.94* (1.61)	-2.96* (1.59)	-2.41 (1.69)	-3.96*** (1.50)	-5.32*** (1.39)
$\boldsymbol{\bar{R}^2}$	0.23	0.44	0.54	0.63	0.61	0.65	0.67	0.80	0.45	0.53
AIC	5.68	1.72	1.76	2.26	2.47	2.45	2.39	2.33	2.87	3.00
F-Test$_{(PSS)}$	11.19**	5.58*	9.82**	18.82**	18.41**	16.31**	23.78**	52.26**	9.18**	17.44**
$\boldsymbol{\beta = 1}$	NO	NO	NO	NO	YES	YES	YES	YES	NO	NO
M.A.L	0.5	1.4	1.0	0.5	0.4	0.3	0.3	0.2	0.4	-0.1

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1985 to January 2011 except the interbank data which span January 1996 to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 5.5: Linear-ARDL Interbank Rate Pass-through without Exogenous Variables

	Deposits							Lending	
	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\Phi}$	0.19	0.42**	0.73**	0.97***	1.39***	1.18***	2.33***	1.17**	1.25***
	(0.16)	(0.19)	(0.34)	(0.30)	(0.49)	(0.38)	(0.68)	(0.49)	(0.38)
$\boldsymbol{\alpha}$	-0.09**	-0.18***	-0.16***	-0.17***	-0.23***	-0.20***	-0.35***	-0.09***	-0.08***
	(0.04)	(0.051	(0.04)	(0.04)	(0.06)	(0.04)	(0.08)	(0.03)	(0.03)
$\boldsymbol{\delta}$	0.01*	0.05***	0.07***	0.07***	0.09***	0.08***	0.12***	0.03***	0.04***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.01)	(0.02)
$\boldsymbol{\beta}$	0.13*	0.31***	0.45***	0.42***	0.40***	0.39***	0.34***	0.39***	0.54***
	(0.07)	(0.05)	(0.08)	(0.07)	(0.06)	(0.06)	(0.06)	(0.09)	(0.13)
$\boldsymbol{\gamma_0}$	0.03**	0.01	0.01	0.04*	0.04*	0.05**	0.12***	0.02*	0.019
	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)	(0.02)	(0.04)	(0.01)	(0.01)
$\sum_{j=0}^{12}\boldsymbol{\gamma_j}$	0.03**	0.02	0.05*	0.19***	0.19***	0.11***	0.12***	0.02*	0.019
	(0.01)	(0.01)	(0.03)	(0.06)	(0.06)	(0.03)	(0.04)	(0.01)	(0.01)
$\sum_{j=1}^{12}\boldsymbol{\psi_j}$	0.11*	0.11*		0.13*		0.24***	0.33**	0.19**	0.45***
	(0.06)	(0.06)		(0.08)		(0.07)	(0.14)	(0.08)	(0.13)
$\bar{\boldsymbol{R}}^2$	0.09	0.16	0.14	0.16	0.15	0.16	0.26	0.08	0.12
AIC	2.14	2.04	3.14	2.99	3.53	3.48	3.85	1.77	2.19
F-Test(PSS)	2.66	8.89**	6.97**	11.29**	6.83**	10.35**	10.55**	8.11**	5.20*
$\boldsymbol{\beta = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
M.A.L	10.5	5.6	6.1	5.8	4.1	4.6	2.5	11.3	11.8

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. F-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 5.6: Linear-ARDL Interbank Rate Pass-through Including M2/GDP

	Deposits							Lending	
	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\Phi}$	0.64* (0.38)	0.73*** (0.23)	0.60 (0.39)	0.88** (0.38)	1.32*** (0.49)	1.13** (0.48)	2.03*** (0.65)	1.05** (0.48)	0.99** (0.41)
$\boldsymbol{\alpha}$	-0.12* (0.06)	-0.19*** (0.05)	-0.16*** (0.05)	-0.17*** (0.04)	-0.24*** (0.07)	-0.21*** (0.05)	-0.35*** (0.08)	-0.09*** (0.03)	-0.09*** (0.03)
$\boldsymbol{\delta}$	0.01* (0.01)	0.05*** (0.01)	0.07*** (0.02)	0.07*** (0.02)	0.10*** (0.03)	0.08*** (0.02)	0.12*** (0.03)	0.04*** (0.01)	0.05*** (0.01)
$\boldsymbol{\beta}$	0.10* (0.06)	0.29*** (0.04)	0.44*** (0.08)	0.42*** (0.08)	0.40*** (0.06)	0.40*** (0.07)	0.35*** (0.05)	0.41*** (0.10)	0.57*** (0.11)
$\boldsymbol{\gamma_0}$	0.03* (0.01)	0.01 (0.01)	0.01 (0.02)	0.04* (0.02)	0.04* (0.02)	0.06** (0.02)	0.12*** (0.04)	0.02* (0.01)	0.02* (0.01)
$\sum_{j=0}^{12} \boldsymbol{\gamma_j}$	0.03* (0.01)	0.02 (0.01)	0.07** (0.04)	0.19*** (0.06)	0.19*** (0.07)	0.11*** (0.04)	0.12*** (0.04)	0.02* (0.01)	0.02* (0.01)
$\sum_{j=1}^{12} \boldsymbol{\psi_j}$	0.12* (0.07)	0.12** (0.06)		0.13* (0.085)		0.24*** (0.07)	0.33** (0.14)	0.18** (0.07)	0.43*** (0.11)
M2/GDP	-1.27* (0.71)	-0.95** (0.47	0.62 (1.22)	0.34 (0.96)	0.27 (1.41)	0.18 (1.25)	1.16 (1.69)	0.36 (0.48)	1.52*** (0.49)
$\boldsymbol{\bar{R}^2}$	0.10	0.16	0.14	0.16	0.15	0.16	0.26	0.08	0.14
AIC	2.14	2.04	3.16	3.01	3.54	3.49	3.86	1.78	2.17
F-Test$_{(PSS)}$	2.20	8.50**	8.61**	11.18**	6.50**	9.55**	9.87**	8.04**	7.69**
$\boldsymbol{\beta = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
M.A.L	8.1	5.3	6.0	5.8	4.1	4.6	2.3	11.5	10.6

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1996 to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 5.7: Nonlinear-ARDL Policy Rate Pass-through without Exogenous Variables

