ESSAYS ON THE TRANSMISSION MECHANISM OF MONETARY POLICY

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The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

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ABSTRACT

This study presents coverage of the transmission mechanism of monetary policy in the UK. It shows that historically, monetary policy has evolved through several distinct phases and frameworks over the last quarter of a century. A "new consensus" has emerged as a key theoretical construct of this process, with implications for the nature and role of money in an endogenous framework. It is argued that this is the essential basis for the current mode of economic analysis at the Bank of England. A further series of implications of this are the outcomes of Inflation Targeting as an objective of monetary policy. The stance can be shown to underpin thinking on monetary policy rules and these are used to perform an initial econometric analysis of a monetary policy reaction function. It is argued that the essential time series properties of such rules are generally overlooked in the empirical literature. Tentative analysis suggests that Taylor-type monetary policy reaction functions may not necessarily fit with an Inflation Targeting policy. In addition, the extent of pass through from official to retail bank interest rates is considered and shown to be incomplete.

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CHAPTER ONE

INTRODUCTION AND OUTLINE PLAN OF STUDY

1.1 INTRODUCTION

Chapter two begins with an overview of monetary policy in the UK between 1975 and 2008. This covers the periods of boom and bust, rising unemployment and also the oil price shocks of the early 1970s. The analysis then moves on to a coverage of expansionary monetary and fiscal policy measures and also competition and credit control. Coverage then continues to look at the theoretical origins of monetary policy targets and to this end Friedman's (1960) early analysis is considered. As is Poole's (1970) approach to the IS/LM model. This is followed by a coverage of work by Simons (1936), Lucas (1972) and also Kydland and Prescott (1977). We also refer to Cobham (2002) to identify various types of monetary policy targets. In section 2.3, Svensson (1999) is referred to as in a description of monetary policy rules and an illustration of these is provided with reference to McCallum (1988). More specifically, coverage of monetary policy in the UK looks at monetary targeting in the early 1970s followed by boom and bust as previously mentioned. The analysis then moves on to a look at inflation targeting and also instrument independence at the Bank of England. This is followed by the final and current phase of UK monetary policy which is an operationally independent central bank. The next part of the second chapter considers the role of the policy instrument, competition and credit control. This is followed by chapter three which developed the theoretical basis for this thesis. namely an introduction to monetary policy when money is endogenous. This third chapter presents the operation of monetary policy in terms of a framework where credit money is endogenously created by the banking system. This chapter covers the new consensus as illustrated by Meyer (2001) as well as a look at transmission channels of monetary policy. This is followed by another section on monetary policy and aggregate demand where we make reference to authors such as Arestis and Sawyer (2003). A further section considers the role of monetary policy and the exchange rate followed by a development of the endogenous money framework from a Keynesian perspective. Monetary policy in an endogenous money framework considers liquidity preference, the exchange rate, the role of fiscal policy and also the objectives of monetary policy. The analysis also includes coverage of fine tuning with monetary policy and monetary policy instruments before rounding up with a conclusion of material discussed.

In chapter four, we introduce monetary policy rules as a prelude to forthcoming chapters which will seek to estimate Taylor type monetary policy reaction functions. These include a look at some of the preliminary modelling issues such as types of variables to be used in a potential Taylor rule together with some of the issues. They monetary policy rule of Taylor and others is also presented in this chapter. The second part of this chapter on monetary policy rules considers optimal monetary policy rules and how these might be used in practice and also their relevance to monetary policy transmission. The chapter also offers a consideration of trade-offs and shocks from demand and supply, rule specifications and proposed parameters, the role of the exchange rate and also addresses the issues of stability and the output gap. The chapter concludes with a summary of key issues discussed. Chapter five introduces inflation targeting and considers the role of inflation targeting in a new consensus framework. Some of the theoretical aspects of inflation targeting are also considered including the nominal anchor, real and monetary factors, the causes of inflation and also inflation and the monetary policy transmission mechanism. The chapter then introduces some empirical evidence on inflation targeting including inflation targeting and macro-econometric modelling and inflation targeting in the context of single equation techniques before rounding off with a conclusion on key insights. Chapter six introduces the data and research method for this study. It considers some of the variables to be used for the purposes of estimating Taylor type monetary policy rules. It also considers the important issue of periodisation or how to break the data into manageable regimes. This has been a key issue since there is some debate over how to determine the appropriate time periods. Generally there are two approaches to this; one is using descriptions from the academic literature and the second is to use econometric techniques such as structural break analysis. This section also makes reference to the actual appendix used for this study containing some of the data estimates.

In chapter seven we present the results of an initial econometric analysis and this consists of tests for the order of integration, which include common unit root approaches. The results from unit root tests are used to determine how the data should be modelled and whether or not cointegration analysis should be conducted. This chapter also considers the determination of appropriate lag lengths for cointegration testing, the use of deterministic trends for model selection or in other words the Pantula (1989) principle, the Johansen approach to cointegration testing and also further statistical tests such as weak exogeneity, linear restrictions and parameter stability. Chapter eight discusses the results of these preceding chapter in terms of implications for monetary policy. On the whole it has been shown that the according to the data used in this study it is difficult to estimate reliable Taylor type monetary policy rules for the sub-periods under consideration. In chapter nine we move on to another area in the transmission of monetary policy, namely interest-rate pass through in the UK. This chapter begins with presentation of some theory on interest-rate pass through as well as a review of the empirical literature. Both of these suggest that interest-rate pass through is not complete in the UK. This chapter then introduces some data and specifies a model for estimating interest-rate pass through in the UK. The results are presented towards the end of the chapter and employ a similar econometric approach as described for chapters seven and eight. The essential insight of chapter nine is that interest-rate pass through is incomplete for the UK. Finally chapter ten concludes this thesis with a summary of some of the issues considered.

CHAPTER TWO

UK MONETARY POLICY 1975-2008: AN OVERVIEW

2.1 INTRODUCTION

In 1975, UK economic policy was being framed by a recent economic boom and rising unemployment in the domestic economy, as well as the first world oil price shock. Expansionary monetary and fiscal policy measures had been pursued as a means of stimulating aggregate demand, and broad money was growing on the back of Competition and Credit Control. On the balance of payments side, deficits in the current account had seen the float of sterling which continued to depreciate. Economic growth continued to stagnate and an existing incomes policy had done little to curb rising inflation. Government spending was subsequently reduced, official interest rates increased and bank lending controlled through the Supplementary Special Deposits Scheme. The previous year had seen the election of a new Labour government, and the beginnings of the miners' strike. The economic record of the Labour government is well documented by Artis and Cobham (1991: Chapters 1 and 16) and also by Allsopp (1991) amongst others, who point to largely unsuccessful outcomes in terms of fiscal deficits, monetary growth, rising inflation and reduction in GDP growth. Tighter controls over incomes policy and public expenditure were adopted in 1975, though sterling continued to depreciate, inducing large increases in official interest rates, followed by limits on domestic credit expansion. By 1977, recent sterling depreciations allowed for increased foreign reserves and lower interest rates. Incomes growth was at trend rate, inflation was beginning to subside and sterling M3 became a target for broad money growth. The following year saw a breakdown of negotiations between the government and the trade unions, resulting in the 1978 'Winter of Discontent'. In May 1979, Margaret Thatcher was elected to the office of Prime Minister and signaled a concern for inflation control over unemployment by focusing on monetary targets rather than fiscal policy. Reductions in income tax and increases in VAT however, induced further increases in inflation, leading to a contractionary monetary policy, which was followed by the second world oil price shock. The result was an increase in official interest rates, an appreciation of sterling, and an increase in unemployment. By 1981, official interest rates were reduced and fiscal policy tightened in the introduction of the Medium Term Financial Strategy, which lead to a move away from monetary targeting in 1985. The exchange rate however, had continued to fall prompting large increases in official interest rates. In January 1985 for example, sterling was almost at parity with the dollar. Though economic growth and output were both stimulated somewhat with the ending of the miners' strike in 1985, it was not sufficient to curb rising unemployment. 1987 saw the introduction of Deutschemark shadowing under Chancellor Lamont as a means of achieving greater exchange rate stability, and preparation for membership of the exchange rate mechanism. Such measures coupled with Competition and Credit Control, and the depreciation of sterling, were followed by the 'Lawson boom' in which inflation saw double digits by the early 1990s. UK entry into the ERM in October 1990 was short lived, itself subject to the economic strains of German reunification and speculation over sterling. The exit in September 1990 initiated falls in official interest rates, a sterling depreciation and a shift in monetary policy which consisted of a move towards inflation targeting and a restructuring of the roles of

HM Treasury and the Bank of England. In May 1997, a new Labour government granted operational independence to the Bank of England, making it responsible for managing official interest rates in order to pursue a government determined target for the rate of inflation. In the period since, inflation was brought under control and economic growth moved largely at trend rate.

This chapter presents an overview of UK monetary policy between 1975 and 2008 as a prelude to forthcoming chapters. In section two, the development of monetary policy is traced through five different regimes. This is followed in section three by the various instruments used to implement monetary policy. The chapter concludes with a summary in section four. To this end, the theoretical origins of monetary policy targets are outlined in brief so that the rationale for monetary policy rules and targets might be understood. This is followed by the frameworks within which such rules and targets have been adopted. It is suggested that the theoretical origins of monetary policy targets can be associated with the literature on targets and instruments and on rules versus discretion, and that these origins support thinking on monetary, nominal income, exchange rate and inflation targets.

The latter of these, namely inflation targets, have spawned a large literature on monetary policy rules, in which Taylor (1993) has revived a long-standing theme in economic policy.[1]

The section overleaf, considers the theoretical origins of monetary policy targets.

[1] Johnson (1972: 233): "the tradition of British central banking and monetary theory…identified monetary policy with the fixing of the level of interest rates".

2.2 THEORETICAL ORIGINS OF MONETARY POLICY TARGETS

According to Friedman's (1960) early analysis, the rate of growth of the money supply is constant and equal to the underlying rate of productivity growth. At the same time, a stable demand for money removes any need for discretionary monetary policy. This results in price stability and in money growth during recession being greater than nominal income. In Poole (1970) however, the emphasis is on income stability and not inflation control. The rate of interest is fixed in an IS-LM model with a constant money supply and horizontal LM curve. Income is determined in terms of random shocks to expenditure and also the demand for money, with policy assumed to respond slowly to shocks. When the LM curve is upward sloping in the Friedman (1960) sense, and the IS curve is shifted by expenditure shocks, monetary policy results in a smaller income variance. Conversely, when the LM curve is shifted by money demand shocks, income varies but is constant when the interest rate is fixed, since changes in money demand are met with changes in money supply. The appropriate rule under the presence of both types of shocks depends on their relative variances and covariances, but in general is a combination of both rules in which the money supply and rate of interest both vary with one another, and in a specific way with income, as opposed to a fixed money supply. In Friedman (1975), the supply of money is not directly controlled by the authorities but influenced towards some preferred level via changes in the rate of interest and the level of bank reserves. The desired level of the policy target is determined by *ex ante* assumptions about possible shocks to the economic system. The policy instruments of interest rates and bank reserves are then set to achieve the desired level, with the actual level of the policy target determined by actual *ex post* shocks to the economy. Here, the money supply is an information indicator in the optimal rule, providing an insight into the magnitude of economic shocks. This information is then used to set the interest rate and bank reserves with the level of the policy target in mind. Thus in terms of short-run stabilisation, an intermediate target as implied by Friedman (1960) is not justified. Poole (1970) however, leaves open the question of policy rule responses to different shocks. An alternative early perspective is offered by Simons (1936), in which rules ought to prevent against discretionary monetary policy being subject to bias from political decisions. This is furthered by Friedman (1948, 1953) in which policy lags are destabilising for discretionary policy, and by Phelps (1967) then Friedman (1968) in which monetary policy affects real income only in the short run. In the rational expectations hypothesis of Lucas (1972), policy is not effective, even in the short run, though in the time-inconsistency approach of Kydland and Prescott (1977), a strong case for monetary policy rules or targets is advocated. A private-sector supported and public policy preference for low inflation and unemployment below the natural rate, results in relatively higher inflation expectations.[2] Only at a relatively high rate of inflation and a natural rate of output will a long-run equilibrium exist where the authorities do not have a preference for stimulating output.[3] Both the public and private-sector preference is for the natural rate with a lower level of inflation, but this is dependent on the presence of some ‘precommitment device’ such as an intermediate monetary policy target which penalises against high inflation. For example, failure to meet a pre-announced target has an adverse

[2] Bean (1998) offers a similar point. The monetary authorities do not pursue above natural rate output because of shocks which lower the natural rate below an optimum Walrasian equilibrium rate. They do however, prefer higher output in general and this is partly because of political considerations.

[3] The authorities are assumed to follow a quadratic loss function for inflation in which a strong preference to avoid inflation is present for high levels of inflation. At this level, output can only be increased at the expense of higher inflation.

impact on economic credibility. Alternatively, a monetary 'constitution' allowing monetary policy decisions to be made without an incentive to increase output. For example, an operationally independent central bank mandated with price stability. That said, the analysis above applies largely to monetary authorities with specific preferences over the level of output, but which are not independent. For an operationally independent central bank, the role of a target is more to do with indicating monetary policy intentions. Incidentally, Bean (1998) argues that an operationally independent central bank is of itself a solution to the time-inconsistency problem.

Cobham (2002: 3), identifies three types of pre-announced monetary policy target adopted in the UK over the last thirty years; monetary (growth rate for some monetary aggregate), exchange rate (central parity with a degree of fluctuation) and inflation rate (currently a CPI of 2%).[4] Monetary targets were operational from the mid-1970s to the mid-1980s, exchange rate targets as part of the Exchange Rate Mechanism (ERM) in the early 1990s, and inflation targets since the early 1990s. Operational details are pertinent to the implementation of each target, and these include ensuring correct definition, time period and numeric form, as well action to be taken and announced in the event a target is not met. In terms of the studies highlighted above, this means good short-run stabilisation properties, and transparency, acocuntability and credibility of policy decisions. These are summarised by Cobham (2002: 8), together with a note on the importance of monetary authority control over a target as follows. Monetary targets responded well to domestic and foreign expenditure shocks but not to asset

[4] Nominal income growth is discussed by Brittan (1982) but has not been adopted in the UK.

market and supply shocks. They were difficult to control and intepret, though easier to verify. Nominal income targets are considered to respond well to demand but not supply shocks, and better (worse) than monetary targets on interpretation (verification), with nominal income even harder to control than monetary targets. Exchange rate targets absorb money demand shocks and perhaps also supply shocks, but not so for open economy expenditure and exchange risk premium shocks. Though easier to verify than they are to interpret, control of an exchange rate target is subject to much volatility. Lastly, inflation targeting does well in terms of absorbing demand shocks and being easy to interpret and verify, but poorly on supply shocks and control.

2.3 MONETARY POLICY RULES

In Svensson (1999), monetary policy rules are 'instrument rules' which specify changes in the monetary policy instrument in response to economic events. An example of such rules is McCallum (1988) in which monetary base (M0) growth adjustments are used to achieve a target nominal income level:

$$\dot{m} = k^* - \dot{v} + \lambda(x^* - x) \tag{1}$$

where quarterly monetary base (M0) growth ($\dot{m}$) responds to a constant (k^*), a trend change in velocity ($\dot{v}$), actual (x) and target (x^*) levels of the log of nominal GDP, and a weighted deviation from target (λ), of actual nominal GDP. This is similar to Friedman (1960), but modified to include changes in velocity and greater counter-cyclical effect in the final term. A shortcoming of this rule is the need to control the monetary base – a policy not adopted in the UK, but also according to Goodhart (1994), a risky policy prescription. Perhaps the most popular monetary rule of recent times, is that of Taylor (1993) in which changes in the policy interest rate respond to deviations of inflation from target and of output from trend:

$$r = r^* + \pi_{-1} + a_\pi (\pi - \pi^*) + a_y \left(\frac{y - y^*}{y^*} \right) \qquad (2)$$

where the federal funds rate (r) responds to the 'equilibrium' interest rate assumed close to the steady-state growth rate (r^*), expected inflation proxied by the four-quarter rate of inflation (π_{-1}), an inflation reaction coefficient of 0.5 (a_π), the current rate of inflation (π), the target rate of inflation (π^*), an output reaction coefficient of 0.5 (a_y), current output (y) and the trend level of output (y^*). Rather than a mechanical rule, equation (2) is a stylised representation of monetary policy intended as a yardstick from which other monetary policy decisions can be assessed. As Taylor (1998) notes, the rule is an intermediate target in the sense that it represents pre-commitment without political interest. The empirical literature is replete with Taylor (1993) and Taylor-type rules estimated under a variety of different settings. In Clarida, Gali and Gertler (1999) for example, the response of the policy instrument to inflation, in which a positive coefficient on the deviation of output from trend is required for long-run inflation stability, since an increase in inflation is met with a rise in the real rate of interest. In Ball (1999), a 'monetary conditions index' is constructed in which a weighted average of the rate of interest and the exchange rate respond to changes in inflation, the output gap and lagged exchange rate terms. In Svensson (2000), a forward-looking rule is presented in which the policy instrument responds to the real exchange rate, the foreign interest rate and the foreign exchange risk premium. inflation and the output gap. In Nelson (2000), Taylor-type rules are estimated for different phases of UK monetary policy.

2.4 UK MONETARY POLICY 1975-2008

This section considers the main frameworks of monetary policy adopted in the UK since 1975. These include monetary targeting, the 'Lawson boom', Deutschemark shadowing and the ERM, and inflation targeting. In addition, it considers the significance of operational and instrumental independence of monetary policy.

2.4.1 Monetary Targets

At the beginning of the period under consideration, UK monetary policy saw a shift in focus. A largely defunct Bretton Woods system was abandoned for greater inflation control, and targeting of broad money growth as indicated by the then Governor of the Bank of England, (1978: 33), who stated, "I think it is not therefore entirely accidental that during each of the three years 1974-76, the growth of sterling M3 was about 10%, well below the rate of expansion of national income in current prices." In Kynaston (1995: 31-37), the emphasis on sterling M3 in the Medium Term Financial Strategy, as well as greater power over monetary policy making for HM Treasury is noted. The academic literature does include discussion of monetary targets in terms of Friedman (1960) and Kydland and Prescott (1977) monetary policy rules, with Lane (1985) countering against this idea.[5] However Cobham (2002: 16) offers some thought on the rationale for monetary targeting from a policy perspective, arguing it offered greater stability in the public and private sectors. In this regard, Cobham (2002: 16) cites the following statement by the Bank of England (1984: 4), in which,

> "The Bank has consistently felt the need for a financial anchor, whether it be a fixed exchange rate or a monetary target, which needs to be both publicly announced and vigorously defended, in order to give a confident basis for private sector decision makers to plan forward. But it has never, on the other hand, felt that economic relationships were sufficiently predictable, or the financial system so static, that the conduct of policy could be safely placed on a quasi-automatic basis with the adoption of constant rules."

Further evidence from the Bank of England (1978: 31-37) seems to suggest that broad money was considered an appropriate indicator of inflationary pressure. Furthermore, in Fforde (1983: 201-202) it also seems that broad money targets were part of an overall economic strategy that included the use of fiscal policy operating alongside monetary policy. Nevertheless, the Financial Statement and Budget Report of 1984-1985 (Cobham, 2002: 17), shows that monetary targets were proving "difficult to interpret" and that other, "more satisfactory indicators of financial conditions" were being sought by the authorities. An example of this as reported by the Bank of England (1989), is the conversion of the Abbey National from building society to bank which would have had a significant impact on broad money targeting. However the authorities did not report this, opting instead to move to another broad money target. Monetary targeting might also be noted for a lack of transparency and accountability. In the Financial Statement

[5] The intention here is to consider monetary developments in an economic policy context. For examples of academic issues, see Davis and Meek (1983), Foot (1981) and Summer (1980) amongst others.

and Budget Report of 1984-1985 (Cobham, 2002: 17) for example, decisions are made on "assumptions about the growth of money GDP."

In Llewellyn (1991), the role of financial innovation in monetary targeting is also documented. In the banking sector, this consisted of increased competition between banks and building societies, which resulted in lower transaction and intermediation costs for customers. Building societies themselves became more competitive, moving to provide products conventionally associated with retail banks, and this meant that the distinction between banks and building societies was becoming less clear. In the wholesale markets, competition resulted in a wider choice of financial instruments for individuals as well as greater transparency in the aftermath of the 1986 big bang, also providing lower transaction costs. In Cobham (2002: 37-39), financial innovation during the monetary targeting framework is said to have been aided by volatile financial markets, and non-monetary aspects of economic policy. In addition, deregulation increased competition in the financial sector and was followed by technological advances such as electronic transactions through computers and automated teller machines. Such developments had the effect of reducing transaction costs. Furthermore, "increased competition was in nearly every sphere both a cause and an effect of financial innovation."

2.4.2 Boom and Bust

Overshoot was a major problem with monetary targeting and this seems to have prompted Chancellor Lawson (1992) to seek entry into the ERM on the grounds that it would provide monetary policy with the credible framework that it was lacking. In the first year of informal Deutschemark shadowing however, the UK experienced much interest and exchange rate volatility, followed by a float of sterling and rising inflation. Formally, UK membership of the ERM lasted only from October 1990 to September 1992, following a speculative sterling crisis or 'Black Wednesday', which resulted in a suspension.

According to Congdon (1992: 156), monetary and credit growth were major determinants of the boom, and the result of both, "the change in policy approach" and the lack of attention given to "credit and broad money." Cobham (2002: 54) however, argues that there is little evidence to support this assertion in terms of an increase in monetary growth, and that it ignores the role of competition between banks and building societies, as well as the unreliability of monetary growth statistics. Another issue relates to the problem of causality. Cobham (2002: 55) argues monetary targeting resulted in control of broad money growth during the short term. In the aftermath of overfunding, monetary growth was not subject to control by the authorities and subsequently increased slightly. This resulted in a weak and heavily lagged influence of official interest rates on the demand for bank credit. As a result,

> "monetary growth was much more obviously endogenous from 1985, that is responsive to, and determined by, changes in economic activity and other factors. It is therefore difficult to talk of an exogenous increase in monetary growth initiating a rise in aggregate demand."

A second explanation of the boom in the academic literature, is based on the role of financial liberalisation and deregulation which resulted in increased competition in the financial markets.[6] In this view, the removal of interest rate cartels amongst banks and building societies, the entry of banks into mortgage markets and building societies into banking markets, as well as greater transparency in the wholesale markets, generated increased borrowing in both the public and private sectors. According to Miles (1992: 70) for instance, equity withdrawal in the housing market became a sustained trend. Sargent (1991: 79) however, questions the 'consensus' that financial liberalisation induced the boom, by arguing that large increases in borrowing were the result of increased debtor confidence in ability to repay. In addition, the "climate of over-optimistic expectations which developed in the 1980s about the economy's performance" is argued to be the result of increased productivity. In reference to the economic conditions underpinning such developments, Lawson (1992: 631), notes that, "the exceptional duration of the upswing, led too many borrowers and lenders to believe that it would go on forever." Nelson and Nikolov (2001) however, argue that official demand and output statistics during this period had been subject to much revision and that this resulted in poor growth forecasts. Nevertheless, the Bank of England (1990: 215-220) suggests expectations, financial liberalisation and official interest rate reductions all contributed to increased consumer demand. The role of consumer expenditure in the housing market has also been considered as an important factor in this context. In particular, the increase in borrowing and equity withdrawal on the back of financial liberalisation has been the subject of academic enquiry by authors including Aoki *et al.* (2001), Miles (1994), Bayoumi (1993) and Carruth and Henley (1992). In these studies, it seems feasible that

[6] See for example, Lawson (1992), Sargent (1991), and Muellbauer and Murphy (1989)

financial liberalisation may have contributed to increased borrowing, though the causes of falling savings ratios are less clear.

2.4.3 Inflation Targeting

The UK failure with the ERM paved the way for the introduction of an inflation target for monetary policy. In addition, the Bank of England was to make inflation projections, forecasts and official interest rate recommendations for HM Treasury, which would in turn make the final decision over short term nominal interest rates. Furthermore, details of discussions between HM Treasury and the Bank of England were minuted as a means of developing greater transparency, accountability and credibility in the policy making process. Though well intentioned, it remained subject to political bias. For example, prior to the election of the new Labour government in May 1997, the then Conservative Chancellor failed to increases official interest rates when the economics would have supported such a move. The inflation target thus followed previous monetary and exchange rate targets for monetary policy in the 1980s and ERM periods respectively. An inflation rate of between 1% and 4% was set out and monetary policy would aim for a rate of 1% to 2.5% of the 12-month increase in the retail price index excluding mortgage interest payments, or RPIX. In 1995, the government reset the target to 2.5% or less, with a time lag of two years between monetary policy decisions and their effects on the rate of inflation. The inflation target was also coupled with a monitoring range for the monetary base, M0, which had been targeted since the mid-1980s, and the broad money aggregate M4. The exchange rate was not explicitly monitored, but was nevertheless subject to "regard" by the authorities. (Cobham, 2002: 94). The new setup for monetary policy is described in terms of the following characteristics by Cobham (2002: 94).

First, was a quarterly inflation report produced by the Bank of England, which would include forecasts of expected inflation for the next two years. This ran alongside the Bank of England Quarterly Bulletin and according to King (1994), was only presented to HM Treasury in final form so that it could not be censored. Second, regular and formal meetings between the Chancellor of the Exchequer and the Governor of the Bank of England were adopted as a basis for arriving at monetary policy decisions – which the Chancellor would make. Third, the Bank of England was given some discretion over the timing with which it implemented the interest rate decisions that the Chancellor had made. This was largely intended to increase policy credibility by removing doubts of political bias. Fourth and from 1994, monetary policy meetings were officially recorded with the minutes released some six weeks thereafter. These typically included an account of prevailing economic conditions, the views of the Governor and Chancellor, followed by an explanation of the appropriate monetary policy decision. Fifth, a Monetary Report by HM Treasury was also published to include the monetary and economic data used for making policy decisions. The move to inflation targeting might be considered indicative of a shift in monetary policy among small open economies as identified by Bernanke *et al.* (1999) amongst others. The rationale seems to be an ability to absorb changes in money demand as well as being more transparent, which feed into greater influence over inflation expectations and commitment to achieving the target. The relative difficulty in managing inflation targets compared to monetary aggregates however, implies difficulties over the effective operation of the inflation target. It might also be argued that inflation targeting produces greater variability of real output in response to negative supply shocks, compared to say nominal income targets. Interestingly however, King (1994) argues that when the inflation target is stated in terms of a range, it becomes possible to bypass the effects of negative supply shocks.

Official sources might be used to suggest that the new setup between the government and the Bank of England was to some extent the result of Black Wednesday which caused the government to suffer a loss of credibility. For example, HM Treasury (1992: 3) notes that the changes were intended as "steps to improve the credibility of anti inflation strategy." Similarly King (1994: 123) notes that these were "institutional changes designed to bolster the credibility of the commitment to low inflation." Although both these quotes suggest a preference for greater credibility and transparency, it is argued that these could have been achieved without a separation of the institutional roles of government and Bank of England. Cobham (2002: 95) for example, argues that,

> "It therefore seems obvious that what was happening was that in order to regain credibility the Treasury felt obliged, not merely to undertake to explain its policies and actions more clearly, but also to concede some limited and informal (and therefore reversible) autonomy in monetary policy to the Bank of England, whose reputation had been less adversely affected by the events of September 1992. However, it should also be noted that the shift had the effect of strengthening the Chancellor against pressure from the Prime Minister (Stephens, (1996: 292-293), and of forcing the Bank's views out into the open in a way that could weaken, as well as strengthen, the Bank."

It might also be argued that the time inconsistency problem was officially recognised in the Bank of England Quarterly Bulletin (1992: 441-448) and that this contrasts with the earlier position of the Bank of England Quarterly Bulletin (1990: 482-486) concerning UK entry into the ERM. A possible solution to time inconsistency at the time was Bank of England independence as recommended by the OECD (1993: 43) but this was not adopted. Also, according to Hansard, the authorities were presented with the option of Bank of England independence on the grounds that it would ensure greater policy credibility, but refused citing lack of accountability to Parliament of an independent central bank. Similarly according to Lawson (1992: 867-873), Bank of England independence had also been proposed in the late 1980s but not considered by then Prime Minister Margaret Thatcher.

Official statistics on the target measure of inflation – the 12-month retail price index excluding mortgage interest payments – of 4% show a fall from a previous peak of 9.2% in 1990. The trend continues to 2% in 1994 before rising to 2.8% and 3.3% in 1996, after which falls to 3.1% and 2.9% are followed by another fall to the inflation target of 2.5% in April and May 1997. Additional indications are contained in the Bank of England Inflation Report, which suggests increased inflation expectations after Black Wednesday, a reduction over 1993, a general downward trend over 1994 followed by a rise over 1995. In the latter part of 1995, inflation expectations were 3%, followed by 2.9% for 1997 and 3.3% for 1998. According to Breedon (1995), short term inflation expectations fell after Black Wednesday, before rising during 1994, and falling again over 1995 and 1996. Medium and long term inflation expectations rose in late 1992, falling in 1993 before rising again in 1995 and 1996. In practice, monetary policy decisions under inflation targeting were taken by the Chancellor, though the views of the

Governor of the Bank of England were also published to aid credibility. Both parties were thus seen to be pursuing an inflation target, though Cobham (2002: 102) suggests that this brought additional objectives for each, citing five examples of supporting developments in monetary policy over the same period. For the government, this meant retention of the political power still associated with monetary policy making, of particular importance given the events of Black Wednesday. For the Bank of England, the limited degree of autonomy was to be maintained, if only to increase monetary policy effectiveness in the long run.

The first concerns the willingness by the Chancellor to raise the minimum lending rate in 1994 and 1995. This was well before a possible general election and signaled some degree of credibility in policy. The second concerns an unwillingness to raise interest rates in mid 1995 against market and Bank recommendations, which represented a deliberate undermining of the Bank of England by the Chancellor. The third example concerns four interest rate cuts between December 1995 and June 1996. It might be argued that this was partly influenced as much by a forthcoming election as they were by a slowdown of growth. The fourth concerns the Bank of England being willing to support the Chancellor in cutting interest rates in December 1995. It is suggested that this was the result of the strategic failure earlier in the year in which the Bank disagreed with the Chancellor and lost credibility. The decision to agree the cut is thus considered an opportunity for the Bank to regain leverage in the wholesale markets. The fifth example concerns the Chancellor's continued rejection of Bank of England recommendations to increase interest rates between December 1996 and April 1997. This might be interpreted as intended to induce a significant consumption-led expansion of the economy in time for a forthcoming election, even if this risked an overshoot of the inflation target. As it happened, inflation did overshoot target after the election. Regardless of the correctness of these interpretations, Cobham (2002: 103) argues that,

> "there seems little doubt that the Bank of England made efforts (mostly not observable) to protect and strengthen its autonomy and to further the case for central bank independence. In particular, it worked to improve its monetary expertise (notably its inflation forecasting capacity) and made use of the mechanisms of accountability such as the Inflation Report and the Governor's contributions to the minutes of the monthly Monetary Meetings (as well as speeches by the Governor and other officials) to establish its technical reputation; and while talking about monetary policy mainly in terms of what central banks should do and how, and without referring explicitly to political decision making, it also made small but persistent references to the concept of central bank independence."

In King (1997), the new framework is analysed in terms of four rules, namely a state-contingent rule, a time consistent non-contingent rule, discretion and a conservative rule. It is argued that an optimal state contingent rule is not appropriate since it is time inconsistent, and thus preference is given to the conservative rule. A further argument is that the new inflation targeting framework could be conducive to a more credible monetary policy and allow for a state contingent rule to be operated. The overall analysis seems supportive of the new framework and the giving of a "greater role to the Bank of England." (King, 1997: 97). Also, according to the Bank of England Quarterly Bulletin (1997: 103), the new framework would deliver, "a decade of growth through stability." The credibility of the new monetary policy framework has also been considered by Cobham *et al.* (2001) in which the Bank of England is assumed to be pursuing an inflation target and the Chancellor susceptible to political as well as economic considerations. Another assumption is that any divergence of the Chancellor from the views and recommendations of the Bank of England, would be interpreted by the financial markets as political bias and evidence of the credibility of monetary policy being eroded. In a further study by Adam *et al.* (2001), a monetary policy reaction function covering the inflation targeting framework suggests policy was influenced by both domestic and international variables, particularly the pass through from exchange rates to prices. The authors conclude that a significant international aspect suggests an increased credibility of monetary policy.

The inflation targeting period might thus be described in terms of greater monetary policy transparency compared to previous regimes, and some limited degree of independence for the Bank of England. Initially, inflation also remained within the 1% to 4% band before achieving the target of 2.5%.

2.4.4 Instrument Independence

In May 1997, instrument independence was granted to the Bank of England in the form of the Monetary Policy Committee (MPC), responsible for adjusting short term nominal interest rates to meet a government determined inflation target. This was, and is, supplemented with the publication of inflation reports, forecasts and the minutes of meetings set to decide the level of nominal interest rates. The arrangements of the current set up are included in the Bank of England Quarterly Bulletin (1998: 93-99), which relates a government determined inflation target against which the Bank of England is given an operational remit for setting official interest rates. Formally, this is stated as, "to maintain price stability and, subject to that objective, to support the government's economic policy, including its objectives for growth and employment." Similarly, exchange rate policy is also the responsibility of the government, with the Bank holding foreign exchange reserves to be used at discretion in support of monetary policy. This is in addition to operating government foreign exchange reserves if instructed to do so. In addition, Bank of England debt management and financial market supervision have been transferred to the Debt Management Office and the Financial Services Authority respectively. The three party relationship is now based on the Memorandum of Understanding as in Goodhart and Schoenmaker (1995). Finally monetary policy is set by the Monetary Policy Committee.

2.4.5 Operational Independence

The discussion in this chapter identifies monetary targets, exchange rate targets and inflation targets as the objectives of UK monetary policy. At some points in time there existed no target at all. Interestingly, operational independence for the Bank of England only took place under the latter regime of inflation targeting. In terms of economic performance of macroeconomic variables such as inflation, growth, output and employment, it might be argued that monetary policy under inflation targeting with an operationally independent Bank of England making adjustments of short term nominal interest rates has been relatively more successful. On the other hand, it might also be said that the global economic climate in the 1990s has been more conducive to low inflation than were the 1970s or 1980s. This completes the discussion on monetary targets, boom and bust, inflation targeting, instrument independence and operational independence. The chapter now looks at the policy instrument, which is introduced overleaf.

2.5 THE POLICY INSTRUMENT

Given the variation in monetary policy frameworks during the period under consideration, the instrument of such policy has also changed substantially. Monetary targeting for instance saw the use of credit counterparts to control monetary aggregates. The emphasis on broad money rather than the monetary base or some other monetary aggregate is also indicative of a supply side view. In contrast, inflation targeting required adjustments in the short term nominal interest rate to induce changes in the level of aggregate demand and the rate of inflation, rather than a monetary aggregate.

2.6 COMPETITION AND CREDIT CONTROL

Towards the end of the 1960s there seemed greater official concern of the effect of ever more control over bank structure and competition. The Governor of the Bank of England (1971) objected to examples of direct control including 'requests', 'guideline' and 'ceilings' on the grounds that such non-price approaches to rationing were not conducive to efficiency and equity. Examples of inefficiency included the allocation of funds below market clearing level prices, into export and manufacturing commitments relating to government policy preferences, but which returned less on the initial investment than other areas such as consumer goods. Inequity also resulted from regulations adversely affecting the very institutions they were designed to benefit, rather than those they were not. Non-bank financial intermediaries and newly created secondary banks whose remits kept them out of the controls benefited as the burden of control largely affected clearing banks. The development of new markets and institutions outside the remit of controls, induced a black market non-price regulation effect, in which controls affecting banks and bank customers provide a market incentive for evasion. This is turn fuels new regulatory and enforcement costs, whilst also compromising the credibility of existing indicators and removing important information. This phase of 'squeezing the balloon', in which controls imposed at one point were bypassed by financial innovations elsewhere. lead to further revision of operating procedure.

Another development that was also taking shape through IMF pressure and also because of a shift in thinking towards the more direct linking of monetary aggregates to nominal income through a stable money demand function, was control over the volume of bank credit as a possible intermediate monetary policy target. This resulted after much discussion and debate in Competition and Credit Control aimed at fostering greater banking competition than monetary aggregate control. In the 1973 move towards monetarism, Competition and Credit Control which had officially been introduced in 1971, was already becoming obsolete. The move was aimed at removing all bank and financial house quantitative lending restrictions, and interest rate agreements. An official strategy of deposit creation and gilt market support through the purchase of all bonds with a maturity date of more than one year was also abolished, as was collective Treasury bill tendering by discount houses.

Such measures left open the method of credit or monetary aggregate control. which subsequently resulted in an emphasis on market price. The rationale was largely to avoid possible collusion between borrowers and lenders through non-market-clearing interest rate levels, by changing the price of credit between institutions. Thus short-term interest rates were to be varied as a means of influencing credit and deposit demand. A purpose of Competition and Credit Control here, was thus quick and predictable changes.

In terms of financial innovations, cash and liquid asset ratios of 8% and 28% respectively were replaced with reserve asset ratios of 12.5% and 10% for banks and finance house respectively, where each had assets worth five million pounds or more. The Bank of England was also able to call 'special deposits' – cash deposits at the Bank of England earning treasury bill rates of interest – from banks and finance houses. These reserve asset ratios and special deposits however, were not intended to help control the monetary base, where changes in the supply of Bank of England reserve assets would lead to a change in the quantity of deposits. According to the Governor of the Bank of England (1971),

> "It is not to be expected that the mechanism of minimum reserve asset ratio and special deposits can be used to achieve some precise multiple contraction or expansion of bank assets. Rather the intention is to use our control over liquidity, which these instruments will reinforce, to influence the structure of interest rates. The resulting change in relative rates of return will then induce shifts in the current portfolios of both the public and the banks."

This control over liquidity illustrates the Bank of England's role as lender of last resort, acting as monopoly supplier of funds in response to banking shortages. Though the Bank must supply the reserves, it is still able to determine their price which in turn determines market prices. This has been the mainstay of UK monetary control in the 1980s. In this manner, the Bank is able to speed up interest rate movements through the reserve asset ratio and special deposit calls. The purpose of the reserve asset ratio was to induce banks suffering shortages to withdraw call money from the wholesale market which the Bank of England could shape through interest rate adjustments in response to discount house shortages. A wide range of liquid bank assets were classified as reserves by the government, hoping to prevent banks from responding to shortages with a disposal of assets. Inevitably, a significant offloading of bank assets would induce interest rate rises. The reserve asset ratio however, acted to manipulate interest rate changes more than it did the heart of the fractional reserve multiplier system. Thus less central, it was the Bank of England as lender of last resort, and manipulator of interest rates that took centre stage. According to, this gave a greater role to the management of debt in Competition and Credit Control.

In general, debt management can be undertaken in two ways. It can be supported through a commitment to stable debt prices and market stability through the purchase and sale of debt, or the money supply can be subject to greater control by selling debt to ensure residual financing matches monetary targets. This leads to fluctuations in prices and yields. In the early 1970s, the Bank of England provided some degree of market support. By 1975, large public sector deficits and a preference for monetary growth control meant substantial selling of gilts. The Bank responded with the first in a series of 'Duke of York' methods, by increasing official interest rates substantially in October 1975, before reducing them later as a signal to capital investors to enter the wholesale market. As such, the demand for gilts was determined by the level of official interest rates. When interest rates were reduced, the demand curve shifted out. Official debt was also sold to the wholesale markets through new types of stock and issuing methods. Part-paid stock was first issued in March 1977, followed by stock bearing variable interest rate returns linked to the Treasury bill rate, which compensated to some degree for capital losses for investors when interest rates were high. Stock issuance was subject to much debate in 1975 and 1976 but a partial-tender issue did not take place until 1979.

Another change resulted from Competition and Credit Control was the switch in the official interest rate from Bank Rate to Minimum Lending Rate. Though not formally a part of Competition and Credit Control itself, it might be seen as having been induced by the change in debt management which resulted in greater interest rate variations. The Bank Rate acted as the lender of last resort rate but also the yardstick for market interest rate mark-ups. The level of the Bank Rate for the week ahead was announced each Thursday, but was often stagnant during periods of interest rate smoothing. Since the Bank Rate set the level of market interest rate mark-ups, there existed some degree of inertia. For example when interest rates such as the Treasury bill rate at which the Bank of England was supplying liquidity, fluctuated more widely, the deviation of market interest rates from the Bank Rate became more likely. In October 1972, the Bank Rate was replaced by the Minimum Lending Rate, defined as the treasury bill rate plus 0.5% rounded up to the nearest 25 basis points.

It might be argued that monetary policy was largely expansionary in the early 1970s. A series of budget tax cuts and easy credit induced a sharp increase in the PSBR, a substantial reduction in the balance of payments and increases in the money supply not seen before. In 1972, M3 grew at a rate equivalent to 27% year-on-year; 4.75%, 7.5%, 4.25% and 5% in each quarter. In the budget of the same year, Chancellor Barber indicated that recovery would not be secondary to sterling but take priority over it. This led to substantial difficulties in managing sterling, which was floated on 23rd June. It seems also, that monetary policy played to a Keynesian theme in the sense that unemployment was treated with greatest concern with a belief that monetary and fiscal policies could be used to induce sustainable changes in the level of output and unemployment. At the same time however, the role of monetary aggregates was being scrutinised.

By mid 1973, unemployment had fallen by almost a quarter of a million from the previous year. At the same time, a small current account surplus of the balance of payments in 1972, had become a deficit. By the middle of 1973 it seemed to be heading towards a large deficit. Inflation was at nine per cent and rising, with the number of unfilled vacancies at record level. The official response was a rise in the minimum lending rate of 1.5% in July, and a call on special deposits equaling 1% of eligible liabilities to be made in August. The minimum lending rate was again increased to 13% in November, together with an additional 2% call for special deposits. During this period an interest ceiling for the first time on deposits, further lending guidelines and return of hire purchase term controls were introduced. In addition, the Supplementary Special Deposit scheme (the 'corset') was introduced to limit the quantitative growth of deposits. All of these measures, contributed to a general movement away from Competition and Credit Control. Under the SSD scheme, target rates of growth for bank interest bearing liabilities were set by the Bank of England, with growth rates exceeding target, subject to progressive taxation in the sense that banks were made to make non-interest bearing SSDs with the Bank of England. The SSD operated for five periods between December 1973 and June 1980, with varying targets and penalties. The move away from Competition and Credit Control towards direct control monetary policy in the second half of 1973, might have several explanations. A sluggish or ineffective interest rate, or perhaps a hesitancy on the part of the authorities. Gowland (1982) suggests it was a case of "willing the end but fearing the means" and that circumstances relating to problems in the energy and industrial sectors pushed the government to pressure the Bank of England against interest rate increases. This view seems to be supported by Goodhart (1989) who also adds that liability management and the resulting need to create relative interest rate changes were also problems. Interestingly, the Corset and interest rate ceilings on deposits, were aimed at limiting rises in deposit interest rates while other rates of interest continued to rise. This had the effect of allowing the authorities some influence over key variables. M3 grew to 25% in 1972 and to 27% in the year after. The Corset acted to reduce this sharply to 6% by 1975, by which time the first oil price shock had induced an annual rate of inflation of 24%.

A departure from Keynesian monetary policy was indicated by Prime Minister Callaghan in 1976, amidst sterling weakening ever more and expectations of public spending cuts. The Labour government posited that spending a path out of recession was not possible, and that this tactic was only temporary and followed by higher prices. Shortly afterwards, fiscal policy and monetary targets were abandoned. Though inflation was beginning to stabilise in 1976, a bigger concern was a ten billion pound PSBR, equating to almost 10% of GDP. Between

February 1975 and September 1976, a thirty per cent depreciation in sterling resulted from constant speculation about cuts in public spending and a misunderstood exchange rate policy. By the end of the year, the government had to support sterling by negotiating an IMF loan of $4 billion over two years, which required substantial public spending cuts and revenue increases until 1978, as well as a limit on domestic credit expansion (DCE), the counterpart to sterling M3, to a target range of 9%-13%.