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	3.47	0.54***	0.61***	0.92***	1.24***	1.30***	1.29***	1.84***	1.28***	1.23***
	(2.21)	(0.19)	(0.18)	(0.28)	(0.42)	(0.43)	(0.35)	(0.58)	(0.45)	(0.45)
$\boldsymbol{\alpha}$	-0.37***	-0.03**	-0.05***	-0.08***	-0.10***	-0.10***	-0.10***	-0.14***	-0.08**	-0.08**
	(0.08)	(0.01)	(0.01)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)
$\boldsymbol{\delta^+}$	0.41***	0.001	0.01	0.05*	0.06**	0.06*	0.06**	0.09***	0.08*	0.09
	(0.15)	(0.01)	(0.01)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)
$\boldsymbol{\delta^-}$	0.41***	0.01	0.02*	0.05*	0.07**	0.07*	0.07***	0.11***	0.08*	0.07
	(0.12)	(0.01)	(0.01)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.05)
$\boldsymbol{\beta^+}$	1.11***	0.03	0.27	0.61***	0.61***	0.61***	0.63***	0.67***	0.99***	1.13***
	(0.29)	(0.22)	(0.21)	(0.22)	(0.21)	(0.20)	(0.20)	(0.19	(0.24)	(0.32)
$\boldsymbol{\beta^-}$	1.11***	0.31	0.52**	0.70***	0.69***	0.73***	0.76***	0.78***	0.94***	0.98**
	(0.19)	(0.20)	(0.21)	(0.24)	(0.21)	(0.20)	(0.21)	(019)	(0.23)	(0.25)
$\boldsymbol{\gamma_0^+}$	1.00**	0.15**	0.11	0.09	0.16	0.23*	0.33***	0.32***	0.28*	0.31**
	(0.50)	(0.08)	(0.10)	(0.14)	(0.12)	(0.14)	(0.10)	(0.08)	(0.16)	(0.11)
$\boldsymbol{\gamma_0^-}$	0.14	0.29***	0.42***	0.50***	0.69***	0.56***	0.55***	0.75***	0.94***	1.05***
	(0.45)	(0.07)	(0.10)	(0.14)	(0.13)	(0.10)	(0.14)	(0.15)	(0.19)	(0.25)
$\sum_{j=0}^{12} \boldsymbol{\gamma_j^+}$	1.00**	0.23**	0.38**	0.30***	0.40**	0.40**	0.48***	0.46***	0.40**	0.71***
	(0.50)	(0.10)	(0.17)	(0.10)	(0.16)	(0.15)	(0.14)	(0.15)	(0.17)	(0.18)
$\sum_{j=0}^{12} \boldsymbol{\gamma_j^-}$		0.35***	0.53***	0.65***	0.69***	0.68***	0.55***	0.75***	0.99***	1.15***
		(0.07)	(0.13)	(0.13)	(0.13)	(0.12)	(0.14)	(0.15)	(0.20)	(0.22)
$\sum_{j=1}^{12} \boldsymbol{\psi_j}$	0.23***	0.10**	0.08*		0.10*	0.15	0.08*	0.16***	0.11**	0.09*
	(0.08)	(0.05)	(0.05)		(0.04)	(0.11)	(0.05)	(0.06)	(0.05)	(0.05)
$\boldsymbol{\bar{R}^2}$	0.18	0.14	0.25	0.18	0.25	0.18	0.17	0.22	0.40	0.38
AIC	5.75	2.13	2.25	3.01	3.10	3.28	3.29	3.67	2.99	3.30
F-Test $_{(PSS)}$	6.02**	2.64	4.07	3.77	3.00	2.97	4.38	4.05	2.29	2.38
$\boldsymbol{\beta^+ = 1}$	YES	NO	NO	NO	NO	NO	NO	NO	YES	YES
$\boldsymbol{\beta^- = 1}$	YES	NO	NO	YES	YES	YES	YES	YES	YES	YES
$\boldsymbol{\beta^+ = \beta^-}$	YES	YES	NO^-	NO^-	NO^-	NO^-	NO^-	NO^-	YES	YES
$\boldsymbol{\gamma_0^+ = \gamma_0^-}$	NO^+	NO^-	NO^-	NO^-	NO^-	NO^-	YES	NO^-	NO^-	NO^-
$\boldsymbol{M.A.L.^+}$	0.0	22.7	18.9	11.9	8.4	8.0	7.0	4.8	8.9	8.6
$\boldsymbol{M.A.L.^-}$	2.3	19.1	12.3	6.5	3.2	4.5	4.6	1.8	0.8	-0.8

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1985 to January 2011 except the interbank data which span January 1996 to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). $\beta^+ = \beta^-$ and $\gamma_0^+ = \gamma_0^-$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO^+ and NO^- indicate positive and negative asymmetry, respectively). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 5.8: Nonlinear-ARDL Policy Rate Pass-through Including 1996 Dummies

		Deposits							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	3.47	4.63***	5.05***	6.42***	6.60***	6.73***	7.48***	8.74***	3.62***	5.67***
	(2.21)	(1.51)	(1.28)	(1.20)	(1.21)	(1.30)	(1.11)	(0.94)	(1.13)	(1.06)
$\boldsymbol{\alpha}$	-0.37***	-0.43***	-0.49***	-0.60***	-0.60***	-0.62***	-0.66***	-0.77***	-0.28***	-0.41***
	(0.08)	(0.14)	(0.13)	(0.12)	(0.11)	(0.13)	(0.11)	(0.09)	(0.09)	(0.08)
$\boldsymbol{\delta^+}$	0.41***	0.24**	0.38***	0.56***	0.55***	0.69***	0.70***	0.85***	0.42***	0.62***
	(0.15)	(0.10)	(0.11)	(0.12)	(0.11)	(0.17)	(0.13)	(0.11)	(0.12)	(0.13)
$\boldsymbol{\delta^-}$	0.41***	0.24**	0.39***	0.58***	0.57***	0.71***	0.73***	0.88***	0.39***	0.59***
	(0.12)	(0.10)	(0.11)	(0.12)	(0.11)	(0.17)	(0.13)	(0.11)	(0.11)	(0.12)
$\boldsymbol{\beta^+}$	1.11***	0.57***	0.78***	0.92***	0.92***	1.10***	1.06***	1.09***	1.46***	1.48***
	(0.29)	(0.11)	(0.07)	(0.07)	(0.09)	(0.09)	(0.08)	(0.05)	(0.14)	(0.12)
$\boldsymbol{\beta^-}$	1.11***	0.57***	0.79***	0.96***	0.96***	1.14***	1.10***	1.13***	1.39***	1.13***
	(0.18)	(0.11)	(0.06)	(0.07)	(0.09)	(0.10)	(0.08)	(0.05)	(0.14)	(0.12)
$\boldsymbol{\gamma_0^+}$	1.00**	0.28***	0.33***	0.44***	0.51***	0.73***	0.71***	0.70***	0.47***	0.61***
	(0.50)	(0.09)	(0.12)	(0.14)	(0.13)	(0.11)	(0.12)	(0.12)	(0.15)	(0.12)
$\boldsymbol{\gamma_0^-}$	0.14	0.41***	0.57***	0.74***	0.89***	0.88***	0.86***	0.98***	1.05***	1.18***
	(0.45)	(0.06)	(0.05)	(0.06)	(0.06)	(0.11)	(0.06)	(0.04)	(0.12)	(0.13)
$\boldsymbol{\sum_{j=0}^{12}\gamma_j^+}$	1.00**	0.404**	0.40***	0.59***	0.70***	0.73***	0.85***	0.87***	0.55***	1.40***
	(0.50)	(0.11)	(0.13)	(0.16)	(0.12)	(0.11)	(0.11)	(0.11)	(0.16)	(0.51)
$\boldsymbol{\sum_{j=0}^{12}\gamma_j^-}$		0.50***	0.70***	0.89***	0.96***	0.99***	1.01***	1.02***	1.05***	1.29***
		(0.07)	(0.07)	(0.07)	(0.06)	(0.10)	(0.07)	(0.04)	(0.12)	(0.11)
$\boldsymbol{\sum_{j=1}^{12}\psi_j}$	0.23***	0.10*	0.10**	0.05*	0.12**	0.09**	0.03**	0.04***	0.07*	
	(0.08)	(0.05)	(0.04)	(0.02)	(0.05)	(0.04)	(0.01)	(0.01)	(0.03)	
Φ-Dummy		-2.08**	-1.01*	-0.03	-0.27	0.95	0.62	0.73	-0.85	-0.27
		(1.02)	(0.58)	(0.69)	(0.83)	(1.03)	(0.82)	(0.69)	(0.75)	(0.74)
α-Dummy		0.43***	0.52***	0.67***	0.65***	0.69***	0.73***	0.83***	0.31***	0.41***
		(0.15)	(0.12)	(0.11)	(0.10)	(0.12)	(0.12)	(0.07)	(0.08)	(0.07)
δ-Dummy		-0.25**	-0.40***	-0.62***	-0.61***	-0.75	-0.78***	-0.91***	-0.39***	-0.60***
		(0.10)	(0.10)	(0.11)	(0.11)	(0.17)	(0.13)	(0.10)	(0.10)	(0.11)
$\boldsymbol{\bar{R}^2}$	0.18	0.43	0.56	0.63	0.59	0.63	0.66	0.80	0.51	0.60
AIC	5.75	1.73	1.74	2.22	2.500	2.44	2.40	2.32	2.82	2.87
$\boldsymbol{F\text{-}Test_{(PSS)}}$	6.02**	3.15	5.05**	11.28**	12.79**	8.87**	15.81**	29.73**	4.62*	9.19**
$\boldsymbol{\beta^+ = 1}$	YES	NO	NO	YES	YES	YES	YES	YES	NO	NO
$\boldsymbol{\beta^- = 1}$	YES	NO	NO	YES	YES	YES	YES	NO	NO	NO
$\boldsymbol{\beta^+ = \beta^-}$	YES	YES	YES	YES	YES	YES	YES	NO^-	NO^+	NO^+
$\boldsymbol{\gamma_0^+ = \gamma_0^-}$	NO^+	YES	NO^-	NO^-	NO^-	YES	YES	NO^-	NO^-	NO^-
$\boldsymbol{M.A.L.^+}$	0.0	1.7	1.3	0.9	0.8	0.4	0.4	0.4	1.8	0.9
$\boldsymbol{M.A.L.^-}$	2.3	1.4	0.9	0.4	0.2	0.2	0.2	0.2	-0.2	-0.4