From 1979 to 1985 economic policy was concerned primarily with monetary aggregate growth. This was followed by the exchange rate from 1985 to 1989 and by credit growth rates, the exchange rate and asset prices since 1989. Within these sub-periods, four themes can be identified. First, a preference for the rate of interest as monetary policy instrument over a secondary importance for fiscal policy. In effect, this makes the official interest rate the main instrument of macroeconomic policy in general. Towards the end of the 1980s, this method was being criticised as a 'one-club approach'. Second, a stable monetary climate as the main objective of macroeconomic policy. Since monetary and fiscal policies could not have real effects in the long run, control over inflation was a priority. Though the Phillips curve might have been interpreted as vertical in the short-run, as between 1979 and 1982 for example, it was undoubtedly vertical in the ling-run. Third, a concern over exchange rates. The behaviour of exchange rates continued to be a key concern in deciding upon the level of interest rates, even during the 'high-water mark of national monetarism' – a reference to the 1979-82 period by Goodhart (1989). For example, in October 1981 a weak pound resulted in an increase in official interest rates from 13% to 15%. According to Goodhart

(1989), "It was no accident that the main occasions from 1981 through to 1986 on which interest rates were jerked upwards…all coincided with periods of pound weakness on the forex market". Fourth, the limitations of interest rates. These relate in particular to high interest rates being politically acceptable, and increasing levels of consumer debt as a result of government preferences for owner-occupiers.

The Medium Term Financial Strategy (MTFS) announced in the 1980 Budget, set reductions for growth rates of sterling M3, and for a declining proportion of GDP taken by the PSBR. A monetary growth target of 7%-11% was ambitious given inflation at 21% and interest rates in November at 17%. Negative real interest rates lead to concerns over the ability of interest rates to control monetary growth and also over the relationship between monetary growth and nominal income. Targets were intrinsically linked to information availability. Pre-announced targets brought credibility for the authorities, providing greater financial stability and opportunities for planning in the private sector. Targets also signaled potential bankruptcy and unemployment in response to excessive price and wage rises, thus doing away with a steep and costly learning curve. In addition, pre-announced target growth rates for the years ahead restrained any political motives for deviating away from a counter inflationary position.

The rate of unemployment saw a substantial increase in 1980 from 1.3 million to 2.2 million, largely on the back of interest rates and the UK being a major oil producer pushing nominal and real exchange rates to new highs, which in turn induced further deflationary pressure. Though inflationary pressures began to ease towards the end of the year and interest rates fell to 14%. the 1981 Budget was distinctly deflationary with inflation falling further, even though sharp monetary growth of 14.5% was stimulated by a Civil Servant's strike. Concerns over the exchange rate reversed the trend in interest rates late in the year, with rates falling even further during 1982. A strong preference for monetary targets and removal of direct credit controls as a result of the breakdown in Competition and Credit Control, lead to a major rethink of monetary policy, resulting in a departure from control of the monetary base. The new direction was a revised approach to Competition and Credit Control aimed predominantly at ensuring greater interest rate effectiveness compared to previous years. The process began with identification of institutions to whom the new measures would apply, which the Banking Act of 1987 referred to as the banking sector. This included all financial institutions recognised as banks in the Banking Act of 1979, as well as 'licensed deposit takers', TSBs, National Girobank and the Banking Department of the Bank of England. This resulted in the elimination of a previous two-tier structure under Competition and Credit Control.

This arrangement resulted in 0.5% of banking sector eligible liabilities held as non-operational deposits at the Bank of England. In the wholesale markets too, the Bank of England increased influence over official interest rates by increasing the number of banking sector institutions' securities subject to discount. A minimum of 4% and an average of 6% of eligible liabilities were secured as call money, so that the Bank of England had the necessary supply of bills for open market operations. This allowed it to provide liquidity and thereby set interest rates. In addition, the Bank of England was able to influence a larger number of banking sector assets through changes in official interest rates. A public announcement of the minimum lending rate was not generally adopted, though retained if the authorities were to judge a statement was warranted. Bank of England interest rates thus operated unannounced, with call deposits still available. The intention behind unpublished official interest rates was similar to that under Competition and Credit Control, whereby the authorities aimed to for a policy which reflected monetary economics rather than monetary politics. In the absence of publicly announced official interest rates, the banking sector was able to deposit bills at the Bank of England with discretion, though the Bank of England also reserved the right to reject these depending on the discount rate involved. A perception of market oriented interest rates was further promoted with a Bank of England move towards dealing in bills maturing within two weeks, allowing long-term interest rates to be determined by the market. The Bank also sought to curb monetary expansion through the purchase of bills at higher rates of discount than before and the rejection of banking sector bills to generate a shortage of liquidity. This prompted changes in the discount rates of the banking sector which the Bank then accepted.

The velocity of sterling M3 and an official preference for monetary targets began to decline in 1982, resulting in an expansion of the number of indicators used, together with a public commitment to broad money targeting. Between 1982 and 1985, deflationary policy was evident from employment, output, inflation and asset prices, together with two further monetary aggregates; narrow M1 money and the broader PSL2. Bank lending on the other hand, continued growing at almost 20% per annum, with bank deposits set to grow similarly unless restrained.

Part of this growth came from the entry of many banks into the mortgage market. Though demand for bank loans seemed interest inelastic, demand for mortgages seemed especially interest inelastic, with property having been a safe hedge against the inflation rises of the 1970s, and with house prices rising quickly again at the beginning of the 1980s. With official interest rates above 10% by 1982, the official preference to avoid interest rate measures to control the housing market was partly political, since a general election was approaching. and so an 'overfunding' of the PSBR through government stock issuance was adopted. This measure was of some use in reconciling the growth of private sector borrowing and low monetary targets, but resulted in regular liquidity shortages in the banking sector. The Bank responded by purchasing treasury bills from the bank institutions, followed by further large purchases of commercial bills. In this way, the Bank lent short to the private sector, funded through the sale of gilts. A common criticism of this approach was the fact that private corporations were able to borrow from wholesale markets themselves and independently of such Bank actions, which ended in 1985 amidst concerns over relative yield distortions and values of money stock targets.. Thus by the mid-1980s, an accurate targeting of broad money through interest rates was ineffective, while a sharp fall in money velocity undermined the rationale for monetary targeting. The Bank of England responded to this by abolishing formal monetary targets from 1986.

In 1985, concerns over declining velocity and equilibrium in the foreign exchange markets, contributed to a move in monetary policy from monetary aggregate to exchange rate targets. On the international scene, the US dollar misalignment of 1984/5 caused monetary policy in several countries to focus on exchange rate stability. In the UK, Prime Minister Thatcher's opposition to British entry into the exchange rate mechanism (ERM) of the European Monetary System (EMS) against Chancellor Lawson's wishes, meant UK monetary policy could not formally be aligned with exchange rate movements. By the autumn of 1985 however, official UK interest rates were determined almost exclusively by the pound to Deutschemark exchange rate. In addition, 'guidelines' for M0 growth were published in the UK, not in preparation for a move towards monetary base control, but rather because of the stable (relative to other aggregates) relationship with nominal GDP and the intended role as indicator of nominal GDP changes. During 1987, an exchange rate target was in operation though unofficially, with the pound operating against the Deutschemark within a narrow band consisting of an upper limit of 3.00 Deutschemarks. During this period, circumstances were conducive for interest rate cuts rather than rises, such as after the stock market crash of October, but further increases in banking and non-banking sector credit, a balance of payments deficit and higher house prices pointed to a return of inflationary pressure. Under the existing exchange rate policy, the interest differential between the pound and the Deutschemark resulted in increased capital inflows, to which the authorities responded by intervention and increases in broad money. In the second quarter of 1988, the response was an increase in official interest rates, and towards the end of the year exchange markets had caught up with the weakening UK position. Official interest rates had reached 13% in December as sterling weakened, followed by another peak to 15% in October 1989. Rising levels of unemployment and indications of a recession in late 1990 provided an opportunity for interest rate reductions, particularly since a general election was close. During this period, mortgage repossessions, bad debt threats to bank and building society solvencies as well as official statistics on output and employment, pointed to recession. Sterling however continued to suffer, as the authorities sought to maintain the pound at DM2.95. A slow improvement in the current account of the balance of payments and high wage settlements reflecting changes in a retail price index boosted by interest rate rises, caused problems for the exchange rate. In October 1990, the UK entered the ERM with a rate of DM2.95 in the 6% band. The authorities hoped to convince the foreign exchange markets of their long-term commitment to reducing inflation, strengthening the pound and reducing official interest rates.

The primary rationale for UK entry into the ERM seems to have been a desire for credibility over inflation control, by aligning with the financial authority held by Germany. Initially this seemed to be successful, with official interest rates reduced in a series of cuts through 1991, reaching 10.5% in September, and sterling only deviating slightly from DM2.95 to DM2.89. Between September 1990 and 1991, the headline rate of inflation fell from 10.9% to 4%, contributing adversely to the problems for sterling in the ERM during 1992. In the same year, inflation rose to 4%, official interest rates to 10%, ex post real rates to 7% and sterling to DM:2.85, posing further credibility questions. The situation was exacerbated by a series of falls in non-oil output to almost 5% below the peak of 1990, including falls in service as well as manufacturing output. Unemployment increased from 5.6% in early 1990 to 10.1% in late 1992, affecting in particular London and the South East where the greatest incidence of debt accumulation had taken place during the housing market rises of the 1980s. In the second half of the year, falling house prices gave rise to 'negative equity' which threatened repossession for home owners and insolvency for banks and building societies.

By the summer, the UK and other European authorities were faced with higher interest rates or an abandoning of the exchange rate. Possible realignments within or exits from, the ERM rested on German interest rate reductions but the Bundesbank, concerned with sharp monetary growth, domestic inflationary pressure and costs of reunification, responded independently of UK and other European concerns. This simply furthered its credibility. In September 1992 ERM robustness was undermined with doubts over the Maastricht Treaty. An already weak pound was sold aggressively, and the Bank of England raised official interest rates from 10% to 12% on September 16th, with a statement that the MLR was to rise to 15% the day after. These measures however, did not prove successful and a UK exit from the ERM was announced. Shortly afterwards, official interest rates were reduced in the beginning of a series of cuts that continued until 1993, but financing of the PSBR remained a problem in the 1990s as it had in the previous two decades. Part of this related to the possibility that bad debt residual financing may induce an overshoot of monetary growth targets.

The UK convention of issuing governments bonds at a fixed price, with unsold stock bought and reintroduced into the wholesale market by the Bank of England 'tap' ensured new issues did not adversely affect existing prices, but with sales volume acting as an equilibrating residual. Under a theme of monetary control in the 1970s, a tender system similar to the one already in operation for treasury bill sales was considered where the volume of stock would be guaranteed with price becoming the residual. It was generally considered that price fluctuations would make long-term debt unattractive, or that tight control over monetary aggregates would ensure lower and less volatile inflation, interest rates and therefore long-run debt price stability. In March 1979, the Bank of England adopted a 'partial-tender' system in which bid issues were subject to a minimum price. With bids ranked in descending order by price, the number of bids clearing the issue were those accepted. The 'strike price' was then the price to be paid of the minimum bid accepted, with insufficient bids which do not clear the stock, released through the tap system. In 1987, this system incorporated gilt auctions, where a bid rather than strike price is paid, with there being no minimum price. The sale of such stock is limited however to small issues of new stock, with short dates to maturity and moderate price variations. The increased preference for monetary aggregates and sales of debt to the private sector led to the introduction of new types of stock. Conventionally, this had consisted of government bonds issued with fixed maturity dates and coupons, but from 1982 included short-dated stock with low coupons and substantially discounted relative to redemption value. This allowed for tax free capital gain on redemption for investors. Index linked gilts had also been introduced in 1981, but restricted to institutional investors only before being opened to the wider market in the following year.

CHAPTER THREE

MONETARY POLICY WITH ENDOGENOUS MONEY

3.1 INTRODUCTION

This chapter describes the operation of monetary policy in a framework where credit money is endogenously created by the banking system. Under an exogenous money framework, the supply of money is indirectly controlled by the government through the Central Bank. During the 1980s, this was the thrust of UK monetary policy, under which the Bank of England targeted the rate of growth of the money stock. As chapter two shows, exogenous monetary policy experienced a breakdown in this period both in theory and practice. This resulted in a shift of monetary policy towards the targeting of a government determined inflation rate with a Bank of England interest rate employed as the primary instrument of policy.[1] In this new framework, the supply of money is determined by the demand for money balances and the supply of bank loans. This chapter considers the role of monetary policy in controlling inflation from an endogenous money perspective.

Endogenous money created by the banking system is important from a Keynesian standpoint, in that money is regarded as bank money rather than a stock which can be controlled exogenously. In addition, endogenous money closely reflects a current UK monetary policy stance of inflation targeting with an official interest rate as the policy instrument. In this approach the causal relationship between the

[1] This is currently the repo rate at which the Bank of England supplies reserves to wholesale markets.

money stock and price is the opposite of that under exogenous money, and the causal relationship between investment and savings implies that loan supply increases investment, resulting in a corresponding increase in savings and bank deposits.

The "new consensus" and the Keynesian bank money approach represent two schools of thought where money is endogenous. As with many economic theories, there exist differences both within and between these two approaches but the main one is the endogeneity of money. In the "new consensus" money is endogenously created, the stock of money is a "residual" based on the demand for money, the money stock does not share a causal relationship with inflation and the rate of interest is Bank rather than market determined. In the Keynesian approach, money is determined by the banking sector in the sense that the Central Bank sets the discount rate and supplies reserves to commercial banks. Loans are then made available by commercial banks at rates of interest representing a mark-up over the discount rate. This mark-up is determined by a series of factors such as bank market power, liquidity preference and risk assessment.[2] In contrast to the "new consensus", the Keynesian approach emphasises the process of loan and deposit creation and removal, and also causal relationships between investment spending and loan creation, and inflation and money creation. In addition, monetary policy is interest rate oriented in both schools of thought, but with substantial differences in interpretation between them. The rest of this chapter is presented as follows. The next section considers the "new consensus" model. Section three looks at interest rate monetary policy and the exchange rate. Section four presents

[2] See Dueker and Thornton (1997) for a discussion of bank mark-ups.

monetary policy from a Keynesian endogenous money perspective. This is followed in section five by the effectiveness of monetary policy in a Keynesian set-up. Section six discusses monetary policy in a Keynesian endogenous money framework. Section seven concludes this chapter with a summary.

3.2 THE "NEW CONSENSUS"

In Meyer (2001), the "new consensus" macroeconomic model is presented as follows:[3]

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 E_t\,(y_{t+1}) - \alpha_3\,[R_t - E_t\,(p_{t+1})] + s_1 \tag{1}$$

$$p_t = \beta_1 y_t + \beta_2 p_{t-1} + \beta_3 E_t\,(p_{t+1}) + s_2 \tag{2}$$

$$r_t = R^* + E_t\,(p_{t+1}) + \gamma_1 y_{t-1} + \gamma_2\,(p_{t-1} - p^T) \tag{3}$$

where y_t represents the output gap at time period t, R the nominal rate of interest, p_t the rate of inflation, p^T the target rate of inflation, R^* the "equilibrium" real rate of interest when the output gap is zero and a constant rate of inflation, s_i (with i = 1, 2) and E_t expectations. Equation (1) is an aggregate demand representation in which the output gap is a function of past and expected future output gap and the real rate of interest. Equation (2) is a Phillips (1958) curve in which inflation is a function of current output gap and past and future inflation, and where (b_2+b_3=1). Equation (3) is a Taylor-type monetary policy reaction function with sluggish adjustment, in which the nominal rate of interest is a function of expected inflation, output gap, the deviation of inflation from trend, and the "equilibrium"

[3] McCallum (2001) and Clarida, Gali and Gertler (1999) are similar, alternative examples.

real rate of interest.[4] Equation (3) has been variously modelled with a lagged interest rate term which represents interest rate smoothing by the Central Bank.[5] The importance of equation (3) is that it represents an endogenously determined official interest rate in line with Taylor (1993), where interest rates are implemented in a closed economy without consideration of exchange rates or international interest rates. In addition, the official interest rate responds to changes in the output gap and to subsequent changes in the rate of inflation. Equation (2) illustrates constant inflation when the output gap is zero. In equation (3), the nominal interest rate represents a real interest rate equal to the "equilibrium" real rate of interest, consistent with zero output gap and constant inflation. In equation (1) the value of the real "equilibrium" rate of interest needs to be α_0 / α_3. If an accurate estimate of R^* is available, a zero output gap and a constant rate of inflation equal to target can be achieved, in which case the level of aggregate demand in equation (1) is consistent with a zero output gap. In a private sector economy, R^* implies equality between *ex ante* savings and investment, with the equilibrium interest rate akin to a Wicksellian "natural rate" of interest.[6]

The model outlined above is based on the following assumptions. The money stock is not a model parameter, though its residual nature can be reflected by including an equation which relates the stock of money to output, interest rate and

[4] According to Fair (2001), the coefficient on inflation must be greater than unity for equation (3) to be stable.

[5] An example is McCallum (2001). The system of equations is not rigid; in Arestis and Sawyer (2003a) for example, interest rate smoothing is omitted since it does not affect the results of their analysis. Similarly lagged output is omitted in equation (1), since the emphasis is on expected future output gap. Also, in Arestis and Sawyer (2002b), it is shown that a fourth equation reflecting the stock of money as a function of income, price and the rate of interest, though indicative of the endogenous money approach where the money stock is demand driven, is not required because the money stock is a residual with no feedback effect on model parameters.

[6] Wicksell (1965: 102) defines this natural rate as "the rate of interest which would be determined by supply and demand if no use were made of money and all lending were effected in the form of real capital goods."

inflation. This raises the question of how to address money in terms of the money stock having an effect on economic activity. Bernanke and Gertler (1999) consider reinstating money in terms of three assumptions. These include the idea that money is one of many assets in wholesale markets, that money has wealth effects and that money involves credit frictions. Monetary policy and the official interest rate are assumed to respond systematically to changes in economic activity and not to exogenous shocks. That said, the inflation targeting process is symmetric, in that above (below) target inflation induces interest rate rises (falls). A lagged price level in the Phillips-curve implying sticky prices, and long-run flexibility of prices, mean the model contains both lagged adjustment and forward-looking terms.

Money is neutral in that equilibrium values of real variables are independent of the money supply, and inflation is determined by monetary policy where the instrument is the official interest rate. This outcome is to be expected since the money stock is not a model parameter, though if it had been a fourth equation representing money demand, money would still be treated as neutral. The effects of changes in the policy instrument are transmitted to aggregate demand in equation (1) and from aggregate demand to inflation in equation (2).

In the long-run, inflation is constant and expectations are met. Here, the real rate of interest in equation (1) is derived as $R - p = a_0/a_3$. Similarly, equation is derived as $R - p = R^* + c_2(p_{t-1} - p^T)$. Therefore unless $R^* = a_0/a_3$, then $R^* = a_0/a_3 + c_2(p_{t-1} - p^T)$ and the long-run rate of inflation will deviate from the target rate of inflation. R^* is the "natural rate" of interest after Wicksell (1965), corresponding to inflation and a zero output gap. In the model outline above, the inflation targeting process operates through equation (1), where interest rates which are determined by the monetary policy rule in equation (3) impact aggregate demand. Changes in aggregate demand then affect inflation through equation (2). The strength, timing and predictability of interest rates changes on aggregate demand are important considerations. Interest rate rises (falls) will tend to reduce (increase) aggregate demand, with an assumption that lower (increased) aggregate demand will reduce (increase) the rate of inflation. The effect of interest rates as firm costs which translate into higher consumer prices is not considered. In addition, monetary policy operates through a single interest rate and the transmission of short-term nominal interest rates to long-term interest is an important question. Furthermore, and as Federal Reserve Chairman Volcker (2002: 9) notes, this "new" approach to monetary policy since the 1980s, "relies upon direct influence on the short-term interest rate and a much more fluid market situation that allows policy to be transmitted through the markets by some mysterious or maybe not so mysterious process."

The fact that the stock of money does not appear in the model above is not to suggest that every monetarist proposition is to be rejected. Instead, it implies a rejection of a possible causal relationship between the money stock and the rate of inflation. The model does however, contain two key propositions in that monetary policy influences inflation to the extent that inflation converges towards a target, and also that monetary policy does not influence the level and rate of growth of potential output. As Meyer (2001: 3) notes with regard to inflation being controlled by the Central Bank one can,

> "clearly see the influence of monetarism in the consensus model. Monetarism focused attention on the role of the central bank in determining inflation by emphasising the relation between money and inflation. The consensus model may bypass money, but it has retained the key conclusion that central banks may ultimately determine the inflation rate."

Meyer (2001) seeks to reinstate money into the "new consensus" model since it is based on the relation between money, output and inflation. The proposal is a fourth LM equation to supplement equations (1) to (3) above, together with the stock of money as the fourth variable:[7]

$$M_t = d_0 + d_1R_t + d_2Y_t + d_3E_t(p_{t+1}) + s_3 \tag{4}$$

Where M represents the money stock and s_3 represents random shocks. Meyer (2001: 3) does however concede, that the addition of this fourth equation is not satisfactory since the "LM curve ... is not part of the simultaneous structure of the expanded model." Rather, this set up solves for a money stock consistent with output, price and interest rate values which are simultaneously determined by the solutions of equations (1) to (3). The LM parameter therefore simply proxies the Central Bank money stock required under the existing monetary policy rule and economic shocks. In this case, Meyer (2001: 4) notes that "money supply has become a less interesting, minor endogenous variable in the story." It might be said that concern over the stock of money provides grounds for monetary policy aimed at controlling sustained levels of inflation, but the empirical literature does not seem to offer any evidence as to whether this should include the role of money as a causal factor. Meyer (2001: 4) however argues that money can be reinstated

[7] Money here is defined as the money stock rather than the money supply, since it is determined by the demand for money; the context of this analysis.

in the model outline above on the grounds that "if the money demand equation is stable, there will be a stable relationship between money and inflation in the long run." Thus subject to a stable demand for money, the new "consensus" implies a long-run relationship between money and prices. As a result, Meyer (2001: 14) notes that,

> "monitoring money growth has value, even for central banks that follow a disciplined strategy of adjusting their policy rate to ongoing economic developments. The value may be particularly important at the extremes: during periods of very high inflation, as in the late 1970s and early 1980s in the United States, and when the policy rate is driven to zero in deflationary episodes, as in the case of Japan today."

However, there is no indication in the Meyer (2001) analysis of the value of monitoring monetary growth. The amount of money in circulation is determined by money demand, which in turn depends on past and contemporaneous values of prices, incomes and so forth. It appears therefore, that the stock of money is not significant unless money demand is a function of expected future price and income levels. If this is so, the money stock may contain information reflecting such expectations.

If output, price and interest rates are stable in the demand for money equation, then growth of the money stock will move closely with the rate of inflation. This is because of the movement of money demand over time. However the demand for money equation also implies that changes in the money stock move with changes in price, either simultaneously or with a time lag. However, if expected price changes were of relevance to money demand then it is possible that actual price changes lag behind money demand. The money stock is also a lead indicator of nominal expenditure, when loans are used to finance nominal expenditure and when increased loan supply increases bank deposits and the money stock.

In McCallum (2001: 146), equation (4) is added to equations (1) and (3) but is insignificant since output gap, price and inflation rate do not respond to changes in the money stock. Instead, it simply reflects the volume of money required to implement the monetary policy rule in equation (3), with no requirement for equation (4) as a determinant of output gap, price and inflation. In McCallum (2001: 146) however, it is argued that equations (1) to (3) should be interpreted with the inclusion of a monetary aggregate because "the central bank's control over the one-period nominal interest rate ultimately stems from its ability to control the quantity of base money in existence." This can be seen in equations (1) to (3) where $y_t = 0$, $c_3 = 0$ and there is assumed to be no interest rate smoothing. From equation (1) this gives $[R_t - E_t(p_{t+1})] = a_0/a_3$ and from equation (3) this gives:

$$a_0 / a_3 = r^e + c_2(p_t - p^T) \tag{5}$$

where r^e is the official equilibrium real rate of interest. If this is set at a_0 / a_3, then actual inflation is equal to target, p^T, with the rate of inflation determined by the Central Bank. Also, the Phillips curve is not relevant, with inflation a monetary policy phenomenon rather than a non-monetary policy Phillips, or quantity of money stock phenomenon. This approach reflects conventional monetary policy in that official interest rates influence the rate of inflation via their influence on the level of aggregate demand. Alternatively, fiscal policy could also be used in the same way, in which case monetary policy in equation (3) would be replaced by a fiscal policy parameter which is adjusted in response to deviations of inflation from target and of output from trend level. In this case, inflation becomes a fiscal policy phenomenon.

In McCallum (2001) then, a four-equation system includes money in equation (1), a fourth money demand equation and some further modifications. These include government spending less expected government spending in equation (1), but exclude interest rate smoothing in equation (3) since $c_3 = 0$. Overall, the system can be presented as follows:

$$y_t = a_0 + a_1(y_{t-1}) + a_2E(y_{t+1}) - a_3[R_t - E_t(p_{t+1})] + a_4[m_t - E_t(m_{t+1})] + s_1 \tag{6}$$

$$p_t = b_1y_t + b_2(p_{t-1}) + b_3E_t(p_{t+1}) + s_2 \tag{7}$$

$$R_t = r^e + E_t(p_{t+1}) + c_1y_{t-1} + c_2(p_t\text{-}p^T) + c_3R_{t-1} \tag{8}$$

$$m_t = m_0 - m_1\,\rho_t + m_2y_t + s_3 \tag{9}$$

where m is the logarithm of the real value of the money stock, M, ρ is the logarithm of R, y is the logarithm of actual output, and $c_3 \neq 0$ represents interest rate smoothing. Equation (9) is an optimising identity, in the sense that the elasticity in terms of ρ is constant, with elasticity unity in terms of spending which proxies the output gap. The next question is to determine whether the $[m_t - E_t(m_{t+1})]$ term in equation (6) represents the information set of an otherwise omitted variable that would bias model results, since money balances impact transaction costs. Unanticipated increases (decreases) in money balances lower (increase) transaction costs, thus influencing expenditure. As a result, the sign of the coefficient on a_4 will positive. Transaction costs as in McCallum (2001) are but one theoretical justification for the inclusion of the $[m_t - E_t(m_{t+1})]$ term in equation (6). In Leahy (2001: 161-162), further possibilities include non-separable utility, utility constraints, cash-in-advance constraints, good and asset market segmentation and lending. McCallum (2001: 149-150) uses calibration analysis to show that "although it is theoretically incorrect to specify a model without money, the magnitude of the error thereby introduced is extremely small." This observation is similar to that of Ireland (2001), in which a_3 type parameter estimates are shown to have statistically insignificant coefficients. These findings seem to suggest that the $[m_t - E_t(m_{t+1})]$ term is not empirically or theoretically robust when modelling aggregate expenditure, a point noted by King (2002). Overall, McCallum (2001: 157) argues that "policy analysis models without money, based on interest rate policy rules, is not fundamentally misguided." However, such policy rules are not "preferable to ones based on a controllable monetary aggregate, such as total reserves or the monetary base."

An alternative view is that of Laidler (1999) in which endogenous money is distinguished from exogenous money, with endogenous money then further split into passive and active roles. In this analysis, passive money is consistent with equations (1) to (3) above, with the money stock a residual which does not determine output or inflation, and interest rates are the instrument of policy. Laidler (1999: 10) argues that "the quantity of money is an endogenous variable in the economic system, but it clearly plays an active role in the transmission mechanism." However, it is uncertain what this process involves. As Laidler (1999: 11) acknowledges, "there seems virtually no limit to the possibilities, a sure sign of some deficiency in our theoretical understanding of the matters under discussion." Hendry (1995) offers empirical evidence suggesting this approach to money is deficient, with Laidler (1999: 14) acknowledging a "non-trivial passive element to money's role in that mechanism."

Another approach is that of Bernanke and Gertler (1999: 87) based on the link between asset prices and real economic activity. This focuses on credit market frictions and operates through the balance sheet channel on the back of two assumptions. The first emphasises the importance of capital to assets and debt to assets ratios. Second, that credit markets exhibit friction in the form of "problems of information, incentives, and enforcement in credit relationships." A key outcome of this approach is that borrowers with strong financial credentials are able to access credit more easily and at a lower cost than those who are not financial sound. Frictions in credit markets also imply that cash flow and balance sheet positions determine the ability of individuals to borrow and lend. In response to these frictions, borrowers supply collateral which results in external finance being more expensive to obtain than internal finance, when collateral is not available for the former. This phenomenon is the basis of an "external finance premium" which represents the difference between the cost of external borrowing and the opportunity cost of internal firm funds. This premium determines the cost of capital and thereby investment and aggregate demand. Bernanke *et al.* (1999: 4) note that "In short, when credit markets are characterised by asymmetric information and agency problems, the Modigliani-Miller irrelevance theorem no longer applies."

3.2.1 Monetary Policy

In the "new consensus" then, equation (2) represents monetary policy with an interest rate instrument to control demand inflation rather than cost inflation. Gordon (1997: 17) comments in a non "new consensus" but equally relevant context that,

> "in the long run inflation is always and everywhere an excess nominal GDP phenomenon. Supply shocks will come and go. What remains to sustain long-run inflation is steady growth of nominal GDP in excess of the growth of natural or potential real output."

Cost inflation is thus accommodated or unaffected by supply shocks that are on average zero.[8] In the "new consensus" inflation is controlled using interest rates to deflate demand, together with a "natural rate" of interest which achieves equilibrium between aggregate demand and aggregate supply. In addition, this results in a zero gap between actual and capacity output.

In operational terms demand-led inflation poses three questions for monetary policy, and these are identified and answered by Arestis and Sawyer (2003a: 4). First, the degree to which it is effective in influencing aggregate demand and thus inflation. The authors present evidence to suggest it is ineffective. Second, inflation being a "demand phenomenon" in the Phillips curve of equation (2) means monetary policy is again ineffective in influencing aggregate demand, with

[8] As indicated by Clarida, Gali and Gertler (1999).

fiscal policy suggested as an alternative instrument of monetary policy. Third, it is argued that potential, sustained, cost-push, and other non-demand led inflation is treated very lightly in the "new consensus". This is because the Phillips curve in equation (2) is in reduced form, without giving explicit consideration to wages, factor input costs, import prices or money wage pressure. The conduct of monetary policy under the "new consensus" is also criticised by Blinder (1998: 20) who argues that it remains "tight for too long, thereby causing recessions, and remaining easy for too long, thereby allowing inflation to take root." In addition,

> "a prominent institutional feature of some central banks (including the Federal Reserve) may also contribute to this problem. Specifically, in many countries monetary policy is made not by a single individual but by a committee.... who laboriously aggregate individual preferences; that they need to be led; that they tend to adopt compromise positions on different questions; and – perhaps because of all of the above – that they tend to be inertial."

Also, "decision-making by committee may contribute to ... systematic policy errors ... by inducing the central bank to maintain its policy stance too long." In terms of the degree to which the "new consensus" monetary policy as presently implemented has helped to reduce and control inflation, Arestis and Sawyer (2003a: 5) argue that the argument in principle seems correct and inflation has indeed become stable, but the notion that this is entirely because of monetary policy, is "both theoretically weak and empirically unfounded."

There exists empirical evidence that endogenous money leaves little room for monetary policy in terms of inflation.[9] For example, Bank of England (2000: 16-

[9] Including Angeloni *et al.* (2002) and Van Els *et al.* (2001).

17) estimates for the UK involving simulations of Taylor-type rules in which the coefficient on inflation-from-target are successively increased from 0.5 to 1.0 to 1.5, representing aggressive monetary policy responses, are summarised as follows:

> "The maximum effect of the temporary interest rate increase on real activity occurs after about one year, and the maximum effect on inflation occurs after about two years. For the benchmark simulation, where the Taylor rule with a weight of 0.5 on the deviation of inflation from target is adopted, the level of GDP falls by about 0.3 per cent at the end of the first year, recovering to base after three years. Inflation remains broadly unchanged during the first year, reflecting the degree of nominal inertia in the economy, but by the beginning of the third year has fallen by just over 0.3 percentage points. Thereafter, it returns slowly to base."

Arestis and Sawyer (2003a: 5) argue the global decline in inflation has been due to falling commodity prices over the last twenty years, in countries which target inflation but also in countries that do not. In Barro and Gordon (1983a, 1983b) and Barro (1986) it is argued that inflation targeting depends largely on "reputation." In Kydland and Prescott (1977) it is based on an inherent inflation bias in discretionary monetary policy. However, these views are countered by Blinder (1998: 40) who argues that,

> "In fact, the history of much of the industrial world since roughly 1980 has been one of disinflation – sometimes sharp disinflation, and sometimes at high social cost. Furthermore, the monetary authorities of many countries, especially in Europe, have displayed a willingness to maintain their tough anti-inflation stances to this very day, despite low inflation and persistently high unemployment. Whether or not you applaud these policies, they hardly look like grabbing for short-term employment gains at the expense of inflation."

Incidentally, Campillo and Miron (1997) and also Posen (1993), suggest that there exists a weak negative correlation between central bank independence and actual inflation. These studies are based on large samples that include developing countries, with no causal relationship between the two. Fuhrer (1997: 34) notes that "the only significant correlations developed in the specifications examined here suggests a negative correlation between CBI and real growth, and a positive correlation between CBI and unemployment."

3.2.2 Transmission Channels of Monetary Policy

In the simple three-equation model presented above, monetary policy affects the real economy through the real interest rate in equation (1). In the "new consensus" however, monetary policy transmission occurs through many different channels. At least six of these channels are identified by Arestis and Sawyer (2003a: 5). Financial market imperfections affect the real economy through the interaction of borrowers and lenders under an assumption of credit market frictions, in what Hall (2001) defines as the narrow credit or bank lending channel. The emphasis here, is on the role of banks as lenders as explained by Roosa (1951) and also Bernanke and Blinder (1988). In Bernanke and Gertler (1989, 1999) and Bernanke *et al.* (1999) the financial position of borrowers in the broad credit or balance sheet channel, determines the level of aggregate demand through the supply of loans. In the interest rate channel and the monetarist channel, the ability to substitute between money and other assets is the main assumption. Asset price changes are also present in the wealth effect channel where consumption is a function of household wealth, and in the exchange rate channel, monetary policy operates through import prices and net external demand.

Commenting on these channels, Arestis and Sawyer (2003a: 6) suggest they ought to be considered as more than an elaboration of the effect of the policy instrument on the level of aggregate demand. In particular, monetary policy is presented as a function of the expectations and actions of numerous agents, resulting in a "loose" effect of monetary policy rather than the precise effect implied by equation (1). In addition, there is also an implication that monetary policy may affect variables of interest in their own right, such as credit availability, investment spending, asset prices and the exchange rate. This raises the question of whether, and to what extent, monetary policy should take into account these variables in addition to the rate inflation.

3.3 MONETARY POLICY AND AGGREGATE DEMAND

In equation (1) of the "new consensus" above, the level of aggregate demand is assumed to be stable and subject to random and serially uncorrelated shocks. In addition, the response of monetary policy to changes in aggregate demand is captured in equation (3). Arestis and Sawyer (2003a: 6) consider the response of monetary policy in this set up to a "significant and sustained" change in the level of aggregate demand, by examining whether monetary policy can restore aggregate demand after a fall in autonomous demand. Their closed economy model is presented after Arestis and Sawyer (2003b) as follows:

$$C_t = d_1 + d_2 Y_{t-1} - a\,[R_t - E_t\,(p_{t+1})] \tag{10}$$

$$I_t = d_3 + d_4\,\mathrm{E}\,(Y_{t+1}) - b\,[R_t - E_t\,(p_{t+1})] \tag{11}$$

where equation (10) is a consumption function in which Y represents output, and equation (11) is an investment function. These give:

$$Y_t = (d_1 + d_3) + d_2 Y_{t-1} - a [R_t - E_t(p_{t+1})] + d_4 E(Y_{t+1}) - b [R_t - E_t (p_{t+1})] \tag{12}$$

Equation (12) is re-written to include the output gap below:

$$(Y_t - Y^*) = (d_1 + d_3) + (d_2 + d_4 - 1) Y^* + d_2 (Yt\text{-}1 - Y^*) + d_4 [E(Y_{t-1}) - Y^*] - (a + b) [R_t - E_t (p_{t+1})] \tag{13}$$

The "equilibrium" rate of interest for a zero output gap is then:

$$[R_t - E_t (p_{t+1})] = (d_1 + d_3) / (a + b) + [(d_2 + d_4 - 1) / (a + b)] Y^* \tag{14}$$

which implies no particular "natural rate" of interest. The "new consensus" approach underpins most empirical analysis of the effectiveness of monetary policy. This involves a wider specification, including a greater number of model parameters, lags and leads, but with a NAIRU type supply-side equilibrium equating to zero output gap and constant inflation. An outcome of the reaction function in Taylor (1993), is that monetary policy induces supply-side equilibrium with little movement from trend in output, resulting in a limited role for monetary policy. In addition, aggregate demand is thought to equate to capacity output which is itself akin to constant inflation, through a "feasible equilibrium rate of interest."[10] The impact of monetary policy decisions can be illustrated in terms of

[10] The "feasible equilibrium rate of interest" refers to a positive short-term interest rate that is compatible with the existing exchange rate. See Arestis and Sawyer (2003a: 20: Note 6).

shifts in the coefficients of equations (13) and (14). As an example, in order offset a reduction in d_3 so that demand remains at Y^*, would require a change in the real rate of interest of $-Dd_3/(a+b)$. As illustrated by Arestis and Sawyer (2003a: 7), there is unlikely to be a corresponding change in the nominal rate of interest for the following reasons. For a fall in investment spending equivalent to one percent of GDP, and a percentage change in demand divided by the change in interest rates of $(a+b) = 0.2$, the real rate of interest must change by 5%.[11] In Arestis and Sawyer (2002c) it is noted that the ratio of percentage change in interest rate to investment is 1 to 3 and below. Since investment expenditure accounts for between 15% to 20% of GDP, a one percentage point change in the rate of interest leads to a change in GDP of between 0.45% and 0.6% at most. Thus a change in aggregate demand of say 2% would require a 6% reduction in the rate of interest, indicating that relatively small interest rate changes do little to offset the reduction in autonomous demand.

3.4 MONETARY POLICY AND THE EXCHANGE RATE

An outcome of monetary policy, especially after the Taylor (1993) rule captured in equation (3), is that official interest rates are set in a closed economy. This is at odds with the monetary policy of previous UK frameworks such as the fixed exchange rate where official interest rates were used to serve sterling. In the interest rate parity theorem, the differential between domestic and foreign interest rates is equal to the expected rate of change in the exchange rate. This implies relatively high (low) domestic interest rates associated with expectations of a

[11] Investment and interest rate changes are also likely to have multiplier effects such as on the level of output.

currency depreciation (appreciation). Uncovered interest rate parity is not empirically robust, though there may still exist some relationship between domestic relative to international interest rates, and changes in the exchange rate. As Lavoie (2000: 175) notes, "Despite dozens of studies showing that uncovered interest parity is without empirical support, neoclassical authors still rely on it, because, they would say, a more attractive relationship has yet to be found." The focus here however is more on the effect of interest rate changes on the exchange rate and thereby the effects of monetary policy on the exchange rate, rather than the empirical merits of interest rate parity.

Arestis and Sawyer (2003a: 8) offer a number of observations on this issue. First, a distinction between the Central Bank discount rate and the rate of return on foreign exchange transactions on the capital account. The latter is the expected rate of return on financial assets and includes an overall rate of return on equity in the form of interest rates on bonds, bank deposits and such like. Second, interest rate parity implies a relationship between high domestic interest rates and expectations of a currency depreciation, while in fact interest rate rises have often been used to lift a currency. This can be explained in terms of overshooting, where interest rate rises induce a currency appreciation as investment capital flows, before the exchange rate begins to decline against a sustained increase in interest rates. Third, two issues concerning the role of official interest rates for the purposes of targeting inflation. These are that short-run interest rates may present difficulties in prioritising between domestic economic requirements and currency requirements. In addition, the appropriate domestic "equilibrium" real rate of interest that induces a balance between aggregate demand and constant inflation may differ from overseas interest rates. Thus in terms of interest rate parity, the value of the real exchange rate would vary depending on the interest rate differential.

Keynes (1930: 192) cast doubt over the ability of interest rate parity to ensure sustained real exchange rate changes in the space of a few years, by arguing that,

> "the dilemma of modern banking is satisfactorily to combine the two functions. As a purveyor of representative money, it is the duty of the banking system to preserve the prescribed objective standard of money. As a purveyor of loans on terms and conditions of a particular type, it is the duty of the system to adjust, to the best of its ability, its supply of this type of lending to the demand for it at the equilibrium rate of interest, i.e. at the natural rate."

It appears that exchange rate considerations are important when interest rates are the instrument of monetary policy. As Neely and Sarno (2002: 51) indicate, when monetary policy operates in terms of money stock growth and flexible exchange rates, they are of less importance. "One of the most widely studied and still unanswered questions in this literature involves why monetary models of exchange rate determination cannot forecast much of the variation in exchange rates." Where the rate of inflation is determined by the rate of money stock growth, and purchasing power parity ensures the exchange rate is equal to the differential inflation rate, then domestic inflation concerns can be prioritised, since the exchange rate is allowed to adjust through purchasing power parity. As a result, monetary policy ensures the real domestic exchange rate is unchanged. On the other hand, when monetary policy is driven by official interest rates, the real exchange rate can be determined and assumed to have real and long-term effects on economic activity.

3.5 ENDOGENOUS MONEY: A KEYNESIAN PERSPECTIVE

In the Keynesian approach to endogenous money, the Central Bank interest rate is taken as given and official reserves are supplied to the banking sector at a price determined by the Central Bank. The banking sector responds to the demand for credit by supplying loans with an interest rate mark-up over the official interest rate.[12] This mark-up is also determined by bank liquidity preferences, market positions and risk assessments. The creation of bank deposits is ensured through a process of loan supply to meet credit demand. As these loans are repaid, money is destroyed with the remainder a function of the demand to hold money balances. Money is produced in the inflationary process with the rate of inflation influencing the rate of money stock growth. Money itself however, does not cause inflation.

In the short-run, market interest rates such as those on loans and deposits, or mortgage repayments, are viewed as being determined by a constant Central Bank interest rate. Arestis and Sawyer (2003a: 9) note that determination of the official interest rate in the long-run is also of importance to endogenous money analysis, but something largely ignored in the Keynesian endogenous money literature. Instead, the emphasis is more on Central Bank discretion and exchange rate concerns. This point is supported by Moore (1989: 27) who argues that,

[12] Subject to certain credit requirements being met.

> "A central bank's key decision variable throughout the business cycle, and its central control instrument of monetary policy, is the nominal supply price at which it provides additional reserves. Over a wide range the central bank can determine exogenously the supply price at which it provides liquidity to the financial system. The upper and lower limits of this range are set by the size and openness of the economy and by the exchange rate regime in force."

There exists however, little empirical evidence on the determinants of official interest rates. If the policy instrument is set at some "equilibrium rate" where savings equal investment at the target rate of output, as in the "new consensus" model, above or at target employment, the problem of demand deficiency is made redundant. For example, the official interest rate is matched by market interest rates on financial products such as loans, deposits, mortgages or bonds, where savings and investment are equal, with employment at capacity output and with inflation assumed to be constant. In the Keynesian approach to endogenous money, the influence of the official interest rate on market interest rates is recognised in that it is set and enforced by the Central Bank. However, the official interest rate does not share a direct relationship with market interest rates, which may in some instances, vary only slightly. This is because other factors such as market power, position, liquidity preferences and risk assessments of the banking sector may also play an influential role.

The availability of finance is a prerequisite for the causal relationship between investment spending and saving. Investment can be financed *ex post* with savings but not *ex ante*, and the level of income is assumed to change in line with changes in investment spending. This process of savings and income growth being driven by investment is based on endogenous bank money under which banks finance investment by supplying loans. The rate of interest on loans however, is a market rate and subject to influence by the Central Bank interest rate and the determinants of this rate become important in determining the link between savings and investment. In theory, the Central Bank could eliminate deficient demand by adjusting official interest rates such that the level of savings and investment are constantly equal to a supply-side equilibrium such as full employment.