Source: Author’s computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1985 to January 2011 except the interbank data which span January 1996 to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. F-test$_{(PSS)}$ is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). $\beta^+ = \beta^-$ and $\gamma_0^+ = \gamma_0^-$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO^+ and NO^- indicate positive and negative asymmetry, respectively). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 5.9: Nonlinear-ARDL Policy Rate Pass-through including 1996-Dummies and M2/GDP

		Deposit							Lending	
	IBR	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\boldsymbol{\Phi}$	3.96**	5.23***	5.49***	6.99***	7.31***	7.38***	8.01***	9.16***	5.55***	7.73***
	(1.92)	(1.41)	(1.13)	(1.01)	(1.04)	(1.15)	(0.97)	(0.77)	(1.24)	(1.00)
$\boldsymbol{\alpha}$	-0.44***	-0.44***	-0.50***	-0.61***	-0.60***	-0.62***	-0.66***	-0.77***	-0.34***	-0.45***
	(0.08)	(0.14)	(0.12)	(0.11)	(0.11)	(0.12)	(0.10)	(0.09)	(0.09)	(0.07)
$\boldsymbol{\delta^+}$	0.53***	0.25**	0.39***	0.55***	0.54***	0.67***	0.69***	0.84***	0.48***	0.63***
	(0.14)	(0.09)	(0.10)	(0.12)	(0.11)	(0.16)	(0.13)	(0.11)	(0.12)	(0.13)
$\boldsymbol{\delta^-}$	0.70***	0.25**	0.39***	0.57***	0.56***	0.69***	0.71***	0.86***	0.44***	0.59***
	(0.16)	(0.09)	(0.10)	(0.11)	(0.11)	(0.17)	(0.13)	(0.11)	(0.11)	(0.12)
$\boldsymbol{\beta^+}$	1.20***	0.55***	0.77***	0.90***	0.90***	1.07***	1.04***	1.08***	1.37***	1.39***
	(0.21)	(0.10)	(0.06)	(0.06)	(0.08)	(0.09)	(0.07)	(0.04)	(1.10)	(0.10)
$\boldsymbol{\beta^-}$	1.59***	0.56***	0.77***	0.93***	0.93***	1.11***	1.08***	1.11***	1.27***	1.31***
	(0.21)	(0.10)	(0.06)	(0.06)	(0.08)	(0.09)	(0.07)	(0.05)	(0.10)	(0.10)
$\boldsymbol{\gamma_0^+}$	1.40**	0.29***	0.34***	0.45***	0.53***	0.74***	0.72***	0.70***	0.54***	0.65***
	(0.56)	(0.09)	(0.12)	(0.14)	(0.13)	(0.11)	(0.12)	(0.12)	(0.15)	(0.12)
$\boldsymbol{\gamma_0^-}$	0.42	0.40***	0.56***	0.72***	0.88***	0.87***	0.85***	0.96***	1.03***	1.15***
	(0.34)	(0.06)	(0.05)	(0.06)	(0.05)	(0.11)	(0.06)	(0.04)	(0.10)	(0.11)
$\boldsymbol{\sum_{j=0}^{12}\gamma_j^+}$	1.40**	0.42***	0.42***	0.62***	0.74***	0.74***	0.87***	0.89***	0.67***	1.72
	(0.56)	(0.11)	(0.13)	(0.17)	(0.12)	(0.11)	(0.10)	(0.11)	(0.17)	(0.53)
$\boldsymbol{\sum_{j=0}^{12}\gamma_j^-}$	0.42	0.50***	0.48***	0.87***	0.95***	0.97***	1.00***	1.01***	1.03***	1.26***
	(0.34)	(0.07)	(0.11)	(0.07)	(0.06)	(0.10)	(0.06)	(0.04)	(0.10)	(0.08)
$\boldsymbol{\sum_{j=1}^{12}\psi_j}$		0.10**	0.10**	0.04*	0.13**	0.08**	0.04**	0.04**	0.07*	
		(0.05)	(0.04)	(0.02)	(0.05)	(0.04)	(0.02)	(0.01)	(0.03)	
Φ-Dummy		-1.96*	-1.07*	-0.09	-0.32	0.86	0.59	0.64	-1.81**	-1.52**
		(1.08)	(0.63)	(0.70)	(0.83)	(1.03)	(0.85)	(0.76)	(0.77)	(068)
α-Dummy		0.43***	0.53***	0.69***	0.68***	0.71***	0.74***	0.84***	0.43***	0.53***
		(0.15)	(0.12)	(0.10)	(0.10)	(0.11)	(0.09)	(0.06)	(0.09)	(0.07)
δ-Dummy		-0.27***	-0.41***	-0.63***	-0.64***	-0.77***	-0.80***	-0.92***	-0.52***	-0.73***
		(0.09)	(0.10)	(0.10)	(0.09)	(0.15)	(0.12)	(0.09)	(0.11)	(0.11)
M2/GDP	20.94***	-1.51**	-1.25	-2.05	-2.49*	-2.44	-2.10	-1.76	-4.52***	-6.13***
	(7.44)	(0.67)	(0.86)	(1.39)	(1.43)	(1.60)	(1.55)	(1.70)	(1.33)	(1.15)
$\boldsymbol{\bar{R}^2}$	0.21	0.44	0.56	0.64	0.61	0.64	0.67	0.80	0.52	0.64
AIC	5.65	1.72	1.72	2.204	2.47	2.42	2.38	2.30	2.76	2.79
F-Test$_{(PSS)}$	8.57**	4.14*	5.61**	11.16**	12.51**	9.48**	15.91**	29.24**	5.86**	14.27**
$\boldsymbol{\beta^+ = 1}$	YES	NO	NO	YES	YES	YES	YES	YES	NO	NO
$\boldsymbol{\beta^- = 1}$	NO	NO	NO	YES	YES	YES	YES	NO	NO	NO
$\boldsymbol{\beta^+ = \beta^-}$	NO$^-$	YES	YES	YES	YES	YES	YES	NO$^-$	NO$^+$	NO$^+$
$\boldsymbol{\gamma_0^+ = \gamma_0^-}$	NO$^+$	YES	NO$^-$	YES	NO$^-$	YES	YES	NO$^-$	NO$^-$	NO$^-$
$\boldsymbol{M.A.L.^+}$	-0.9	1.6	1.3	0.9	0.8	0.4	0.4	0.4	1.3	0.7
$\boldsymbol{M.A.L.^-}$	1.3	1.3	0.9	0.4	0.2	0.2	0.2	0.1	-0.1	-0.3