Arestis and Sawyer (2003a: 10) identify four factors that cast doubt on the ability of official interest rates to reduce an economy wide equilibrium where demand and supply are in balance and inflation on target. First, the "equilibrium" rate of interest may be either positive or negative, but still so low that it cannot be attained.[13] This is akin to the liquidity trap except that in the liquidity trap, market interest rates are low and prices high so as to dissuade bond purchases in case of capital loss. Negative interest rates are not considered here since cash balances also offer a zero rate of interest. Also, a negative real rate of interest can also be given by a_0/a_3, which amounts to savings and investment not intersecting when interest rates are positive. In the aggregate demand relation of equation (1), aggregate demand and thus investment, are interest rate sensitive with a_3 greater than zero, and a significant autonomous demand component is implied by a_0 which would otherwise be non-positive. Thus $I(r, Y_f) = S(r, Y_f)$, where Y_f denotes an income level at which the output gap is zero, does not have an economically plausible solution. Second, and in addition to this, interest rates may exert only a minimal influence on the levels of saving and investment, making monetary policy ineffective in balancing the two. This is more so because of a lack of

[13] The analysis assumes a market interest rate in excess of the official interest rate, with investment spending a function of the former. Banks are also limited by loan default risk, in the level to which they are able to reduce interest rates.

consensus in the empirical literature, over the sign of the relationship between savings and the rate of interest. Moreover, the literature questions the effect of interest rates on investment, positing instead capacity utilisation and profits as important. For example, Bernanke *et al.* (1999: 1344) note that "In the investment literature, despite some recent rehabilitation of a role for neoclassical cost-of-capital effects ... there remains considerable evidence for the view that cash flow, leverage, and other balance-sheet factors also have a major influence on spending" and that "contemporary macro econometric forecasting models, such as the MPS model used by the Federal Reserve, typically do incorporate factors such as borrowing constraints and cash-flow effects."

In a third point, it is argued that domestic interest rates may be incompatible with international interest rates, or pose difficulties for the current account of the balance of payments. In terms of interest rate parity, the domestic to international interest rate differential will equal the expected rate of change of the exchange rate. The appropriate domestic interest rate required for international capital movements might be a market interest rate, set with reference to the Central Bank interest rate. Despite a lack of empirical robustness of interest rate parity, there may still exist some relationship between domestic relative to international interest rates, and changes in the exchange rate. Such effects as discussed earlier, are not considered in the Taylor (1993) rule. Fourth, it is difficult to ascertain or attain an official "equilibrium rate" of interest because of insufficient information, a constantly changing target or competence and credibility issues. In the equations outlined earlier, the "equilibrium rate" of interest is a function of a_0/a_3 and these parameters are time varying. Also, and assuming the existence of an equilibrium real rate of interest (R^*), there still remains the problem of imperfect information, which may result in a target real rate other than a_0/a_3. Another assumption of equation (3) is the absence of random decision making errors, and accurate information on lagged output and inflation. In terms of real economic activity, these are unlikely to hold. In addition, the UK experienced shifts in the propensity to save during the 1990s, and these, together with changes in investment, exports and fiscal policy may well influence shifts in the equivalent of a_0/a_3. Since accurate information on the "equilibrium rate" of interest is not easily available, attaining this rate may not be the objective of the authorities. In other words, a Taylor-type monetary policy rules may not be adopted for inflation and/or zero output gap targeting, but with the interest rate instrument being used instead, to target money stock growth or exchange rate targets.

3.6 MONETARY POLICY IN ENDOGENOUS MONEY

The Keynesian approach to endogenous money views the macro economy from a different standpoint than the "new consensus". In the former, inflation can result from several factors such as cost push considerations. These include wages and import prices, or income levels and productive capacity. In the latter, inflation is the result of excess demand and expected inflation. Also in the Keynesian approach, is a view that the macro economy is subject to demand and supply side shocks, as well as considerable fluctuations in the level of economic activity over the business cycle. Variations in the level of demand are often the result of changes in investment spending, which is in turn influenced by accelerator type mechanisms, liquidity preference and expectations. The supply of bank loans to finance investment and expenditure, together with changes in liquidity positions and preferences of banks, means the banking sector is a major determinant of business cycle activity. Arestis and Sawyer (2003a), explain the role of monetary policy in the Keynesian approach to endogenous money, by considering liquidity preference, the exchange rate, fiscal policy, monetary policy objectives, fine tuning and monetary policy instruments. These are discussed below.

3.6.1 Liquidity Preference

Liquidity preference determines the allocation of wealth between different financial assets. A preference for more liquid assets changes asset demand, relative price and rate of return. When the nominal price of a financial asset such as bank deposits is fixed, then it obviously does not change. However, the rate of interest on such an asset can vary, for example by a bank reducing the rate of interest on deposits when demand for holding money balances increases.

The influence of liquidity preference impacts monetary policy decisions through relative interest rates which affect aggregate demand, as well as impacting banking sector asset portfolios. Bank loans are relatively illiquid which means a shift in liquidity preference impacts the willingness of banks to supply loans. Although a single interest rate operates in the simple "new consensus" model outlined earlier, the existence of channels of monetary policy transmission implies credit rationing and interest rate changes. Credit rationing might be ever present in some form, but the question is whether it can be influenced in some way through changes in the official interest rate. High interest rates risk loan default since higher interest payments mean a higher risk of the borrower being unable to repay. In addition, the composition of loan portfolios may shift from financing low-risk, low expected return borrowers to high-risk, high expected return borrowers. With regard to low expected return projects, increases in interest rates may well exceed expected loan returns. As bank loans move from low- to high-risk projects, increases in bank interest rates may act to ration credit, instead of increasing the rate of interest. Thus the effects of changes in official interest rates are more uncertain than the simple model outlined earlier suggests. Changes in credit rationing, relative interest rates, and the role of imperfect information as discussed by Stiglitz and Weiss (1981) for example, are thus of importance. The operation of monetary policy departs from the "new consensus", in that it impacts economic activity through credit channels. Changes in official interest rates indirectly affect these channels through changes in credit rationing. For example, increases in official interest rates may influence the willingness of banks to supply loans. Hence, not only does monetary policy operate through price effects on, say, investment spending, but also through credit rationing, the extent of which is determined by bank liquidity preference and credit availability.

3.6.2 The Exchange Rate

When money is regarded as exogenous and the objective of monetary policy is to control the money stock, the exchange rate is not considered. This is because the domestic inflation rate is determined by growth of the money stock, and the exchange rate is determined by purchasing power parity. The nominal exchange rate varies according to the domestic and international inflation rate differential, with no impact of monetary policy on the real rate. However when money is regarded as endogenous and interest rates are the policy instrument, transmission runs from the discount rate to the capital account of the balance of payments followed by nominal and real exchange rates. In some studies, for example Church *et al.* (1997), the exchange rate is a transmission mechanism and the most important path through which official interest rates impact inflation. As discussed earlier, interest rate parity suggests a theoretical relationship between official interest rate differentials and the exchange rate, but there appears no firm empirical consensus on this.

Nevertheless, there have been some indications to the contrary. In Eichenbaum and Evans (1995: 976) for example, VAR analysis of U.S. data suggests federal funds rate monetary policy has an impact on nominal and real exchange rates. The authors note that "we find the maximal effect of a contractionary monetary policy shock on U.S. exchange rate is not contemporaneous; instead the dollar continues to appreciate for a substantial period of time." This finding supports covered interest rate parity and work on the "forward premium bias" as in Hodrick (1987) for example, but not uncovered interest rate parity. On the latter, McCallum (1994: 121) notes that "it is inconsistent not only with existing models but also with views that have been held by actual policy makers for many decades – indeed over a century." Kim and Roubini (2000) on the other hand, provide evidence suggesting an initial exchange rate appreciation as official interest rates rise, but not any "forward discount bias". Engle (1996) notes in this regard, that the lack of empirical robustness in uncovered interest rate parity may be due to expectations that are not rational. Tight domestic monetary policy which increases the domestic and international interest rate differential, and induces a currency appreciation followed by a negative forward premium bias is considered by Rogers (1999). In this VAR based study, monetary policy shocks result in almost a half of the forecast error of the real short run exchange rate between sterling and the dollar. Other simulations in the same study suggest a monetary policy effect of at least 20%. A shortcoming of such evidence though, is identified by Sarno and Taylor (2002) in terms of the identifying restrictions required in VAR analysis. A solution to this problem is proposed by Cushman and Zha (1997) in terms of a structural model for Canada, and by Kim and Roubini (2000) for G7 countries excluding the U.S. Contractionary monetary policy which induces an exchange rate appreciation, is considered to be substantial, and points to the existence of an exchange rate channel for the transmission of monetary policy.

3.6.3 Fiscal Policy

In an endogenous money framework where the policy instrument is the rate of interest, monetary policy has been shown to affect the exchange rate, asset prices and income distribution. The effect on inflation via aggregate demand however, is somewhat less which raises the obvious question of how to supplement this ineffectiveness. Fiscal policy with respect to aggregate demand is highlighted as an omission in the "new consensus" model and as a critical solution to the ineffectiveness of monetary policy by Arestis and Sawyer (2003b). This is because fiscal policy is able to act as an automatic stabiliser in response to fluctuations in aggregate demand. Buti *et al.* (1997) provide evidence for this view by showing that the counter cyclical nature of government budget deficits results in a 0.5% change in the ratio between the budget deficit and GDP, when output relative to trend changes by 1%. In the Phillips curve of equation (2) above, the level of aggregate demand has a significant impact on the rate of inflation, the level of economic activity, employment and output. It is argued that fiscal policy might be an alternative and more effective instrument of monetary policy when inflation is targeted through the level of aggregate demand. In Arestis and Sawyer (2002c) it is that Central Bank estimates indicate that interest rate monetary policy does not have a significant impact on aggregate demand or inflation. In addition, monetary policy is suspect in terms of responding effectively to falls in aggregate demand and here it is only fiscal policy that is most appropriate. Since monetary policy and fiscal policy both influence the level of aggregate demand, with monetary policy also impacting variables other than inflation, there exist strong grounds for a combination of fiscal and monetary policies. This ensures a consistent policy approach to aggregate demand, rather than monetary policy and fiscal policy operating separately, which is the case for an operationally independent Central Bank pursuing a target rate of inflation as the primary monetary policy objective.

3.6.4 Monetary Policy Objectives

The essential rationale behind a monetary policy with the objective of targeting a rate of inflation is the notion that inflation is always and everywhere a monetary [policy] phenomenon. In this classical dichotomy, monetary policy also does not have any real effects on the level of economic activity. These propositions stem from monetarism under which money was treated as exogenous and controllable, and have been extended into current UK monetary policy which is based on inflation targeting through official interest rates. However, when inflation is considered a "demand phenomenon" then fiscal policy is an alternative or complementary policy for targeting the rate of inflation. In general. monetary policy impacts real variables such as investment and the exchange rate. and therefore monetary policy ought at the very least, to give consideration to such real side effects. Even if these effects are relatively small in magnitude, the effects on inflation will also be small. If the effects of monetary policy on inflation are themselves small, as argued above, then there is little strength in an argument for using monetary policy.

It is considered that an individual policy instrument will achieve an individual policy objective. Fiscal policy, which may indirectly influence exchange rates through trade position and market sentiment effects, does not have direct effects. On the other hand, interest are able to directly influence international capital flows and can be expected to influence exchange rates to some degree, even if this proves difficult to quantify. Here there are grounds for fiscal policy to target aggregate demand and for monetary policy to target exchange rates. In the "new consensus" model outlined above, the rate of inflation converges towards target, aided by expectations that it will be close to target, and that increases in inflation will be met with reductions in aggregate demand. The operation of monetary policy in this manner is made successful because there is an expectation of a credible inflation target, but this is nothing novel – any policy setting a credible target rate of inflation, including fiscal policy, is likely to have a similar outcome.

It might therefore be argued that the information set used to make interest rate decisions for monetary policy. ought to be broadened to include factors such as exchange rates, investment and asset prices. Furthermore. the effects of monetary policy on such variables may be long-term, and therefore monetary policy should consider long-term real effects as well as short-term inflation concerns.

3.6.5 Fine Tuning with Monetary Policy

Monetary policy decisions in major Central Banks are taken at frequent intervals, including every two weeks by the European Central Bank, every four weeks by the Bank of England and every six weeks by the Federal Reserve. In many instances, interest rates are either unchanged or adjusted by around 25 basis points which is very small, and monetary policy is also set to target the rate of inflation two years ahead. This frequency of change in monetary policy contrasts with fiscal policy where, say tax rates, cannot be changed so often. It might thus be argued that monetary policy is actually used to fine tune the level of economic activity towards an inflation target, even though it was noted earlier that the effects may be rather muted. Nevertheless, these decisions incur costs and further menu-type costs for implementing monetary policy decisions. These considerations support a less frequent decision making process for monetary policy.

3.6.6 Monetary Policy Instruments

It was noted earlier, that monetary policy decisions are transmitted to the level of economic activity through numerous channels, including "price effects" of interest rate changes or credit rationing. In the latter, this also depends on liquidity preferences, positions and market power of banking sector institutions, as well as their risk assessments. There seems a basis therefore, for some form of credit control policy, implemented by the Central Bank or the government, and operating alongside monetary policy. Banks and building societies for example, often vary the terms and conditions under which loans are supplied. In the case of mortgages then, control over loan to income ratios may be well worth considering. On the other hand, the rationing of credit may adversely affect investment via changes in the quality of intermediation. This negative aspect of credit rationing is justified by Shaw (1973: 86) who argues that,

> "Rationing is expensive to administer. It is vulnerable to corruption and conspiracy in dividing between borrowers and officers of the intermediary monopoly rent that arises from the difference between low, regulated loan rate and the market-clearing rate. It can be frustrated by borrowers who simply do not repay loans and keep their place in the ration queue by extending maturities. The rationing process discriminates poorly among investment opportunities ... and the social cost of this misallocation is suggested by the high incremental ratios of investment to output that lagging economies report."

These arguments are perhaps more relevant to developing rather than developed economies, particularly in terms of the corruption and conspiracy issues referred to above, since it is these countries who most often suffer from weak institutional frameworks. In contrast, it might be argued that credit rationing can be ineffective and expensive in developed economies, given their highly sophisticated institutional frameworks. This provides opportunities for borrowers to effectively evade credit restrictions. Credit rationing policies might therefore be acceptable for the reasons discussed above, but an active credit rationing policy might not be so effective.[14] For example, the 1980s saw sharp credit growth which in turn generated a bubble that inevitably burst. However if the bubble is prevented to begin with, a boom can be sustained for a longer period of time by exercising

[14] See also Stiglitz and Weiss (1981).

control over the amount and direction of credit. It is not argued that credit control in itself would stimulate the level of economic activity since there are potential problems with this approach as identified above. Credit control ought not therefore to be an intrinsic element of monetary policy, but rather adopted in instances where it might be beneficial alongside monetary policy, as illustrated above.

3.7 CONCLUSION

In an endogenous money framework, the Central Bank acts to set the official interest rate. This in turn influences market interest rates, with the stock of money determined endogenously and independently of the Central Bank. The role of interest rates as the instrument of monetary policy raises issues over the effectiveness of monetary policy. Here there are limitations in the use of interest rates, particularly in that they cannot become negative and that they are constrained by the level of international interest rates.

This chapter has presented the effectiveness of monetary policy from an endogenous money perspective. Within this view exist two schools of thought – the "new consensus" and the Keynesian approach. In the former, monetary policy effectiveness depends on whether monetary policy can effectively control inflation and successfully ensure deviations of the inflation rate return to target. In the "new consensus" framework outlined in the equations presented earlier, an assumed "equilibrium rate" of interest acts to generate a level of aggregate demand consistent with capacity output and thus constant inflation. Aggregate demand and the rate of inflation are then stimulated through changes in the rate of interest in terms of the "equilibrium rate", so that inflation converges on target. It has been shown that empirical evidence in Arestis and Sawyer (2002c) indicates interest rates are ineffective as an instrument of monetary policy, in controlling the rate of inflation. The second challenge for monetary policy is whether it can successfully manage shocks to autonomous aggregate demand. Here, it has been shown that the interest rate changes required in response to a shift in aggregate demand, must be so large that they are impossible to implement in practice.

In the Keynesian approach to endogenous money, liquidity preference plays an important role and because of this, the operation of monetary policy differs to that in the "new consensus". Here, fiscal policy is critical for managing aggregate demand, operating alongside monetary policy aimed at the exchange rate. In addition, there may be a case for some form of credit control acting in a supplementary manner as and when required, though it is by no means suggested this policy ought to be a cornerstone strategy. Overall then, the approach and therefore implications of monetary policy in the Keynesian framework are very different to those of the "new consensus".

CHAPTER FOUR

MONETARY POLICY RULES

4.1 INTRODUCTION

Quantifying the response of the Central Bank to changes in the level of economic activity has long been an important issue in monetary policy. Monetary policy reaction functions capture the behaviour of Central Bank policy instrument adjustments (changes in the short term nominal interest rate), in response to deviations of inflation from target and output from trend, on the back of demand or supply shocks. Reaction functions thus capture macroeconomic model dynamics and can be specified and modelled in a variety of ways. In recent years, Taylor (1993) type monetary policy rules have seen a resurgence of research interest, their simple and tractable nature capturing the behaviour of the Central Bank.

The basic premise of the Taylor (1993) rule is that the official interest rate is adjusted in response to deviations of contemporaneous inflation from a pre-determined target rate, and deviations of contemporaneous real output from potential. Historically, macroeconomic model building and subsequent policy recommendations experienced a change in direction during the introduction of rational expectations during the 1970s. An outcome of the time-inconsistency debate involving Kydland and Prescott (1977) and also Calvo (1978), was that policy rules are superior than discretion. This is because of the problems of consistent but sub-optimal planning and economic instability problems associated with discretion. As a result, the objective is to develop a practical rule, simple and easy to understand by economic agents, and one which captures monetary policy decisions and deviations from target. A specification of the Taylor (1993) rule is presented in chapter five, where the nominal Federal funds rate (i) responds to changes in the equilibrium real Federal funds rate (r^*), the four-quarter rate of inflation (π_t), the target rate of inflation (π^*), and the percentage deviation of real deviation from target ($\tilde{y}_t$). For ease of exposition, it can also be rewritten as a Taylor (1999b) nominal interest rate rule:

$$i_t = \delta + (1 + \alpha)\, \pi_t + \beta \tilde{y}_t \tag{1}$$

where $\delta = r^* - \alpha\pi^*$. In terms of the real interest rate $r_t = i_t - \pi_t$, equation (1) can also be written as:

$$r_t = \delta + \alpha\pi_t + \beta \tilde{y}_t \tag{2}$$

In Taylor (1993), both the inflation target (π^*) and the equilibrium real rate of interest (r^*) assume values of 2, with inflation and the output gap assuming values of 0.5 each. This set up is shown to graphically track the U.S. Federal funds rate closely. The parameters in equation (2) capture Central Bank preferences, with a stability condition of α usually assumed to be greater than zero. A value of less than zero implies inflation increases induce falls in the real rate of interest, thereby stimulating positive output increases. A second implication is that the estimated inflation coefficient in equation (1) is greater than one for the stability condition to hold. Also, the assumed values of 0.5 each for the α and β parameters are considered reasonable approximations in Taylor (1993), though in practice, their optimal values will depend on the structure of the model being considered. Since Taylor (1993), many modified monetary policy rules have sought to explain various aspects of monetary policy. This has become an enormous literature in its own right. This chapter presents the essentials of such monetary policy reaction functions, their properties and specifications, as well as their theoretical and empirical foundations. It considers the design of such rules, draws a distinction between calibrated and estimated monetary policy rules, and also highlights the choice of optimal monetary policy rules. The aim is to emphasise the specification and estimation of monetary policy rules and to consider how the influence the dynamics of macroeconomic models. To this end, the rest of the chapter is structured as follows. Section two presents a review of the empirical modelling issues involved. Section three looks at some Taylor-type rules estimated in the empirical literature. Section four examines optimal instrument rules and section five concludes.

4.2 PRELIMINARY MODELLING ISSUES

Since Taylor (1993), various modifications known more generally as Taylor-type rules, have produced pertinent outcomes for the design of monetary policy reaction functions. Among these are the various ways of measuring inflation, and estimating the equilibrium real interest rate and also potential output. Inevitably then, the robustness of estimated rules is subject to data selection sensitivity. Another issue relates to the timing of data available to the Central Bank, which in turn may influence reaction function specifications and estimated outcomes. A legitimate concern then is over the relevance of contemporaneous inflation and output gap observations in instrument rules, in contrast to the lagged data used by the Central Bank. Revised data is also a common ingredient of estimated historical policy rules, which is again in contrast to real time data observations used in Central Bank decision making. Structurally too, the Taylor (1993) implies instrument adjustments are based on current information, which contrasts with the forward looking nature of many Central Banks and hence forward looking policy rules. Lastly, lagged interest rate terms are also incorporated into many policy rules to reflect Central Bank interest rate smoothing. All of these issues are now considered in further detail.

There is no consensus in the empirical literature on Taylor-type rules over which price variables and length of inflation periods to use. In the original specification, Taylor (1993) measures inflation with the change in the year-on-year GDP price deflator. Alternative price indices have however been used and these include Kozicki (1999), in which four alternative measures of U.S. inflation are considered. These include a CPI measure of year-on-year inflation, a core CPI measure, a GDP price deflator measure and a measure of expected inflation derived from an average of private-sector forecasts. Inflation and output are taken as given and an interest rate feedback effect is not considered. A Federal funds rate is then calculated using a Taylor-type rule representing monetary policy, for the four different measures of inflation. Inevitably perhaps, the estimated results differ markedly, with official interest rate differentials ranging from 0.6 percentage points to 3.8 percentage points. The presence of an output gap in policy rules is given many empirical justifications, with the most common being that it reflects a Central Bank preference for output stability. Alternatively, the output gap is used to proxy expected future inflation as in Favero and Rovelli (1999). In Levin *et al.* (1999), it is argued that the estimated output gap parameter should remain above a certain value. The authors calculate figures of 0.6 or 0.8 to support this. Rationale for output gaps in policy rules aside, the measurement of potential output remains subjective and this makes any accurate assessment an uncertain exercise. In Taylor (1993), potential output is measured with a time trend fitted to actual output. Other common methods in the empirical literature include regressions of actual output on segmented linear trends and quadratic filters, Hodrick-Prescott (1997) filters, and also structural methods as adopted by the U.S. Congressional Budget Office.[1] As with inflation, different measures of potential output can produce quite different estimated policy rules. In Kozicki (1999) for example, robustness tests indicate monetary policy decisions based on different measures of potential output range from 0.9 percentage points to 2.4 percentage points.

The equilibrium real interest rate is perhaps the most difficult Taylor-type parameter to estimate, particularly because of the additive specification of Taylor-type rules. This means that measurement and estimation of equilibrium real interest rates has a direct influence on policy rule outcomes. Taylor-type rules are generally specified in terms of an unobserved equilibrium real interest rate and often, an unobserved target rate for inflation. A conventional solution to this problem is to assign a value for one of these parameters before estimating the other. Typical illustrations of this approach include Clarida, Gali and Gertler

[1] It might be noted that Woodford (2001) and also McCallum and Nelson (1999) have argued against estimating potential output using time trends since potential output is subject to exogenous shocks which are not captured in these exogenous estimates.

(2000), Kozicki (1999), and Judd and Rudebusch (1998), in which the equilibrium real interest rate is calculated as the differential between the average Federal funds rate and the average rate of inflation. With this measure of the equilibrium real interest rate, the inflation target is estimated and then extracted from the constant term in the estimated policy rule. Alternatively, estimation begins with an inflation target with the equilibrium real interest rate then calculated from the constant term. In Rudebusch (2001), a more involved approach is adopted in which the equilibrium real interest rate is derived from an IS equation as follows:

$$\tilde{y}_t = \alpha_1 \tilde{y}_{t-1} + \alpha_2 \tilde{y}_{t-2} - \beta(i_{t-1} - \pi_{t-1} - r^*) + v \qquad (3)$$

where the equilibrium real interest rate (r^*) is estimated as 2.2 per cent – close to the original Taylor (1993) rule. This estimated equilibrium real interest rate is then included in the constant term of a Taylor-type policy rule.

A constant equilibrium real interest rate however, is a controversial assumption that raises questions regarding the issue of measurement. In Kozicki (1999), U.S. equilibrium real interest rate estimates show a variation over the sample period, indicating implying that the equilibrium real interest rate may not be constant. In Rapach and Weber (2004), real interest rate estimates for several economies also point to the existence of structural breaks.

When the Central Bank implements monetary policy decisions, it does so on the basis of lagged rather than current data. Inevitably, this has led to the question of whether current or lagged data should be used in estimated policy rules.

Empirically, it does not seem that monetary policy reaction functions estimated using lagged data, suffer a significant reduction in performance compared to those using current data. Illustrative studies in this regard include Levin *et al.* (1999), McCallum and Nelson (1999) and also Rudebusch and Svensson (1999). In these studies, it appears that the loss is small because inflation and output persistence ensure lagged inflation rate and output gap values proxy current values well. In addition, Batini and Haldane (1999) suggest that the Central Bank has a greater amount of information on the level of economic activity at the point of instrument adjustment, than is available through inflation and the output gap alone. On this basis, it has been argued in Kozicki (1999) and Rudebusch and Svensson (1999), that contemporaneous rather than lagged data implicitly includes information not otherwise captured in measures of inflation and the output gap.

In general, Central Banks adjust the policy instrument on the basis of expected future economic activity. As a result, forward looking or forecast based interest rate rules are preferred over contemporaneous data rules in some studies. The arguments concerning the relevance of forward looking rules are similar to those associated with contemporaneous versus current data. However, there do not appear to be any empirical indications suggesting forward looking rules perform significantly better than contemporaneous or backward looking rules. Owing perhaps, to inflation and output persistence. This issue is considered in further detail in the rest of this chapter.

The numerous revision of economic data, often long after release is well known. To this end, it appears that estimates of Taylor-type policy rules based on real time data produce substantially different results from those based on current time data. In Taylor (1999b), current time data indicates the inflationary experience of the U.S. in the 1970s might have been avoided had Federal Reserve monetary policy followed the Taylor (1993) rule. Orphanides (1998) however, contradicts this position with estimates of Taylor (1993) rules using data available to the Central Bank at the point of instrument adjustment. The results suggest that any attempt to follow a Taylor (1993) rule would not have succeeded in averting inflation.

Instrument adjustments by Central Banks tend to be smooth, slow and in the same direction with little change. Thus Taylor-type rules often incorporate lagged interest rate terms to reflect interest rate smoothing. Sack and Wieland (1999) consider if interest rate smoothing is a deliberate Central Bank policy or simply the result of reactions of monetary policy to persistent macroeconomic conditions. A small or insignificant lagged interest rate coefficient would indicate this latter point. Empirically however, estimated Taylor-type rules with lagged interest rate terms generally produce large and significant coefficients, implying that interest rate smoothing is a deliberate Central Bank policy. The main reason for interest rate smoothing appears to be a reluctance by Central Banks to engage in frequent reversals in the direction of instrument adjustments. Williams (1999) suggests that frequent reversals might be interpreted by the public as policy mistakes and that any momentum in interest rate adjustments gives confidence to the Central Bank. Also in Sack and Wieland (1999), interest rate smoothing is considered to be the result of a lack of accurate economic information and uncertainties over the real state of affairs in the economy associated with the transmission mechanism of monetary policy. As a result, Central Banks may prefer to adjust the policy instrument slowly towards target.

4.3 MONETARY POLICY RULES

Empirical estimates of Taylor-type rules are extensively documented in the research literature. The main emphasis is on capturing the shift in macroeconomic policy towards inflation targeting, as experienced by many economies in the 1980s and early 1990s. The findings of such studies however, differ substantially depending on the types of data and models used. Three studies in particular are indicative of the issues affecting empirical Taylor-type estimates, as discussed above.

The generalised monetary policy rule of Taylor (1999b) in equation (1) above, is modified by Judd and Rudebusch (1998) to include an error correction mechanism which captures interest rate smoothing by the Central Bank. The modified rule is:

$$i_t^* = r^* + \pi_t + \alpha(\pi_t - \pi^*) + \beta_1 \tilde{y}_t + \beta_2 \tilde{y}_{t-1} \tag{4}$$

with the adjustment process given as:

$$\Delta it = \gamma(i_t^* - i_{t-1}) + \rho \Delta i_{t-1} \tag{5}$$

where the error in interest rate setting is corrected with the γ parameter, and the 'momentum' of the previous period's instrument adjustment is measured with the ρ parameter. Equations (4) and (5) are combined to give an estimated Taylor-type monetary policy rule with interest rate smoothing:

$$\Delta i_t = \gamma\xi - \gamma i_{t-1} + \gamma(1+\alpha)\pi_t + \gamma\beta_1\tilde{y}_t + \gamma\beta_2\tilde{y}_{t-1} + \rho\Delta i_{t-1} \tag{6}$$

where $\zeta = r^* - \alpha\pi^*$. In Judd and Rudebusch (1998), measures of the rate of inflation include the GDP price deflator, core CPI and a personal consumption expenditure deflator. Inflation is also defined as the four quarter average of the quarter-over-quarter change in the price level. Potential output is also proxied with several measures and these include the Congressional Budget Office measure, plus segmented linear and quadratic trends fitted to actual output. The sample period corresponds to three U.S. monetary policy regimes, namely Burns between 1970Q3 and 1978Q2, Volcker between 1970Q3 and 1987Q2, and Greenspan between 1987Q3 and 1997Q4. Estimation is based on the non-linear least squares method. In Judd and Rudebusch (2000), the problem of estimating Taylor-type monetary policy rules where the results are sensitive to measures of inflation and the output gap are illustrated. Rearranging equation (6) so that the nominal interest rate appears on the left hand side of the equation, simplifies the problem:

$$i_t = \gamma[\xi + (1+\alpha)\pi_t + \beta_1\tilde{y}_t + \beta_2\tilde{y}_{t-1}] + (1-\gamma)i_{t-1} + \rho\Delta i_{t-1} \tag{7}$$

The results of Taylor-type rules for different measures of inflation and potential output for the various frameworks of Federal Reserve monetary policy are presented in Table 2. It can be seen that the size of policy instrument adjustments varies significantly, depending on the measure of inflation or potential output being used. Generally speaking, the variation across monetary policy framework for inflation measures is less than those of potential output measures, with statistically insignificant model parameters omitted in the final estimations. Of interest is the estimated coefficient on inflation for the Burns period. This is statistically insignificant and suggests no response of the policy instrument to inflation. In this same period, the estimated coefficient on the error correction term is consistently greater than the estimated coefficient for momentum in interest rate adjustments. This suggests policy makers preferred to adjust official interest rates towards a desired level more than they did to maintaining the momentum of monetary policy. During the Greenspan regime, this relationship operated in reverse.

The authors note, though do not substantiate with empirical evidence, that monetary policy is more responsive to the change in, rather than the level of, the output gap during the Volcker period. To this end, the estimated coefficients on current and lagged output gap are restricted to sum to zero. In addition, the estimated coefficient on inflation is positive, indicating a non-accommodative monetary policy stance during this period. For the Greenspan period, the estimated policy parameters are less robust for different measures of inflation and potential output, compared to the Burns and Volcker periods. As the parameters vary, monetary policy responses to the output gap vary modestly but substantially in response to inflation. Furthermore, the gradual adjustment of the policy instrument produces estimated interest rate responses that are smaller in magnitude to those of the Taylor (1993) rule in equation (1) above. It is also evident that the estimated coefficient on the interest rate response to inflation

(1+α) is reduced by the error correction parameter (γ) implying a policy instrument response of less than one.

In Clarida *et al.* (2000, 1998), a Taylor-type rule is modelled with a partial adjustment parameter commonly used in studies such as McCallum (2001) and Kozicki (1999), but also modified to reflect a forward looking Central Bank. The estimated policy rule is:

$$i_t^* = i^* + \phi\left(E\left[\pi_{t,k} | \Omega_t\right] - \pi^*\right) + \beta E\left[\tilde{y}_{t,q} | \Omega_t\right] \tag{8}$$

where the target nominal interest rate (i_t^*) responds to changes in the required nominal interest rate (i^*) when inflation and output reach their respective target values, the change between time period t and $t+k$ in inflation ($\pi_{t,k}$), the average output gap between time period t and $t+q$, ($\tilde{y}_{t,q}$), and the information set available to the Central Bank when the policy instrument is adjusted. Interest rate smoothing is captured with a partial adjustment mechanism of the form:

$$i_t = \rho(L) i_{t-1} + (1-\rho) i_t^* \;\; ; \;\; \rho(L) = \rho_1 + \rho_2 L + \ldots + \rho_n L^{n-1} \;\; ; \;\; \rho \equiv \rho(1) \tag{9}$$

where the current policy instrument of the Central Bank is i_t. Equations (7) and (8) are combined to give the following estimated policy rule:

$$i_t = (1-\rho)\left[r^* - (\phi - 1)\pi^* + \phi \pi_{t,k} + \beta \tilde{y}_{t,q}\right] + \rho(L) i_{t-1} + \varepsilon_t \tag{10}$$

where the long run real equilibrium interest rate is $r^* = i^* - \pi^*$ and

$$\varepsilon_t = -(1-\rho)[\phi(\pi_{t,k} - E[\pi_{t,k}|\Omega_t]) + \beta(\tilde{y}_{t,q} - E[y_{t,q}|\Omega_t])]. \qquad (11)$$

The rate of inflation is measured by the annualised quarterly growth rate of the GDP deflator, and potential output by the Congressional Budget Office definition. This forward looking specification proxies expected inflation with future actual values of inflation. Other measures of potential output and inflation in the same study include the CPI for the latter and a quadratic output trend rather than potential Congressional Budget Office output, and the gap between actual and trend unemployment rather than the output gap, for the former. In addition, the equilibrium real rate of interest is the average of the real interest rate over the sample period, with the target rate of inflation then estimated jointly with the remaining instrument rule parameters. The monetary policy regimes considered in this study are pre-Volcker between 1960Q1 and 1979Q2, and Volcker to Greenspan between 1979Q3 and 1996Q4. The estimation approach in this study is the generalised method of moments (GMM) and the error term in equation (11) is a linear sum of forecast errors. As such, it is orthogonal to the information set parameter (Ωt) and this allows for a set of instruments to be obtained from the information set parameter (Ωt) for use in with GMM. The instruments include a lagged policy instrument, inflation, the output gap, commodity price inflation, and the spread between the long-term bond rate and the three-month Treasury bill rate. The monetary authority instrument is represented by the nominal Federal funds rate in all three of the studies discussed in this section. For the U.K. a similar study is that of Nelson (2000), in which seven separate policy regimes are considered, and for a broader set of economies, Clarida *et al.* (1998), in which Germany, Japan, France and Italy are also considered in addition to the U.K. The estimated policy rule in Clarida *et al.* (2000), requires estimates of the real equilibrium interest rate (r*) and the target rate of inflation (π*). The former is proxied by the sample average of the observed real interest rate, which varies from one subsample to another. Given r*, the target rate of inflation (π*) is then jointly estimated with the remaining variables in equation (10). The estimation results are presented in Table 3, using one-quarter-ahead expectations of the inflation and output gaps. In other words $k = q = 1$ in equation (10). Both GDP and CPI deflator measures of inflation, and quadratic trend and Congressional Budget Office potential output measures of the output gap are used to check the results for robustness. The output gap is also replaced with a measure of the unemployment rate deviating from trend. Furthermore, a backward looking version where $k = q = -1$, together with one-year-ahead (k=4) and one-quarter-ahead (q=1) expectations for inflation and the output gap respectively, are also estimated. In the main, these estimates are similar to one-quarter-ahead results and suggest the policy rule is reasonably robust to measurement over different time periods.[2]

The approach in Clarida *et al.* (2000) is also adopted by Cao *et al.* (2000) for the 1988 to 1998 period, with the results indicating an interest rate smoothing parameter of 0.8. In contrast to Clarida *et al.* (2000) however, the estimated coefficient on the output gap parameter is statistically significant and close to unity. The results in Clarida *et al.* (2000) however, are also sensitive to the measure of inflation and potential output being adopted. The estimated coefficients on both inflation and the output gap fall when potential output as

[2] Note however, that the Clarida *et al.* (2000) policy rule of equation (9) cannot be directly compared to equation (5) since the real interest rate is not an explicit model parameter. Also, the ϕ term is qualitatively equivalent to $(1+\alpha)$ in equation (9).

defined by the Congressional Budget Office is replaced with a quadratic trend of output and a trend unemployment rate. In some instances. definitions of potential output produce statistically insignificant parameters. Furthermore, CPI measures of the inflation rate do not substantially alter the results, though the magnitude of the output gap increases considerably. In contrast to Judd and Rudebusch (1998), Clarida *et al.* (2000) report a larger interest rate smoothing parameter, indicating smaller responses of the policy instrument to changes in the rate of inflation and the output gap. It is important to note however, that the sluggish response of monetary policy under rules with interest rate smoothing is a common characteristic and cannot be used for direct comparisons with original Taylor-type rules as in equation (1).

In Taylor (1999b), inflation is defined as the four quarter average of the quarter-over-quarter change in the GDP price deflator. In addition, a Hodrick-Prescott (1997) filter of real GDP is used to measure potential output. The estimation periods for the policy rule include the Gold Standard between 1879Q1 and 1914Q4, Bretton Woods between 1960Q1 and 1979Q4, and the post-Bretton Woods period between 1987Q1 and 1997Q3. The estimation method used in this study is OLS and the results are summarised in Table 1. The estimated value of k in equation (1) (where $k = 1 + \alpha$) for the 1960Q1 to 1979Q4 period is less than 1, implying that the coefficient on inflation is negative and that therefore monetary policy was accommodative. In the post 1987Q1 period however, the estimated value of k is greater than 1, implying a monetary policy preference for stable inflation. This seems consistent with the high levels of inflation in the 1970s and subsequent policy measures aimed at inflation control from the 1980s. The last of the sample periods covers a time of increasing concern over output stabilisation and this seems to be captured by an increase in the value of the estimated output gap coefficient.

The findings in Taylor (1999b) are similar in some sense to those of Clarida *et al.* (2000). Both studies report larger estimated inflation and output gap coefficients for the Volcker-Greenspan periods of 1979Q3 to 1996Q4, compared to the pre-Volcker period of 1960Q1 to 1979Q2. For the inflation rate, the estimated coefficient in the pre-Volcker period is less than one but greater than one for the Volcker-Greenspan period. In contrast to Taylor (1999b) and Judd and Rudebusch (1998) however, the estimated output gap parameter becomes statistically insignificant for the Volcker-Greenspan period. The magnitude of interest rate smoothing however increases in the latter of these periods, in line with the findings of Judd and Rudebusch (1998).

In each of these studies, the overall policy rule specification is similar but the variables and methods used to represent the rate of inflation and potential output parameters are somewhat different. As noted earlier, these differences in parameter measurement have produced widely varying empirical estimates. In the studies cited above, there are substantial differences in the estimated policy rules. In general however, it can be noted that they all reflect a common shift in monetary policy towards inflation control. This is illustrated by the fact that the estimated coefficient on the inflation parameter has consistently increased over the studies considered, during the 1980s and early 1990s.

4.4 OPTIMAL MONETARY POLICY RULES

The studies cited above estimate Taylor-type rules for monetary policy using single equation techniques. The results of these are not generally very robust since small changes in their underlying assumptions, such as the measures of inflation or potential output, lead to widely varying policy recommendations. This in turn raises questions over the relevance of estimated rules as guides for monetary policy. On a positive note, such rules are useful general descriptions of the behaviour of monetary policy. They also play an important role in macroeconomic models which require policy rules to be specified. since they offer a useful representation of Central Bank response to changes in the level of economic activity. In this sense, the role of relative weights on inflation and output gap parameters in Taylor-type monetary policy rules is less dependent on the estimated results produced by such functions, and more on the interaction of such rules within the wider macroeconomic models which they make up. In addition, studies by Taylor (1999a), Muscatelli *et al.* (1999), Clarida *et al.* (1998) and Ball (1997) to name but a few, argue that policy makers preferences also determine the relative weights of monetary policy rules in addition to the specifications of such equations. Such preferences are conventionally represented by loss functions defined as the deviation of inflation from target, output from trend and sometimes deviation of the nominal interest rate itself. Thus given policy maker preferences and particular policy rule types, relative weights which minimise the loss function are used.

The relative weights in such models are generally obtained through random simulations of macroeconomic models using different monetary policy reaction functions, with the objective of minimising a pre-determined policy maker loss function. Large variations in inflation and output parameters are penalised in such policy rules. Often the loss function is used to derive policy parameters which produce the most favoured combinations of unconditional variances in inflation and the output gap. The points on such parameters represent different policy maker preferences for the variables included in the loss function. Each instrument rule on the policy frontier is considered efficient in that it minimises the loss function, and thus the variance or deviation from target of inflation, the output gap, or even the nominal rate of interest. When variability in the policy instrument is not explicitly specified in the loss function, it is captured in terms of the frontiers where the variance of the policy instrument is restricted to equal to some specific value. Since the construction of such rules is model-consistent, they are often termed optimal rules in the empirical literature.

It was noted earlier, that the robustness properties of specific Taylor-type rules vary over different models and measures of parameters. Though Levin *et al.* (1999) and Taylor (1999a) regard such models to be robust in the terms of model uncertainty, their results are questioned on the basis that the models specified are too similar to one another. In Cote *et al.* (2002a, 2002b) for example, several Taylor-type rules are compared using a variety of economic models. In contrast to Levin *et al.* (1999) and Taylor (1999a), these indicate that Taylor-type rules are not robust to model uncertainty. In particular, the importance of model specification when constructing a policy rule, is emphasised. Additionally, issues such as interest rate smoothing, forward looking or backward looking models and expectations, which are important in historical Taylor-type rules, are also important in the estimation of optimal policy rules. Many of these issues discussed above, become equally important when taken in the context of wider macroeconomic models. The next section considers the empirical methods of generating optimal policy rules.

4.4.1 Monetary Policy Transmission and Optimal Policy Rules

Central to the construction of optimal policy rules, is the channel of monetary policy transmission specified in the model. Since the parameters of an optimal rule are subject to influence from price and output persistence, interest rate elasticity of demand, the degree of transparency and expectations, the identification of the channels of monetary policy transmission is a pre-requisite of efficient instrument rule design. The models discussed in this chapter might be classified in terms of the financial market price view of the transmission mechanism of monetary policy. In other words, monetary policy influences aggregate demand and inflation through market prices and rates of return on financial assets. The specification of this view might be represented in a simple three equation system consisting of aggregate demand, price adjustment and the instrument rule. Alternatively, it might include more detail on aggregate demand and the adjustment of prices.