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1985 to January 2011 except the interbank data which span January 1996 to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). $\beta^+ = \beta^-$ and $\gamma_0^+ = \gamma_0^-$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO$^+$ and NO$^-$ indicate positive and negative asymmetry, respectively). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 5.10: Nonlinear-ARDL Interbank Pass-through without Exogenous Variables

	Deposits							Lending	
	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\Phi}$	1.01** (0.46)	1.82*** (0.55)	2.04*** (0.68)	1.99*** (0.57)	2.71*** (0.95)	2.66*** (0.73)	4.68*** (1.01)	1.67*** (0.56)	1.86*** (0.52)
$\boldsymbol{\alpha}$	-0.15** (0.07)	-0.23*** (0.07)	-0.19*** (0.06)	-0.16*** (0.04)	-0.23*** (0.07)	-0.20*** (0.05)	-0.37*** (0.07)	-0.08*** (0.02)	-0.07*** (0.02)
$\boldsymbol{\delta^+}$	0.002 (0.01)	0.07*** (0.02)	0.09*** (0.03)	0.07*** (0.02)	0.10** (0.03)	0.09*** (0.02)	0.13*** (0.03)	0.03*** (0.01)	0.04*** (0.01)
$\boldsymbol{\delta^-}$	0.01 (0.01)	0.07*** (0.02)	0.09*** (0.03)	0.07*** (0.02)	0.09** (0.03)	0.09*** (0.02)	0.13*** (0.02)	0.03*** (0.01)	0.04*** (0.01)
$\boldsymbol{\beta^+}$	0.01 (0.08)	0.31*** (0.04)	0.50*** (0.08)	0.47*** (0.08)	0.43*** (0.07)	0.45*** (0.08)	0.35*** (0.05)	0.39*** (0.11)	0.54*** (0.11)
$\boldsymbol{\beta^-}$	0.03 (0.07)	0.31*** (0.04)	0.48*** (0.08)	0.45*** (0.08)	0.42*** (0.07)	0.44*** (0.08)	0.34*** (0.04)	0.39*** (0.10)	0.53*** (0.12)
$\boldsymbol{\gamma_0^+}$	0.02 (0.01)	0.01 (0.02)	0.03 (0.03)	0.06*** (0.02)	0.06** (0.03)	0.06* (0.03)	0.07* (0.04)	0.01 (0.02)	0.02 (0.02)
$\boldsymbol{\gamma_0^-}$	0.02 (0.02)	0.02 (0.03)	0.01 (0.05)	0.02 (0.03)	0.04 (0.05)	0.07 (0.05)	0.19*** (0.04)	0.01 (0.01)	0.01 (0.02)
$\boldsymbol{\sum_{j=0}^{12}\gamma_j^+}$		0.09*** (0.03)	0.10*** (0.03)	0.16*** (0.03)	0.32*** (0.08)	0.11** (0.05)	0.41*** (0.12)	0.06*** (0.01)	0.09** (0.04)
$\boldsymbol{\sum_{j=0}^{12}\gamma_j^-}$			0.03* (0.02)	0.11*** (0.04)	0.18*** (0.06)	0.16** (0.06)	0.44*** (0.10)		0.04** (0.02)
$\boldsymbol{\sum_{j=1}^{12}\psi_j}$	0.21** (0.09)			0.13* (0.09)		0.11* (0.06)	0.17** (0.07)	0.10*** (0.03)	0.45*** (0.10)
$\boldsymbol{\bar{R}^2}$	0.10	0.20	0.17	0.18	0.15	0.15	0.31	0.11	0.14
AIC	2.14	2.28	3.12	2.96	3.54	3.50	3.86	1.80	2.21
F-Test(PSS)	2.16	5.79**	4.29*	5.91**	3.81	5.53**	8.23**	5.64**	4.94**
$\boldsymbol{\beta^+ = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
$\boldsymbol{\beta^- = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
$\boldsymbol{\beta^+ = \beta^-}$	NO$^-$	YES	YES	YES	YES	YES	YES	YES	YES
$\boldsymbol{\gamma_0^+ = \gamma_0^-}$	YES	YES	YES	YES	YES	YES	YES	YES	YES
$\boldsymbol{M.A.L.^+}$	6.4	4.2	5.0	5.5	4.1	4.5	2.5	11.8	12.5
$\boldsymbol{M.A.L.^-}$	6.4	4.2	5.1	5.8	4.4	4.5	2.1	11.8	12.5

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1996 to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran ***et al***. (2001). Test of complete pass-through is the *Wald*-test for $\beta = 1$ (YES connotes complete pass-through). $\beta^+ = \beta^-$ and $\gamma_0^+ = \gamma_0^-$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO$^+$ and NO$^-$ indicate positive and negative asymmetry, respectively). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 5.11: Nonlinear-ARDL Results for Interbank Pass-through with M2/GDP

	Deposits							Lending	
	SDR	7-Day	1-Mth	3-Mth	6-Mth	1-Yr	>1-Yr	PLR	MLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\Phi}$	3.26*** (0.66)	2.27*** (0.70)	2.88*** (0.88)	2.54*** (0.63)	3.15*** (1.01)	3.05*** (0.74)	4.69*** (0.99)	1.49*** (0.53)	1.84*** (0.46)
$\boldsymbol{\alpha}$	-0.54*** (0.11)	-0.25*** (0.07)	-0.22*** (0.06)	-0.18*** (0.04)	-0.24*** (0.07)	-0.21*** (0.05)	-0.37*** (0.07)	-0.08*** (0.02)	-0.09*** (0.02)
$\boldsymbol{\delta^+}$	0.01 (0.01)	0.08*** (0.02)	0.11*** (0.04)	0.09*** (0.02)	0.11*** (0.04)	0.10*** (0.02)	0.13*** (0.03)	0.02*** (0.01)	0.03*** (0.01)
$\boldsymbol{\delta^-}$	0.01 (0.01)	0.08*** (0.02)	0.11*** (0.03)	0.08*** (0.02)	0.10*** (0.03)	0.09*** (0.02)	0.13*** (0.03)	0.03*** (0.01)	0.04*** (0.01)
$\boldsymbol{\beta^+}$	0.01 (0.02)	0.33*** (0.04)	0.53*** (0.08)	0.50*** (0.08)	0.46*** (0.08)	0.48*** (0.09)	0.35*** (0.06)	0.35*** (0.10)	0.43*** (0.09)
$\boldsymbol{\beta^-}$	0.02 (0.02)	0.32*** (0.03)	0.50*** (0.07)	0.47*** (0.08)	0.44*** (0.07)	0.46*** (0.08)	0.35*** (0.05)	0.36*** (0.10)	0.45*** (0.09)
$\boldsymbol{\gamma_0^+}$	0.01 (0.01)	0.01 (0.02)	0.03 (0.03)	0.06*** (0.02)	0.06* (0.03)	0.06 (0.03)	0.17*** (0.04)	0.01 (0.02)	0.02 (0.02)
$\boldsymbol{\gamma_0^-}$	0.02 (0.02)	0.03 (0.04)	0.03 (0.05)	0.04 (0.03)	0.05 (0.05)	0.08 (0.05)	0.19*** (0.05)	0.01 (0.01)	0.01 (0.02)
$\boldsymbol{\sum_{j=0}^{12}\gamma_j^+}$	0.04* (0.02)	0.07** (0.03)	0.06** (0.02)	0.15*** (0.03)	0.31*** (0.08)	0.05* (0.03)	0.41*** (0.12)	0.06*** (0.01)	0.09** (0.04)
$\boldsymbol{\sum_{j=0}^{12}\gamma_j^-}$			0.03* (0.02)	0.11*** (0.04)	0.14*** (0.04)	0.08*** (0.03)	0.25*** (0.09)		0.03* (0.01)
$\boldsymbol{\sum_{j=1}^{12}\psi_j}$	0.23*** (0.08)			0.13* (0.08)		0.11* (0.06)	0.17** (0.07)	0.09*** (0.03)	0.43*** (0.09)
M2/GDP	-0.43 (0.81)	-1.91* (1.13)	-3.76* (1.90)	-2.41* (1.39)	-2.25 (1.84)	-2.16 (1.72)	-0.04 (2.32)	1.16* (0.70)	2.76*** (0.65)
$\boldsymbol{\bar{R}^2}$	0.35	0.21	0.19	0.19	0.16	0.15	0.30	0.11	0.17
AIC	1.88	2.27	3.27	2.95	3.54	3.51	3.87	1.80	2.18
F-Test$_{(PSS)}$	8.01**	5.53**	4.02	6.30**	3.53	5.84**	8.21**	6.87**	8.35**
$\boldsymbol{\beta^+ = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
$\boldsymbol{\beta^- = 1}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
$\boldsymbol{\beta^+ = \beta^-}$	NO$^-$	YES	YES	YES	YES	YES	YES	YES	YES
$\boldsymbol{\gamma_0^+ = \gamma_0^-}$	YES	YES	YES	YES	YES	YES	YES	YES	YES
$\boldsymbol{M.A.L.^+}$	1.8	3.8	4.3	5.0	3.9	4.4	2.2	11.9	10.6
$\boldsymbol{M.A.L.^-}$	1.8	3.7	4.3	5.1	3.9	4.2	2.1	12.1	10.7

Source: Author's computations based on data from the Central Bank of Nigeria.

Note: Econometric estimation was conducted using *EViews 7.0* software. All data are of monthly frequency for the period January 1996 to January 2011. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F*-test($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using asymptotic critical values from Pesaran *et al*. (2001). Test of complete pass-through is the *Wald*-test for β = 1 (YES connotes complete pass-through). $\beta^+ = \beta^-$ and $\gamma_0^+ = \gamma_0^-$ are *Wald*-tests of asymmetric pass-through in the long- and short-run, respectively, (YES suggests symmetry, while NO$^+$ and NO$^-$ indicate positive and negative asymmetry, respectively). *M.A.L* is the mean adjustment lag of pass-through.

Appendix 6.1: Result ARDL Model of Investment (Various Interest Regimes)