The role of aggregate demand in the transmission mechanism might also be considered to differ across models in three particular ways. First, the response of aggregate demand to changes in the policy instrument across models. In some models, it is assumed that aggregate demand responds to short run nominal interest rate changes, and in others, to long rates. Second the persistence of output which varies from model to model, and which has a partial influence on the magnitude of instrument adjustments required to achieve output stability. Third, if open economy components of aggregate demand are included, then an additional channel of monetary policy transmission can have a significant influence on the time lags of monetary policy. In some macroeconomic models, an external component is not included which means optimal interest rate rules in some models may not be relevant for others which incorporate an open economy. The specification of inflation can also vary from model to models and this influences the effects of monetary policy on real model parameters. In some models, price setting behaviour is entirely backward looking, whilst in others it is a descriptive adjustment of the price mechanism. In such instances, staggered prices or wage setting are common assumptions, allowing the rate of inflation to be either forward looking, or a combination of expected future and past inflation. Models in which rational expectations are explicit assumptions, introduce further channels of monetary policy transmission. As a result, inflation expectations induce price movements which in turn enter the transmission mechanism through a subsequent influence on short term real interest rates. Taken with an expectations approach to the term structure of interest rates, this combination will influence the level of aggregate demand via movements in current long term interest rates. However, the effects of expectations on real interest rates also depends on the assumptions of wage and price setting behaviour inherent in models by Taylor (1995) or Svensson (2000). As Smets (1998) notes, a credible inflation target will result in low expected inflation, with less need for a large coefficient on the inflation parameter in the instrument rule. A simple empirical example of the relationship between the transmission mechanism of monetary policy and the choice of an optimal instrument rule, is the backward looking structural model of Ball (1997). This defines the economy in terms of a dynamic IS equation and a Phillips (1958) curve. These appear as equations (12) and (13) respectively:

$$\tilde{y}_t = -\omega\tilde{r}_{t-1} + \phi\tilde{y}_{t-1} + \varepsilon_t \qquad ; \qquad \omega > 0, 0 \leq \phi \leq 1 \qquad (12)$$

$$\tilde{\pi}_t = -\psi\tilde{\pi}_{t-1} + \phi\tilde{y}_{t-1} + \eta_t \qquad ; \qquad \omega > 0, \phi > 0 \qquad (13)$$

where the output gap ($\tilde{y}_t$) responds to changes in the difference between the real interest rate and the equilibrium interest rate level ($\tilde{r}_t$), the difference between inflation and the average inflation level ($\tilde{\pi}_t$), and white-noise error terms (ε_t, η_t). The Central Bank is assumed to set real interest rates after observing contemporaneous shocks (ε_t, η_t), with changes in interest rates only affecting expected output in the following period. It is assumed that (ε_t) cannot be forecast, with expected output thus determined as:

$$E[\tilde{y}_{t+1}] = -\omega\tilde{r}_t + \phi\tilde{y}t \qquad (14)$$

The required level of expected output can be set by selecting an appropriate level of the real interest rate. In doing so however, expected inflation is taken as given since real interest rates impact inflation with a lag of two periods. Expected output therefore, is determined as a function of expected inflation:

$$E[\tilde{y}_{t+1}] = -q\,E[\tilde{\pi}_{t+1}]$$

$$= -qE[\psi\tilde{\pi}_t + \varphi\tilde{y}_t + \eta_{t+1}]$$

$$= -q\psi\tilde{\pi}_t - q\varphi\tilde{y}_t \tag{15}$$

The monetary policy rule is then derived from equations (14) and (15) as follows:

$$\tilde{r}_t = \left(\frac{\psi q}{\omega}\right)\tilde{\pi}_t + \left(\frac{\phi + \varphi q}{\omega}\right)\tilde{y}_t$$
$$\equiv \alpha\tilde{\pi}_t + \beta\tilde{y}_t \tag{16}$$

Equation (16) is exactly the same as the Taylor (1993) rule in equation (1), and the parameter q in this model is determined by minimising the Central Bank loss function. Thus for a loss function of the form:

$$L = \sigma_y^2 + \mu \cdot \sigma_\pi^2 \tag{17}$$

(σ_y^2) represents the variance of the output gap, (σ_π^2) the variance of the inflation gap, and μ is the weight assigned to the rule by policy makers. The solution to this minimisation problem is:[3]

$$q = \frac{-(1-\psi^2+\mu\varphi^2)+\sqrt{(1-\psi^2+\mu\varphi^2)^2+4\varphi^2\psi^2\mu}}{2\psi\varphi} \tag{18}$$

Hence q is a function of model parameters and the weight assigned to inflation and output variance in the loss function by policy makers. The relative weights in the instrument rule of equation (16) are given by:

[3] If ψ is set equal to 1, then the solution for q is exactly the same as that of Ball (1997). In this chapter, the general form of Ball (1997) is presented.

$$\alpha = \psi q / \omega; \beta = \frac{\phi + \varphi q}{\omega} \tag{19}$$

The q term can also be shown as an increasing function of μ. Because of this, as the Central Bank gives more weight to the variance of inflation, both the weight on the inflation gap (α) and the weight on the output gap (β) in the policy rule will increase. This implies that for any random shock, changes in the policy instrument will need to be larger in order to stabilise the economy.

The relative persistence of inflation and output can be illustrated as follows. If inflation persistence, given by the value of ψ increases, relative to the persistence of output, given by the value of ϕ, then α will increase relative to β.[4] The reverse is true when ϕ increases relative to ψ. In other words, the optimal parameter values in the instrument rule are positively related to the relative persistence of the corresponding variables in the model.[5] In addition, they are also influenced by changes in the level of aggregate demand in response to changes in the policy instrument. This can be illustrated by an increase in the gradient of the *IS* function, indicated by an increase in the size of ψ. This leads to a fall in α and β because as aggregate demand becomes more responsive to changes in the rate of interest, the policy instrument will need to deviate less from their equilibrium values in order to stabilise the economy.

[4] q is also a function of ψ. However, it can also be shown that $\psi\, q$ increases with ψ.
[5] Empirical evidence for this is presented by Rudebusch (2001), Peersman and Smets (1999), and Smets (1998).

4.4.2 Trade-Offs and Shocks from Demand and Supply

In the model outlined above, inflation and output move in the same direction with output increases in the previous period leading to inflation increases in the current period. An increase in the value of inflation or output coefficients reduces the variance of both inflation and output. However, this is not the case in every macroeconomic model because the price adjustment process will vary from one to another. As a result, there may exist a trade off in inflation and output variability, as the relative weights assigned to the inflation and output gap parameters in the policy rule change.

This issue is taken up in McCallum and Nelson (1999), in the form of two alternative price adjustment mechanisms in a simple IS/LM model. The first specification is a Calvo-Rotemberg model of price adjusment, in which gradual adjustments in price are assumed and the costs of adjustment are quadratic.[6] The second specification is a P-bar model of price adjustment, in which price is assumed to be determined one period in advance.[7] As a result, output adjusts in response to any change in the level of aggregate demand, and adjustment costs represent the costs involved in changing production levels. This leads to a short run trade off between inflation and output variability. When prices are determined in advance, increases in the level of aggregate demand are met with increases in output. Large policy instrument responses to output result in a quick return of output to equilibrium, but at the expense of adjustment costs of output changes leading to a higher degree of variation in inflation. Empirical estimates by McCallum and Nelson (1999) for the Calvo-Rotemberg model indicate that

[6] See Roberts (1995) for an exposition of the Calvo-Rotemberg model.
[7] See McCallum (1994) for an exposition of the P-bar model.

increased weights on either inflation or output, while the other is held constant, leads to a reduction in the variance of both inflation and output in the policy rule. In the P-bar model this relationship does not hold. Instead, increased weights on output for given weights of inflation, lead to a decrease in the variance of output, but an increase in the variance of inflation. The authors point to the role of assumed price adjustment in the model, introducing an additional element of decision making in the design of an optimal policy rule. In other words, the Central Bank may have to decide which variable to stabilise, at a potential cost to the other.

A second issue relates to the response of Taylor-type rules to demand and supply shocks, namely that different models produce different responses. When aggregate demand is subject to a positive shock, both output and prices will increase and move in the same direction. If the Central Bank is following a Taylor-type reaction function, the response will be to increase official interest rates in order to induce falls in output and inflation. Supply shocks such as oil price increases on the other hand produce different outcomes. The transmission of such shocks into the general price level will raise the rate of inflation above target, inducing an increase in Central Bank interest rates. This in turn causes output to fall below potential, and this negative pressure further leads to inflation falling back to target level. Inflation responds with a lag, allowing prices and output to respond to shocks by simultaneously pushing interest rates in opposite directions. In the course of such shocks, it becomes more difficult to reduce interest rates to the levels required for offsetting increases in the rate of inflation, whilst simultaneously avoiding undue downward pressure on output.

4.4.3 Rule Specifications and Parameters

A reasonable assumption in model specification might be that the Central Bank sets official interest rates based on expectations of future economic activity. This is reflected in the forward looking or forecast based nature of some models which are preferred over backward looking or contemporaneous specifications. Batini and Haldane (1999) for example, seek to capture the lag between instrument adjustment and initial effects on inflation and output using a forecast based specification. A rationale for this is that the absence of lags in the model may result in cyclical instability. In addition, Central Bank expectations are formed on the basis of a wide information set and in this sense, forecast based or forward looking rules can be thought of as information encompassing rules. This is a characteristic not available in backward looking rules. Although forward looking models might seem more robust for the reasons given above, the choice of an optimal policy rule will still depend on the structure of the model being considered. Of particular importance here, is the wage-price contracting process. In Batini and Haldane (1999) for instance, when wage bargaining is backward looking, it is shown that forward looking rules help to stabilise the backward looking nature of private sector agents. Conversely, if wages are completely flexible, a forward looking parameter is not required in the instrument rule. In the extreme case of excessive forward looking expectations held both by the Central Bank and the private sector however, forward looking rule may have a destabilising effect.

It might be noted that forward looking specifications do not enjoy a firm consensus in terms of robustness in the empirical literature. Forward looking rules are shown to marginally perform better than contemporaneous Taylor-type specifications in the backward looking model of Rudebusch and Svensson (1999). In Smets (1998) models the same specification as Rudebusch and Svensson (1999) but without endogenous potential output. This modification allows a contemporaneous rule specification to perform in a similar, and sometimes slightly better, manner to forecast based rules. Taylor (1999a) finds little difference in the performance of inflation forecasts and actual inflation, thus concluding that forecast based rules have little advantage over contemporaneous specifications. In a further paper, Taylor (2000) notes that forward looking rules are similar to backward looking specifications, when the forecasts being used in the former are not too far out in the future.

Instrument rule parameters often include an interest rate smoothing term, though in practice the success of such coefficients seems to depend on rule specification and model structure. In general, these two issues determine the degree to which smoothing speeds up the process of stabilisation or not. Interest rate smoothing has been incorporated in a number of ways in the empirical literature, with different rule specifications generating substantial variations in the magnitudes of interest rate movements. To illustrate this, a smoothing parameter can be incorporated into the simple rule in equation (16) to give:

$$\tilde{r}_t = \alpha\tilde{\pi}_t + \beta\tilde{y}_t + \rho\tilde{r}_{t-1} \qquad (20)$$

Similarly in the Clarida *et al.* (2000), interest rate smoothing can be represented as:

$$i_t = (1-\rho)[(r^* - \pi^*) - (\phi - 1)\pi^* + \phi\pi_{t,k} + \beta y_{t,q}] + \rho(L)i_{t-1} + \varepsilon_t \qquad (21)$$

Smoothing parameters close to unity in rules such as equation (20) induce larger interest rate responses because the response to the current level of economic activity is incorporated into the previous interest rate change. Alternatively, a large interest rate smoothing parameter in rules such as equation (21) induce relatively small interest rate responses because the policy instrument remains closer to the level of the previous period.

As noted earlier, the structure of a policy instrument is an important determinant of the degree of interest rate smoothing. In particular, smoothing depends largely on the form of expectations assumed in the term structure of interest rates. Under rational expectations, long term interest rate changes respond to changes in expected future short term interest rates. In studies such as Woodford (2001), Taylor (2000, 1999a), and Levin *et al.* (1999), it is shown that if aggregate demand is specified as a function of long term interest rates, then the Central Bank will stabilise fluctuations in output, without any extensive adjustments in short term interest rates. In the last of these three studies, the magnitude of the optimal smoothing parameter is shown to decline when the maturity of the long term interest rate in the model is shortened. When rational expectations are not incorporated into model specifications, expectations are assumed either implicitly or explicitly to be backward looking. Thus if long term interest rates do not respond to changes in expected future short term interest rates, the magnitude of changes in long term interest rates will be smaller and with less influence on the level of aggregate demand. Furthermore, short term interest rate changes will only marginally by reflected in the term structure of long term interest rates. In these specifications, the effect of interest rate smoothing is simply to slow down the response of aggregate demand. If however, aggregate demand responds to short term interest rates rather than long term interest rates, then the inefficiencies of interest rate smoothing are reduced.

The relationship between interest rate smoothing and types of expectations in the term structure of interest rates is considered by Williams (1999). The model used in this study is that of the Federal Reserve Board which incorporates rational expectations in price setting behaviour and in the term structure of interest rates. Empirically, the best performance in terms of reducing the variance of inflation and output, is found in rules specified in first differences and assuming rational expectations, rather than VAR based expectations.. In other words, where the interest rate smoothing parameter is equal to one. In Ball (1999), further empirical evidence is presented in support of interest rate smoothing inducing large variations in inflation and output variance, in a backward looking model. A general observation in the empirical literature is a longer feedback process in the absence of rational expectations in the term structure of interest rates. Again, though rational expectations are theoretically robust, the exact result depends heavily on the way in which the assumption is modelled. Taylor (1999a, 1999b) for example, notes that the use of lagged data to generate expectations of the future in rational expectations models, implies a backward looking specification. Hence there is no clear evidence to suggest rational expectations model properties based on lagged information, produce significantly better results than models estimated using backward looking expectations.

4.4.4 The Exchange Rate

For economies with international trade making up a significant proportion of overall economic activity, the exchange rate will be an important channel for the transmission of the monetary policy rule. In Ball (1997), this effect is modelled by including an exchange rate channel in a modified system of the IS/Phillips-curve equations of (12) and (13) presented above. This gives:

$$y_t = \omega' \widetilde{r}_{t-1} - \sigma \widetilde{e}_{t-1} + \phi' y_{t-1} + \varepsilon_t; \tag{22}$$

$$\pi_t = \psi' \widetilde{\pi}_{t-1} + \varphi \widetilde{y}_{t-1} - \xi(\widetilde{e}_{t-1} - \widetilde{e}_{t-2}) + \eta_t; \tag{23}$$

$$\widetilde{e}_t = v \widetilde{r}_t + v_t \tag{24}$$

The parameters in this system are all positive. Equation (22) is an open economy IS curve, equation (23) is a Phillips curve and equation (24) is an interest rate parity condition. The real exchange rate takes the form of deviation from mean $\widetilde{e}_t = e_t - \bar{e}$, with a higher rate implying appreciation. In the closed economy system of equations in section 4.1, instrument adjustments impact inflation with a lag of two periods, while in the modified open economy system of Ball (1997) above, interest rates impact inflation with a one period lag, thereby increasing the speed of monetary policy. Solving equations (22) to (24) generates a policy instrument rule of the form:

$$\gamma_1 \widetilde{r}_t + (1 - \gamma_1)\widetilde{e}_t = \gamma_2 y_t + \gamma_3 (\pi_t + \zeta e_{t-1}) \tag{25}$$

where the γ parameters represent functions of the remaining model variables. Thus the policy rule in an open economy model becomes a function of both the interest rate and the exchange rate, compared to it being a function of only the interest rate in a closed economy set up. The left hand side of equation (25) is interpreted by Ball (1997) as a monetary condition index. In other words, in an open economy, the Central Bank takes into account the interaction between nominal interest rates and the exchange rate before adjusting the policy instrument. Another innovation of this approach is the last term in the policy rule of equation (25). This represents long term inflation, which is included to produce net effects of direct but temporary exchange rate effects on the rate of inflation. This model is calibrated and the policy rule of equation (25) evaluated in terms of an inflation-output variance trade-off frontier where different combinations of parameter weights are used. The estimated results are then adjusted for comparison purposes with a closed economy system to capture the response of the interest rate to changes in inflation and output. When inflation and output are assigned equal weights in the loss function, the optimal coefficient on the inflation coefficient in the open economy model does not change. The coefficient on the output gap is slightly larger in the open economy system compared to the closed economy set up. Between the open and closed economy interest rate rules then, there is little change in the magnitude of policy instrument adjustments. Ball (1997) thus infers that for a given output variance, an optimal open economy rule does not reduce inflation variance much more than a close economy specification.

Svensson (2000) also models the exchange rate in a Taylor-type rule but without conclusive results. The approach is a small open economy specification similar to that of Ball (1999), except with forward looking aggregate demand and supply equations. These are derived from an exchange rate channel incorporated into the transmission mechanism of monetary policy. The inclusion of the exchange rate in the estimated Svensson (2000) policy rule, leads to a lower variance for the inflation parameter, but a higher variance on output and the real interest rate compared to Taylor (1993). A point to note however, is that the loss function used by Svensson (2000) can bias the results towards the preferences of the Central Bank. Similar findings are reported by Taylor (1999a), in which empirical support for an exchange rate parameter in the policy rule is weak. The approach taken in this study is based on an earlier multi-country model adopted by Taylor (1993b), in which Germany, Italy and France represent European Monetary Union (EMU) economies, and in which Britain, Japan, Canada and the United States represent economies pursuing independent monetary policies. The model is simulated with a closed economy interest rate rule as in equation (16), and an open economy interest rate rule of the form:

$$\widetilde{r}_t = \alpha\widetilde{\pi}_t + \beta\widetilde{y}_t + \chi_0\widetilde{e}_t + \chi_1\widetilde{e}_{t-1} \qquad (26)$$

The study finds that the open economy policy rule performs just marginally better than the close economy specification, in terms of reducing the variance of output and inflation. In general, the findings in Svensson (2000), Taylor (1999a) and Ball (1999) do not provide convincing evidence that the inclusion of an exchange rate parameter in modified Taylor-type rules, improves model performance. These studies relate to large open economies, and in contrast, Clarida *et al.* (2000, 1998) aim to model Taylor-type instrument rules for small open economies with exchange rate parameters. Here monetary policy reaction functions for Germany and Japan are adapted to include the U.S. Federal funds rate and also their respective exchange rates with the U.S. The estimated results show statistically significant parameters which are small in magnitude and positive in sign. For the German reaction function however, the inclusion of a real exchange rate parameter produces a negative coefficient on inflation.

Returning to Svensson (2000), Taylor (1999a) and Ball (1999), Taylor (2001) argues that even if the parameters χ_0 and χ_1 in equation (25) above are set to equal zero so that the policy instrument does not respond directly to changes in the exchange rate, it will nevertheless react indirectly to movements in the exchange rate. This is because changes in the exchange rate are transmitted through aggregate demand and inflation, filtering through into the interest rate rule of equation (25). For this reason, it is not necessary to include an explicit exchange rate parameter in instrument rules. In Cote *et al.* (2002a), the weak performance of open economy instrument rules is due to the exchange rate absorbing economic shocks, which means any attempt to smooth fluctuations in the exchange rate, acts as an obstacle to adjustment processes in the economy.

4.4.5 Stability and the Output Gap

Instrument rules in which the inflation parameter is less than zero will generate upward sloping demand curves and unstable reaction functions. This is illustrated by Taylor (1999a) in terms of an IS curve, in which stable equilibrium in Taylor-type rules depends on the structure of the macroeconomic model, the specification of the instrument rule and how it behaves within the overall model. The stability condition for Taylor-type instrument rules is illustrated by Svensson and

Woodford (2003) in terms of a forward looking IS/Phillips curve model. To illustrate, the Phillips curve can be presented as follows:

$$\pi_t = \varphi \tilde{y}_t + \psi E_t \pi_{t+1} \qquad (27)$$

where $\tilde{y}$ is the output gap, $E_t \pi_{t+1}$ is the expectation of inflation at time $t+1$ given the information set available at time period t. The IS equation can be presented as:

$$\tilde{y}_t = E_t \tilde{y}_{t+1} - \omega(i_t - E_t \pi_{t+1}) \qquad (28)$$

where i_t is the policy instrument. A Taylor-type monetary policy reaction function can thus be presented as:

$$i = \bar{i} + \alpha(\pi_t - \bar{\pi}) + \beta(\tilde{y}_t) \qquad (29)$$

where $\bar{i}$ is an intercept term, and $\bar{\pi}$ is the inflation target. To illustrate the role of α and β in achieving stability, the Blanchard and Kahn (1980) approach to solving linear difference models is adopted by the following condition:

$$\alpha + \frac{1-\psi}{\varphi}\beta > 1 \qquad (30)$$

in which instrument rule stability is determined by both the inflation parameter (α), and the output parameter (β). In this model, stability is achieved through a large coefficient on either estimated parameter. The Blanchard and Kahn (1980) approach is also used to test for stability in the calibrated forward looking

IS/Phillips curve model of Clarida *et al.* (1998). The estimates indicate a decreasing lower bound on the inflation coefficient in response to increases in the output gap coefficient. Inflation is only found to equal one when the output coefficient is equal to zero. Thus the policy instrument does not respond by a magnitude greater than one to inflation. Instrument rule stability can also be achieved if there is a sufficient response of the policy instrument to changes in the output gap.

The relationship between the slope of the Phillips curve and the values of the estimated inflation (α) and output (β) parameters is also reflected in equation (30). An increase in the gradient of the Phillips curve implies an increase in φ. In response, β increases for a given value of α. In Isard *et al.* (1999), the Blanchard and Kahn (1980) method is applied to capture the stability conditions of a Taylor (1993) rule using a non-linear Phillips curve model, with forward looking and model consistent expectations. The original Taylor (1993) is shown to achieve equilibrium when output is at potential, but breaks down for high levels of excess demand where the gradient of the Phillips curve reaches a critical point. These findings are indicative of the implications of equation (30) above in that as the gradient of the Phillips curve (φ) increases, the estimated coefficient on the inflation parameter must increase for a given value of the output gap. Thus the original Taylor (1993) rule is shown to succeed in achieving unique solutions for low levels of excess demand, but breaking down for high levels.

This analysis is extended by Svensson and Woodford (2003) for stability conditions in forward looking Taylor type rules. This specification is given in equation (31) below with the corresponding stability conditions given in equations (30) and (32). For a forward looking interest rate rule then, the lower bound on the value of α for given value of β is equation (30), and the upper bound is equation (32). The two combine to meet the following stability conditions:

$$i=\bar{i}+\alpha(E_t\pi_{t+1}-\bar{\pi})-\beta(\tilde{y}_t) \tag{31}$$

$$\alpha<1+\frac{1+\psi}{\varphi}(\beta+2\omega^{-1}) \tag{32}$$

An implication of equation (32) is that instrument adjustments in response to deviations of expected future inflation from the target rate of inflation, under large values of the inflation parameter (α), can induce fluctuations in equilibrium that are simply the outcome of self-fulfilling expectations. Clarida *et al.* (2000) also present estimates of an upper bound on the inflation parameter (α), which is high.

As with single equation estimates of Taylor-type rules, optimal policy rules are also subject to bias from errors in the measurement of the output gap. It was discussed earlier, that these can lead to substantial variations in the weights on the inflation and output gap parameters. The theme of measurement error and the resulting loss in performance of the policy rule is taken up by Orphanides *et al.* (1999) using the model of the Federal Reserve Board. A Taylor (1993) rule is used in the specification to show that increases in the size of measurement error lead to increases in the variance of nominal interest rate, inflation and output. A modification of the initial specification to include interest rate smoothing, and a reduction in measurement error, reduces the variance of the parameters relative to

Taylor (1993). However, as the measurement error is allowed to increase, the modified Taylor-type rule performs worse than the original. Though it is not argued that the value of the output gap in the rule should be set to equal zero, a small weight (less than the 0.5 in Taylor (1993)) on the output gap parameter in the presence of measurement error, still produces a lower variance on inflation and output than when the weight is zero. Similar findings are reported by Smets (1998) for an IS/Phillips curve specification which compares the weights on inflation and output gap parameters for six different monetary policy reaction functions, including four Taylor-type rules. When no measurement error is assumed for the output gap, the estimated coefficients on the output gap appear consistently larger than those on the inflation gap. When an assumption of measurement error is retained for the output gap, the results change, with the estimated coefficients on the output gap for Taylor-type rules falling substantially. In two of these rules, the weights on output gap parameters are actually smaller than those for the inflation gap, with inflation gap coefficients falling only very slightly.[8]

4.5 CONCLUSION

In specifications of Taylor-type monetary policy rules, the policy instrument in the form of short term nominal interest rates responds to deviations of contemporaneous inflation from a predetermined target, and to deviations of contemporaneous real output from the potential level of output. The magnitude of interest rate responses to shocks is determined by the relative weights assigned to

[8] An extensive literature review of instrument rule uncertainty is available in Armour and Cote (1999).

the inflation and output gap coefficients of the rule concerned. Though such monetary policy reaction functions are simple and tractable, they do nevertheless describe the essential workings of Central Bank monetary policy. In general, the relative weights on inflation and output gap coefficients are determined either through direct estimation of a Taylor-type rule for a specific time period, or through simulating a model in which a loss function represents the policy preferences of the Central Bank. These preferences are defined as the trade off between fluctuations in inflation and output. In this latter approach, optimal weights for inflation and output parameters are those which minimise the loss function. This chapter has considered both approaches to the design of Taylor-type monetary policy functions.