	(A) ARDL Model			(B) T-ARDL[1] Model			(C) T-ARDL[2] Model		
	I	***I_N***	***I_O***	***I***	***I_N***	***I_O***	***I***	***I_N***	***I_O***
Regressor	(1)	(2)	(3)	(5)	(6)	(7)	(8)	(9)	(10)
μ	1.12*** (0.30)	1.19*** 0.30	-2.21* (1.15)	1.37*** (0.38)	1.53*** (0.27)	-0.22 (0.90)	2.98*** (0.52)	2.14*** (0.29)	0.80 (1.40)
α	-0.21*** (0.04)	-0.38*** (0.06)	-0.52*** (0.08)	-0.20*** (0.04)	-0.40*** (0.04)	-0.47*** (0.09)	-0.49*** (0.07)	-0.59*** (0.05)	-0.50*** (0.13)
$\delta^{(1)}$	-0.08* (0.04)	-0.19*** (0.06)	-0.11 (0.07)	0.03 (0.06)	0.02 (0.08)	0.10 (0.16)	-0.36*** (0.06)	-0.54*** (0.11)	-0.12 (0.11)
$\delta^{(2)}$				-0.14*** (0.04)	-0.20*** (0.06)	-0.05 (0.08)	0.20*** (0.04)	0.07 (0.05)	0.16** (0.07)
$\delta^{(3)}$							-1.12*** (0.23)	-0.40*** (0.10)	-1.02*** (0.36)
$\beta^{(1)}$	-0.37* (0.19)	-0.50** (0.19)	-0.21 (0.15)	0.19 (0.30)	0.06 (0.21)	0.22 (0.33)	-0.73*** (0.10)	-0.90*** (0.17)	-0.24 (0.21)
$\beta^{(2)}$				-0.74*** (0.22)	-0.49*** (0.17)	-0.10 (0.16)	0.41*** (0.06)	0.12 (0.09)	0.32** (0.14)
$\beta^{(3)}$							-2.27*** (0.44)	-0.67*** (0.17)	-2.03** (0.81)
CPS_{t-1}	-0.04** (0.01)	-0.05** (0.02)	-0.03 (0.02)	-0.05*** (0.01)	-0.07*** (0.02)	-0.05** (0.02)	-0.06*** (0.02)	-0.09*** (0.03)	-0.05** (0.02)
Y_{t-1}	0.003 (0.02)	0.06** (0.03)	0.49*** (0.14)	-0.02 (0.03)	0.05 (0.03)	0.25** (0.11)	-0.03 (0.03)	0.04 (0.03)	0.16 (0.17)
GI_{t-1}	0.24*** (0.04)	0.38*** (0.06)	0.49*** (0.11)	0.22*** (0.04)	0.37*** (0.04)	0.41*** (0.10)	0.50*** (0.07)	0.69*** (0.07)	0.42*** (0.13)
CU_{t-1}					0.30*** (0.10)		0.09 (0.06)	0.33*** (0.07)	
EV_{t-1}	-0.02** (0.01)	-0.03*** (0.01)	-0.02** (0.01)	-0.02** (0.01)	-0.01* (0.006)	-0.03*** (0.01)	-0.05*** (0.01)	-0.04*** (0.01)	-0.03** (0.01)
PO_{t-1}			-0.12*** (0.04)			-0.12*** (0.04)			-0.11*** (0.03)
$PV(Dummy$	-0.04*** (0.01)	-0.05*** (0.01)		-0.04*** (0.01)	-0.04*** (0.01)		-0.06*** (0.01)	-0.07*** (0.01)	
$\sum_{s=0}^{4}\Delta r_{t-s}^{(1)}$	0.15*** (0.05)	0.15** (0.07)	0.30** (0.12)	0.14* (0.08)	-0.08 (0.09)	-0.23 (0.22)	-0.16 (0.12)	0.28* (0.15)	-0.20 (0.20)
$\sum_{s=0}^{4}\Delta r_{t-s}^{(2)}$				0.11** (0.05)	0.13 (0.08)	0.27** (0.12)	0.56*** (0.14)	0.74*** (0.15)	0.41*** (0.11)
$\sum_{s=0}^{4}\Delta r_{t-s}^{(3)}$							0.64** (0.28)	-0.48*** (0.13)	1.05* (0.57)
$\sum_{s=0}^{4}\Delta I_{t-s}$	0.26*** (0.06)	0.35*** (0.08)	0.17*** (0.05)	0.42*** (0.08)	0.62*** (0.09)	0.27*** (0.07)	0.40*** (0.08)	0.61*** (0.07)	0.24*** (0.06)
$\sum_{s=0}^{4}\Delta CPS_{t-s}$	0.14*** (0.05)	0.24*** (0.07)	0.10** (0.05)	0.16** (0.06)	0.23*** (0.08)	-0.03 (0.05)	0.13** (0.05)	0.33*** (0.06)	0.10** (0.04)
$\sum_{s=0}^{4}\Delta Y_{t-s}$	0.95*** (0.09)	0.46*** (0.11)	0.63*** (0.11)	0.50*** (0.15)	0.60*** (0.15)	0.48*** (0.07)	1.83*** (0.32)	1.38*** (0.08)	0.57*** (0.07)
$\sum_{s=0}^{4}\Delta GI_{t-s}$	0.35*** (0.04)	0.39*** (0.06)	0.51*** (0.09)	0.26*** (0.04)	0.01 (0.08)	0.58*** (0.06)	-0.33*** (0.11)	-0.54*** (0.11)	0.58*** (0.07)
$\sum_{s=0}^{4}\Delta CU_{t-s}$					-0.71 (0.80)		-2.03*** (0.48)	-1.30** (0.65)	
$\sum_{s=0}^{4}\Delta EV_{t-s}$	-0.01*** (0.002)	-0.01* (0.006)	-0.03** (0.01)	-0.01** (0.003)	-0.02*** (0.01)	-0.02** (0.01)	0.06*** (0.01)	0.04*** (0.01)	-0.01* (0.006)
$\sum_{s=0}^{4}\Delta PO_{t-s}$			0.48*** (0.16)			0.40*** (0.16)			0.4821** (0.2091)

Appendix 61: Cont'd

$\bar{R}^2$	0.91	0.79	0.66	0.91	0.86	0.68	0.96	0.91	0.71
RSS	0.10	0.25	0.71	0.10	0.17	0.72	0.03	0.10	0.66
AIC	-3.60	-2.76	-1.62	-3.59	-3.02	-1.67	-4.20	-3.30	-1.69
F-Test $_{(PSS)}$	6.09**	10.31**	8.94**	4.87**	18.67**	4.79**	10.58**	21.37**	3.82**
RESET	3.11* [0.06]	3.95** [0.03]	3.01* [0.09]	0.02 [0.89]	3.53* [0.06]	0.06 [0.81]	0.27 [0.43]	0.08 [0.72]	0.08 [0.77]
***LR-Sym*(1)** $\beta = \beta^{(1,2,3)}$				NO	NO	YES	NO	NO	NO
***LR-Sym*(2)** $\beta^{+} = \beta^{-}$							NO	YES	NO
***SR-Sym*(1)** $\theta = \theta^{(1,2,3)}$				YES	YES	NO	NO	NO	NO
***SR-Sym*(2)** $\theta^{+} = \theta^{-}$							NO	NO	NO
$M.A.L^{(1)}$	3.9	2.2	1.3	4.3	2.7	2.6	2.4	1.2	1.6
$M.A.L^{(2)}$				4.4	2.1	1.5	0.9	0.4	1.2
$M.A.L^{(3)}$							0.7	0.9	0.1

Source: Author's computations based on data from the Central Bank of Nigeria and the National Bureau of Statistics.

Note: Econometric estimation was conducted with *EViews 7.0* software using data are from 1985:Q1 to 2011:Q2. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F-test*($_{PSS}$) is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using 5% asymptotic critical values from Pesaran *et al*. (2001). *RESET* is the *F*-statistic of Ramsey's specification error test using the squares of fitted residuals; *p*-values are in [ ]. *LR-Sym*(·) and *SR-Sym*(·) are *Wald*-tests for asymmetric elasticities in the long- and short-run, respectively, where test(1) investigates asymmetry in all regimes in a given model and test(2) is for positive or negative asymmetry in model C. *RSS* means residual sum of while M.A.L is the mean adjustment lag.

Appendix 7.1: Results of the Linear-ARDL Phillips Curve Models

	(A) Simple PC			(B) Supply-Augmented PC		
	Whole Economy	*Non-Oil Sector*	*Oil Sector*	*Whole Economy*	*Non-Oil Sector*	*Oil Sector*
Regressors	(1)	(2)	(3)	(4)	(5)	(6)
$\boldsymbol{\mu}$	0.03** (0.01)	0.03 (0.02)	0.02** (0.01)	0.06 (0.05)	0.12*** (0.05)	0.08** (0.03)
$\boldsymbol{\alpha}$	-0.09** (0.04)	-0.09* (0.05)	-0.06 (0.04)	-0.09* (0.05)	-0.09* (0.05)	-0.08** (0.04)
$\boldsymbol{\delta}$	-0.23* (0.13)	-0.17 (0.15)	-0.05 (0.16)	0.02 (0.20)	-0.12 (0.15)	0.38*** (0.13)
$\boldsymbol{\beta}$	-2.40* (1.43)	-1.93 (1.50)	-0.86 (2.98)	0.27 (2.06)	-1.32 (1.62)	4.51* (2.47)
$\boldsymbol{\Xi}^{[E_{t-1}]}$				0.14*** (0.03)	0.14*** (0.03)	0.13*** (0.02)
$\boldsymbol{\Xi}^{[\Lambda_{t-1}]}$				0.10 (0.10)	0.18* (0.09)	0.13* (0.07)
$\boldsymbol{\Xi}^{[\pi_{t-1}^{oil}]}$				-0.04* (0.02)	-0.04* (0.02)	-0.03 (0.03)
$\boldsymbol{\Xi}^{[\pi_{t-1}^{imp}]}$				-0.25 (0.33)	-0.35 (0.32)	-1.06** (0.46)
$\boldsymbol{\Gamma}^{[E_{t-1}]}$				1.41* (0.80)	1.50* (0.81)	1.59* (0.91)
$\boldsymbol{\Gamma}^{[\Lambda_{t-1}]}$				1.03 (1.44)	1.88* (1.05)	1.61 (1.42)
$\boldsymbol{\Gamma}^{[\pi_{t-1}^{oil}]}$				-0.44 (0.30)	-0.50 (0.33)	-0.37 (0.37)
$\boldsymbol{\Gamma}^{[\pi_{t-1}^{imp}]}$				-2.59 (4.09)	-3.72 (4.15)	-12.40 (7.82)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}$	0.57*** (0.10)	0.41** (0.21)	0.35* (0.18)	0.49* (0.28)	0.58** (0.25)	0.61*** (0.19)
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}_{t-s}$	-0.30 (0.22)	0.40* (0.21)	-0.09 (0.11)	-1.76*** (0.59)	-0.34* (0.20)	-0.34** (0.14)
$\sum_{s=0}^{8} \Delta\boldsymbol{E}_{t-s}$				-0.90*** (0.17)	-0.93*** (0.16)	-0.96*** (0.13)
$\sum_{s=0}^{8} \Delta\boldsymbol{\Lambda}_{t-s}$				2.37*** (0.71)	2.35*** (0.68)	3.28*** (0.83)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}^{oil}$				-0.33*** (0.13)	-0.37*** (0.12)	-0.38*** (0.12)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}^{imp}$				6.08*** (1.63)	6.55*** (1.64)	7.50*** (2.16)
$\bar{\boldsymbol{R}}^2$	0.27	.025	0.29	0.56	0.54	0.60
RSS	0.45	0.45	0.42	0.20	0.21	0.17
AIC	-2.40	-2.36	-2.42	-2.73	-2.71	-2.81
F-Test*(PSS)*	2.66	1.36	1.76	8.15**	7.92**	8.56**
RESET	4.21** [0.03]	5.34** [0.01]	3.05** [0.04]	0.06 [0.80]	0.01 [0.97]	0.27 [0.59]

Source: Author's computations based on data from the Central Bank of Nigeria, the National Bureau of Statistics and OECD database.

Note: Econometric estimation was conducted with *EViews 7.0* software using data are from 1985:Q1 to 2011:Q4. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *RSS* denotes residual sum of squares while *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F-test*$_{(PSS)}$ is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using 5% asymptotic critical values from Pesaran *et al*. (2001). *RESET* is the *F*-statistic of Ramsey's specification error test using the squares of fitted residuals; *p*-values are in [ ].

Appendix 7.2: Results of the Nonlinear-ARDL Phillips Curve Models

	(D) NARDL Model			(E) T-ARDL[1] Model			(F) T-ARDL[2] Model		
	Whole Economy	*Non-Oil Sector*	*Oil Sector*	*Whole Economy*	*Non-Oil Sector*	*Oil Sector*	*Whole Economy*	*Non-Oil Sector*	*Oil Sector*
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\boldsymbol{\mu}$	-0.34**	-0.30***	0.78***	-0.38***	-0.20**	0.18***	-0.50***	-0.51***	0.26***
	(0.14)	(0.09)	(0.09)	(0.13)	(0.09)	(0.06)	(0.11)	(0.08)	(0.06)
$\boldsymbol{\alpha}$	-0.15***	-0.21***	-0.62***	-0.16***	-0.22***	-0.21***	-0.14***	-0.18***	-0.11***
	(0.05)	(0.03)	(0.07)	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)	(0.03)
$\boldsymbol{\delta}^{(1)/(+)}$	4.48***	1.40**	-1.66***	2.78***	1.45***	-0.29**	2.58***	1.07***	-0.03
	(0.92)	(0.61)	(0.22)	(0.51)	(0.37)	(0.12)	(0.27)	(0.12)	(0.02)
$\boldsymbol{\delta}^{(2)/(-)}$	-4.49***	-1.58**	1.53***	-2.76***	-1.49***	0.23*	1.58***	-0.46***	0.10***
	(0.93)	(0.58)	(0.21)	(0.50)	(0.36)	(0.12)	(0.34)	(0.11)	(0.05)
$\boldsymbol{\delta}^{(3)}$							-2.46***	-1.21***	-0.05
							(0.26)	(0.13)	(0.05)
$\boldsymbol{\beta}^{(1)/(+)}$	28.82**	6.38**	-2.67***	16.47***	6.54***	-1.34**	17.93***	5.76***	-0.32
	(12.49)	(3.05)	(0.39)	(5.63)	(1.82)	(0.52)	(6.18)	(1.58)	(0.22)
$\boldsymbol{\beta}^{(2)/(-)}$	-28.82**	-7.23**	2.47***	-16.34***	-6.75***	1.07**	10.99***	-2.47***	0.96*
	(12.39)	(2.98)	(0.37)	(5.59)	(1.84)	(0.51)	(3.95)	(0.71)	(0.53)
$\boldsymbol{\beta}^{(3)}$							-17.14***	-6.56***	-0.51
							(5.91)	(1.77)	(0.52)
$\boldsymbol{\Xi}^{[E_{t-1}]}$	0.20***	0.16***	0.23***	0.21***	0.18***	0.11***	0.23***	0.39***	0.07
	(0.05)	(0.05)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)	(0.05)	(0.05)
$\boldsymbol{\Xi}^{[\Lambda_{t-1}]}$	0.51**	0.68***	-0.01	0.60***	0.43***	-0.01	0.61***	0.23*	-0.06
	(0.19)	(.016)	(0.08)	(0.20)	(0.13)	(0.09)	(0.16)	(0.13)	(0.09)
$\boldsymbol{\Xi}^{[\pi^{oil}_{t-1}]}$	-0.19**	0.15***	0.32***	-0.07*	0.002	0.003	-0.26***	-0.21***	-0.02
	(0.08)	(0.05)	(0.04)	(0.04)	(0.03)	(0.34)	(0.04)	(0.05)	(0.03)
$\boldsymbol{\Xi}^{[\pi^{imp}_{t-1}]}$	-0.71	-3.43***	-6.79***	-0.33	-1.51***	-2.60***	-0.53	-2.53***	-2.27***
	(0.70)	(0.98)	(0.82)	(0.30)	(0.38)	(0.78)	(0.33)	(0.60)	(0.67)
$\boldsymbol{\Gamma}^{[E_{t-1}]}$	1.29*	0.74**	0.37***	1.26***	0.81***	0.50**	1.61**	2.12***	0.65
	(0.68)	(0.31)	(0.04)	(0.39)	(0.22)	(0.23)	(0.61)	(0.64)	(0.56)
$\boldsymbol{\Gamma}^{[\Lambda_{t-1}]}$	3.33**	3.11***	-0.02	3.58**	1.96**	-0.09	4.27**	1.25*	-0.55
	(1.71)	(0.76)	(0.14)	(1.66)	(0.01)	(0.43)	(1.89)	(0.67)	(0.96)
$\boldsymbol{\Gamma}^{[\pi^{oil}_{t-1}]}$	-1.27***	0.70**	0.52***	-0.46**	0.01	0.01	-1.85**	-1.14***	-0.24
	(0.39)	(0.28)	(0.07)	(0.22)	(0.15)	(0.15)	(0.73)	(0.39)	(0.35)
$\boldsymbol{\Gamma}^{[\pi^{imp}_{t-1}]}$	-4.60	-15.62***	-10.92***	-1.97	-6.81***	-11.90***	-3.67	-13.64***	-20.56***
	(4.00)	(4.58)	(1.44)	(1.94)	(2.29)	(3.30)	(2.74)	(4.78)	(6.88)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}_{t-s}$	0.58***	0.75***	0.90***	0.55***	0.68***	0.72***	0.64**	0.78***	0.84***
	(0.12)	(0.15)	(0.23)	(0.08)	(0.07)	(0.10)	(0.25)	(0.18)	(0.12)
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}^{(1)/(+)}_{t-s}$	-16.78***	-2.51	0.91***	-9.58***	-0.35	-0.57**	-6.69***	0.98	-0.97***
	(3.78)	(2.28)	(0.17)	(2.01)	(0.84)	(0.27)	(0.88)	(0.79)	(0.24)
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}^{(2)/(-)}_{t-s}$	20.35***	12.06***	-0.63*	12.04***	3.51**	-0.13	-5.04***	-7.25***	0.55***
	(4.97)	(2.70)	(0.33)	(2.65)	(1.53)	(0.08)	(1.24)	(1.36)	(0.23)
$\sum_{s=0}^{8} \Delta\tilde{\boldsymbol{y}}^{(3)}_{t-s}$							9.52***	6.10***	-0.03
							(1.20)	(1.19)	(0.06)
$\sum_{s=0}^{8} \Delta\boldsymbol{E}_{t-s}$	-2.16***	-1.43***	-0.30**	-2.00***	-1.47***	-0.93***	-1.67***	-2.77***	-0.90***
	(0.24)	(0.26)	(0.11)	(0.25)	(0.29)	(0.15)	(0.21)	(0.34)	(0.13)
$\sum_{s=0}^{8} \Delta\boldsymbol{\Lambda}_{t-s}$	3.94*	8.27***	8.91***	3.15***	2.94**	4.25***	4.51***	5.30***	4.75***
	(2.13)	(2.90)	(1.06)	(1.26)	(1.10)	(0.94)	(1.06)	(1.36)	(1.34)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}^{oil}_{t-s}$	0.87*	-0.73***	-0.35*	0.02	-0.09	-0.49***	-1.26***	0.79***	-0.46***
	(0.48)	(0.23)	(0.19)	(0.17)	(0.12)	(0.13)	(0.18)	(0.21)	(0.09)
$\sum_{s=0}^{8} \Delta\boldsymbol{\pi}^{imp}_{t-s}$	5.73***	6.63***	7.98***	6.05***	8.19***	14.40***	5.52***	7.17***	14.22***
	(1.92)	(1.52)	(1.68)	(1.42)	(2.11)	(3.43)	(0.72)	(1.91)	(2.55)

Appendix 7.2: Cont'd

$\bar{R}^2$	0.52	0.60	0.62	0.58	0.65	0.61	0.68	0.72	0.63
RSS	0.12	0.11	0.12	0.13	0.11	0.14	0.10	0.07	0.12
AIC	-2.61	-2.78	-2.82	-2.72	-2.90	-2.82	-2.99	-3.17	-2.89
F-Test$_{(PSS)}$	12.86**	9.25**	16.70**	16.00**	7.96**	7.37**	20.92**	17.64**	8.55**
RESET	0.08 [0.77]	0.62 [0.43]	0.01 [0.90]	0.61 [0.43]	0.31 [0.57]	0.61 [0.43]	0.43 [0.40]	2.42 [0.12]	0.52 [0.46]
***LR-Sym*(1)** $\beta^{(+)} = \beta^{(-)}$	NO	NO	NO	NO	NO	NO	NO	NO	YES
***LR-Sym*(2)** $\beta = \beta^{(1,2,3)}$							NO	NO	YES
***SR-Sym*(1)** $\theta^{(+)} = \theta^{(-)}$	NO	NO	NO	NO	NO	NO	NO	NO	NO
***SR-Sym*(2)** $\theta = \theta^{(1,2,3)}$							NO	NO	NO
$\tau -$ ***LR Test***				40.48**	62.87**	16.94**	21.65**	44.53**	-1.80

Source: Author's computations based on data from the Central Bank of Nigeria and the National Bureau of Statistics.

Note: Econometric estimation was conducted with *EViews 7.0* software using data are from 1985:Q1 to 2011:Q2. Figures in ( ) are HAC standard errors. ***, ** and * indicate significance at the 1%, 5%, and 10%, respectively. *RSS* denotes residual sum of squares while *AIC* is the Akaike information criterion for evaluating models: smaller values are preferred. *F-test*$(_{PSS})$ is the cointegration bounds-tests (for case III: unrestricted intercept and no trend) using 5% asymptotic critical values from Pesaran *et al*. (2001). *RESET* is the *F*-statistic of Ramsey's specification error test using the squares of fitted residuals; *p*-values are in [ ]. *LR-Sym*(·) and *SR-Sym*(·) are *Wald*-tests for asymmetric multipliers in the long- and short-run, respectively, where test(1) investigates asymmetry in all regimes in all models and test(2) is for nonlinearity in model C. $\tau - LR\ Test$ is the likelihood ratio test for threshold validation.