The literature presented here indicates that estimated Taylor-type rules are not robust for a variety of reasons. For example, estimated relative weights for inflation and output experience shifts over sample horizons, with some also changing sign. This is often due to a change in the objective of monetary policy. Because of this, data observations over long periods of time prove inappropriate for estimating Taylor-type instrument rules, especially if the period concerned consists of several switches in policy regime. At the same time, small sample estimates reflecting individual monetary policy frameworks may be at risk of small sample bias, leading to inaccurately estimated parameters weights. Additionally, Taylor-type rule specifications are simple, incorporating modifications such as interest rate smoothing parameters or an exchange rate term. The empirical evidence in this chapter has shown however, that the weights of such policy rules are sensitive to different measures of inflation and potential output. In models representing economies without official inflation targets, the problems are exacerbated since further estimation techniques are required to ensure robustness of model results.

Other relative weight specification concerns relate to the use of current versus lagged and real time data, forward looking versus backward expectations and interest rate smoothing parameters. Models covered in this chapter, indicate that the outcomes of current or lagged data estimates are broadly similar. Although the Central Bank adjusts the policy instrument using real time data, the use of current time data in estimating Taylor-type monetary policy rules reflects the breadth of the information set available to the Central Bank other than inflation and output. In terms of backward looking or forward looking specifications, as well as interest rate smoothing, there exists no firm consensus in the empirical literature in favour of any particular method. It can be noted that all of these approaches are able to produce robust results, depending on the structural characteristics of the model concerned.

An alternative to the direct estimation of relative Taylor-type weights is the random simulation of models in order to identify the relative weights for minimising the value of a given loss function. Model-consistent or optimal Taylor-type rules however, are dependent to a large extent on the interaction between the individual policy rule and the wider model within which it operates. Differences in the dynamic structures of models, such as the transmission mechanism of monetary policy, produce very different functional forms of policy rules. Furthermore, the selection of relative weights for policy rules is determined by Central Bank preferences, which are in turn determined by a loss function defined over the variance of the inflation gap and the output gap. As a result, the degree of importance attached by the Central Bank to fluctuations in inflation and output in the loss function, will determined the relative weights assigned to Taylor-type rule parameters.

Another theme common to both estimated Taylor-type rules and the design of optimal monetary policy reaction functions is the definition and measurement of variables such inflation and potential output, forecast based and backward looking expectations, current data and lagged data, and also interest rate smoothing and the exchange rate. Here again there exists no firm consensus over the best approach to take, and indeed estimates outcomes in the empirical literature depend more on the dynamic structural characteristics of the models being used. For example, if aggregate demand in a given model is sensitive to interest rate changes, then for a given loss function, the relative weights in the policy rule will be lower than under low interest elasticity. Finally, the specific inclusion of an exchange rate channel in the transmission of monetary policy is an important consideration. However, the empirical literature suggests that the inclusion of an exchange rate term in Taylor-type rules does not substantially improve the performance of macroeconomic models. In addition, it might also be argued that since the effects of overseas prices are captured in conventional Taylor-type rules in the form of changes in the level of aggregate demand and the costs of production, the exchange rate effect is already accounted for.

CHAPTER FIVE

INFLATION TARGETING

5.1 INTRODUCTION

Since the early 1990s, a number of Central Banks have resorted to Inflation Targeting as a means of achieving low levels of inflation. and many empirical studies have advocated Inflation Targeting for monetary policy. For example, Mishkin (1999: 595) argues that "the performance of inflation-targeting regimes has been quite good. Inflation-targeting countries seem to have significantly reduced both the rate of inflation and inflation expectations beyond that which would likely have occurred in the absence of inflation targets." In addition to reductions in the rate of inflation and inflation expectations, Inflation Targeting is seen to overcome dynamic time-inconsistency problems together with an independent Central Bank, reduce inflation variability, stabilise output if applied in a "flexible" way (Svensson, 1997) and absorb inflationary shocks by "locking in" low inflation expectations. Also, since its inception by New Zealand in 1990, Inflation Targeting has not been abandoned by any of the Central Banks that have adopted it.[1]

In addition to the targeting of a rate of inflation as an objective of monetary policy. Inflation Targeting also includes the following. A government determined target range for the rate of price inflation, monetary policy as the primary instrument of achieving the target, by way of adjustments in official interest rates,

[1] This might suggest that it is premature to argue Inflation Targeting has been "quite good" as quoted by Mishkin (1999) above.

an operationally independent Central Bank, and the rate of inflation as the sole objective of monetary policy. With the exception of short-term effects, the influence of monetary policy on other policy objectives is not considered. This chapter associates Inflation Targeting with the New Consensus Macroeconomics as an important theoretical and policy parameter. Secondly, the importance of Inflation Targeting as a theoretical construct and policy measure is underscored by the fact that it has been adopted in "more than 20 countries" according to Fracasso *et al.* (2003). The rest of this chapter is organised as follows. Section two identifies Inflation Targeting with the New Consensus Macroeconomics. Section three presents the theoretical basis of Inflation Targeting with a breakdown of the issues involved. Section four discusses the mechanism through which Inflation Targeting is used to control inflation. Section five reviews the empirical evidence on Inflation Targeting in terms of structural macroeconomic and single equation models. Section six concludes.

5.2 INFLATION TARGETING AND THE NEW CONSENSUS

As indicated in chapter three, the New Consensus can be illustrated as in Meyer (2001) or McCallum (2001). The example below follows Arestis and Sawyer (2003a):

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 E_t\,(y_{t+1}) - \alpha_3\,[R_t - E_t\,(p_{t+1})] + s_1 \qquad (1)$$

$$p_t = \beta_1 y_t + \beta_2 p_{t-1} + \beta_3 E_t\,(p_{t+1}) + s_2 \qquad (2)$$

$$r_t = (1 - c_3)\,[R^* + E_t\,(p_{t+1}) + c_1 y_{t-1} + c_2\,(p_{t-1} - p^T)] + c_3\, r_{t-1} \qquad (3)$$

where $b_2 + b_3 = 1$, y_t is the output gap, r_t is the nominal rate of interest, p is the rate of inflation, p^T is the target rate of inflation, R^* is the "equilibrium" real rate of interest consistent with zero output gap, implying a constant rate of inflation from equation (2), s_i (with $i = 1, 2$) are random shocks, and E_t are expectations held in time period t. Equation (1) represents an aggregate demand relation where the current output gap is a function of lagged and future expected output gap values, and also the real rate of interest. Equation (2) represents a Phillips (1958) curve where inflation is a function of the current output gap, and also lagged and future inflation. Equation (3) replaces the LM-curve with a Taylor (1993) type monetary policy reaction function, described by Svensson (2003: 448) amongst others, as a "prescribed guide for monetary-policy conduct." The nominal interest rate in this equation is a function of expected inflation, the output gap, the deviation of inflation from target and the "equilibrium" real rate of interest. The lagged interest rate term represents Central Bank "smoothing" to improve performance through "history dependence" as illustrated by Woodford (1999), amongst others. The three unknowns in the system of equations above are then interest rate, inflation and output.[2]

Equation (1) is also akin to a conventional IS curve, but with expenditure determined by the intertemporal optimisation of a utility function. Lagged adjustment and forward looking aspects are captured by sticky prices in the form of lagged inflation in the Phillips curve, and complete long-run price flexibility.

[2] The model is not rigidly fixed and variations are possible. For example, interest rate smoothing or lagged output in equation (3). A fourth, stock of money equation can also be included to represent demand for money variables such as income, price and interest rates. This has the effect of endogenising money where the stock of money is demand determined. However, this would be almost irrelevant since the money stock is a residual with no causal relationship with other model parameters. See Arestis and Sawyer (2003a) for a detailed discussion.

In equation (2), the $E_t\ (p_{t+1})$ parameter reflects Central Bank credibility in that it signals an intention to target and maintain low inflation. This in turn lowers inflation expectations, with current inflation reduced at relatively lower cost in terms of output. In the monetary policy rule of equation (3), monetary policy adjusts systematically to changes in economic activity and not exogenous factors. The nominal interest rate is thus the sum of the real interest rate and expected inflation, and is therefore symmetric in targeting inflation. When inflation exceeds target, interest rates are raised and when inflation is below target they are lowered. The absence of a random shock in equation (3) implies monetary policy is not subject to shocks. The system as a whole assumes money neutrality. monetary policy-led inflation (through official interest rates), and real variable equilibrium values independent of the money supply. Also, the money stock has no causal role in the model and is a residual. Inclusion of a demand for money equation in the model would imply that the money stock is determined by the demand for money. This approach is new consensus in that it emphasises several factors, including the non-accelerating inflation rate of unemployment, or NAIRU, the absence of aggregate demand and fiscal policy, and the priority of monetary policy over fiscal policy.[3]

Inflation Targeting is encapsulated in the system of equations above, particularly expected inflation in equation (3). The inflation target and Central Bank forecasts have a strong influence on expected inflation, by adding a degree of monetary policy transparency inherent in Inflation Targeting. Inflation forecasts are thus a key aspect of Inflation Targeting, and according to Svensson (1997), are a form of

[3] See Arestis and Sawyer (2003a) for a detailed treatment.

intermediate monetary policy target. There is however, a problem with inflation forecasts particularly with regard to the large error margins involved which can affect the credibility and transparency of the Central Bank. On the other hand, inflation forecasts are the basis of inflation expectations which subsequently influence actual inflation. The central role of inflation forecasts in monetary policy is thus critical to Central Banks pursuing Inflation Targeting, particularly with regard to controlling inflation. This is because inflation is subject to large influences from external factors such as oil prices, exchange rates, wages and taxes, and the Central Banks have little control over these. If inflation is sourced to such variables, Inflation Targeting becomes redundant. For example, when negative supply shocks induce rising inflation and falling output, an Inflation Targeting Central Bank would respond by attempting to control inflation, and deepening the recession. Even if a Central Bank succeeds in achieving low and stable levels of inflation and output with output close to potential, the outcome remains the same since the objective of the Central Bank is an inflation target rather than a target rate of output growth.

5.2.1 Inflation Targeting

This section presents the main characteristics of Inflation Targeting in equations (1) to (3) above. There exists no firm consensus on these and this chapter covers those that would probably be accepted by the majority of commentators, as most if not all aspects of Inflation Targeting. In doing so, the approach here follows Arestis and Sawyer (2003a: 6). When monetary policy operates in an Inflation Targeting framework, official inflation targets or ranges are publicly announced, and low and stable levels of inflation are explicitly acknowledged as the primary long-term objectives of monetary policy.[4] The advantage of this framework is clear communication between the Central Bank and public, private and market agents, whilst also ensuring a disciplined, accountable, transparent and flexible approach to monetary policy. The primary objective of price stability is supported by three additional objectives. These are a credible framework which develops trust, a flexible monetary policy which responds optimally to unanticipated shocks, and legitimacy derived from public and parliamentary support.[5]

According to Bernanke and Mishkin (1997: 104), Inflation Targeting is achieved through "constrained discretion" in that monetary policy is restricted to the pursuit of clear, long-term and sustainable objectives.[6] However, reasonable discretion can be used to respond to unexpected shocks if necessary. As a result, Inflation Targeting acts as a nominal anchor for monetary policy, giving a precise commitment to price stability. This in turn, imposes monetary policy discipline on the Central Bank and the government within a flexible policy framework. For example, monetary policy might be used to achieve short-run stability, but without

[4] The analysis here focuses on Inflation Targeting rather than money supply targeting. This is because an unstable money demand results in an unstable LM curve. This is further illustrated by HM Treasury (2003). Also, Inflation Targeting pursues a final rather than intermediate objective of monetary policy. King (1997) argues Inflation Targeting is preferable to money supply targeting because it responds to short-run shocks in an optimal manner, which money growth targeting does not. The circumstances under which Inflation Targeting might operate in an optimal way are illustrated in Svensson and Woodford (2003).

[5] Credibility is central to monetary policy as a means of over-coming time inconsistency. This problem is basically one of a discretionary Central Bank monetary policy aimed specifically at real economic variables such as output or unemployment, which causes inflation in the short-run, without producing any benefit for economic activity in the long run. A further discussion is in Barro and Gordon (1983). Authors such as Kydland and Prescott (1977), Calvo (1978) and Barro and Gordon (1983) argue that if monetary policy is not credible because of time inconsistency, then it is neither optimal nor feasible. A credible policy is one under which the Central Bank does not respond to developments. In addition, even if aggregate demand has a short-run influence on output, non-intervention is preferred in response to time inconsistency.

[6] In Bernanke (2003: 2), "constrained discretion" represents somewhat of a compromise between rules and discretion in the sense that it is "an approach that allows monetary policy makers considerable leeway in responding to economic shocks, financial disturbances, and other unforeseen developments. Importantly, however, this discretion of policy makers is constrained by a strong commitment to keeping inflation low and stable."

compromising the long-run objective of inflation. This process causes policy to be consistent and rational, resulting in clear public expectations and points of reference from which to judge short-run policy decisions. Mishkin (2000: 5) argues that this approach reduces the possibility of deflation by noting that "Targeting inflation rates of above zero, as all inflation targeters have done. makes periods of deflation less likely." Monetary policy also represents the primary instrument of macroeconomic policy since it can be used flexibly to achieve stability in the short to medium term, and adjusted quickly in response to economic shocks. It is the most direct determinant of the rate of inflation, and in the long run, is only effective against inflation.[7] Also, according to HM Treasury (2003), a long run target of price stability should be achieved at minimum cost in terms of deviations of actual output from potential and of inflation from target.

Fiscal policy is not considered as an instrument of macroeconomic policy, especially since it is subject to slow and uncertain legislative issues. It is also passive in the sense that the budget deficit on the balance of payments fluctuates over the business cycle. This according to Mishkin (2000: 2) implies that "Restraining the fiscal authorities from engaging in excessive deficits financing thus aligns fiscal policy with monetary policy and makes it easier for the monetary authorities to keep inflation under control." As a result, "monetary policy moves first and dominates, forcing fiscal policy to align with monetary policy." Because of the factors above, monetary policy takes priority over fiscal policy. In addition, the budget position is counter cyclical over the business cycle, in the sense that deficits rise during downswings and surpluses rise during upswings. In other

[7] Though not economic activity, such as output and employment.

words, an automatic stabilising effect absorbs variations in economic activity. However, changes in the budget occur on average, around a balanced budget. This means that fiscal policy strengthens Inflation Targeting credibility and reduces the real costs to the economy of keeping inflation on target. Low and stable inflation rates are considered preferable since they induce strong rates of economic growth, and monetary policy can be used as an instrument to achieve this. The caveat is that it must not be operated by politicians but rather an independent Central Bank.[8] Furthermore, Rogoff (1985) argues that monetary policy ought to be "conservative" in that low inflation is a greater concern than low unemployment levels. This contrasts with monetary politics, in which political considerations mean low unemployment in the short run is preferred against higher inflation in the long run. This is the time inconsistency problem alluded to earlier. In addition, an operationally independent Central Bank would signal greater credibility to the financial markets and commitment to low inflation, than politicians.

The level of economic activity varies close to a supply-side equilibrium. In equations (1) to (3) above, this is represented by $y_t = 0$, inflation rate at target and real interest rate at R^*. In terms of the non-accelerating inflation rate of unemployment (NAIRU), unemployment levels above (below) the NAIRU will result in lower (higher) rates of inflation. The NAIRU is a supply-side construct

[8] Debelle and Fischer (1994) and also Fischer (1994) note the importance of distinguishing between goal independence and instrument independence. In terms of goal dependence, price stability as an objective of monetary policy is determined by the government. The role of the Central Bank is to pursue the goal by implementing official interest rates independently. Further discussion is presented by Bernanke *et al.* (1999). Instrument independence on the other hand is considered a solution to the time inconsistency problem, and the basis of a forward looking monetary policy with respect to the long and variable lags in official interest rates. Exceptions to this approach include Rogoff (1985) in which goal and instrument independence is advocated, together with a "conservative" approach to monetary policy.

and related to labour market developments. The domestic inflation rate relative to the expected inflation rate, is determined by below NAIRU levels of unemployment, with inflation increasing when unemployment is below the NAIRU. In the long run however, there is not a trade-off between inflation and unemployment, leaving the economy to move on average at the NAIRU in order to avoid rising inflation. In the long run, inflation is a monetary phenomenon in the sense that the rate of increase is the same as the rate of interest. As a result, monetary policy is determined by the Central Bank and controlling the money supply is not important. This is because the demand for money is unstable which means changes in the money supply have an uncertain impact on economic activity.

In the long run, the level of economic activity is not determined independently by the level of effective demand. Rather, demand adjusts to support supply-side influences on economic activity, which corresponds to the NAIRU. This is akin to Say's Law. In addition, monetary policy responds to demand shocks by changes in interest rates as a means of controlling inflation, if unemployment falls below the NAIRU. As a result, monetary policy is restricted, in that it can only have temporary and serially correlated effects on the level of economic activity but no long run effects. Furthermore, interest rate changes result in short term and temporary effects which fade away with changes in prices.

5.3 THEORETICAL ASPECTS OF INFLATION TARGETING

In Arestis and Sawyer (2003a), it is shown that a combination of monetary policy and fiscal policy measures produce better economic outcomes than the single policy instrument of Inflation Targeting, namely the official interest rate. Monetary policy is shown to be a flexible instrument in the stabilisation sense, though not necessarily the most significant determinant of inflation. In a similar proposition, Palley (2003) argues that problems with the balance sheet mean Inflation Targeting is not an appropriate guide for monetary policy. In the present environment of deregulated, highly innovative financial markets, such imbalances are more likely to be present. The effects may not necessarily have immediate influences on inflation, though they may on employment and output costs. Such imbalances, in the form of asset price and debt bubbles, cannot be managed by Inflation Targeting which means further policy objectives are required in support. Palley (2003) also notes the potential for Inflation Targeting induced moral hazard in asset markets. Since monetary authorities tend to be more concerned with asset values during economic downswings, the argument of asset price bubbles is given greater credence.

Another short-coming of Inflation Targeting is the role of the committee in a monetary policy decision making process. Blinder (1998: 20), argues that committees "laboriously aggregate individual preferences ... need to be led ... tend to adopt compromise positions on difficult questions ... tend to be inertial." This latter factor is considered to contribute to "inducing the central bank to maintain its policy stance too long" which results in them "to overstay their stance." A disciplined management of the committee may well go some way to countering these issues, though "a chairman who needs to build a consensus may have to move more slowly than if he were acting alone."

In equation (2) above, inflation expectations influence actual inflation and in equation (3), deviations of inflation above target result in official interest rate increases. In this respect, Inflation Targeting or a similar approach to controlling inflation, can thus reduce and maintain low levels of inflation if expectations of inflation can be influenced accordingly. It might be argued that money supply control in the 1980s was a similar policy. Therefore a target rate of money supply growth that is below the current rate of inflation would reduce inflation expectations, with actual inflation then reduced with minimal short run consequences for unemployment and no effects in the long run. Targets for money supply growth were not met where this approach was been followed in the past, such as in the U.S., U.K., or Germany. More important however, is the fact that inflation was not quickly reduced. Thus it might be said that target growth rates for the money supply were not successful, though as Mishkin (2002) suggests, Inflation Targeting may have been more successful.

In addition, Arestis and Sawyer (2002b), suggest that the credibility of Inflation Targeting, strengthened by transparency and accountability, may also have contributed. A problem here however, is that Central Banks which have not adopted Inflation Targeting have also been successful in controlling inflation, whilst at the same time making no discernible effort to be more transparent and accountable.

5.3.1 The Nominal Anchor

Another criticism concerns the role of a nominal anchor such as the inflation target. This leaves little room for stabilising output. The majority consensus on this issue is that it is feasible in the short run and not necessary in the long run because output returns to equilibrium. However, there do exist proponents of Inflation Targeting who argue that both output and price variations should be the concern of monetary policy. Meyer (2001) and also Bernanke (2003) distinguish between two approaches. In the first, price stability is the priority and all other policy objectives are secondary. In the second, price stability and economic activity objectives are of equal concern. Both these authors support the latter view, with Bernanke (2003: 10) arguing that, "Formally, the dual mandate can be represented by a central bank loss function that includes both inflation and unemployment (or the output gap) symmetrically." Furthermore, Bernanke (2003a: 2) has also argued that,

> "In practice ... this approach has allowed central banks to achieve better outcomes in terms of *both* inflation and unemployment, confounding the traditional view that policymakers must necessarily tradeoff between the important social goals of price stability and high employment."

Others such as King (2002), argue that central banks should not be "inflation nutters." In Mishkin (2002: 3), it is argued that, "the objectives for a central bank in the context of a long run strategy should not only include minimising inflation fluctuations, but should also include minimising output fluctuations." In Svensson (1999) this is defined as "flexible inflation targeting." Rudebusch and Svensson (1999) and Svensson (1997) argue that even when Inflation Targeting is the sole policy objective, policy responses to the factors which determine inflation, as well as current inflation and the output gap are optimal. This is because both inflation and the output gap are determinants of future inflation. Svensson (2003: 451) also argues for "forecast targeting" as a means of, commitment to minimise a loss function over forecasts of the target variables. In the loss function, both inflation and output gap forecasts are target variables. With regard to a general forecast target, Svensson (2003: 455) notes a problem with the degree to which monetary policy objectives are accurately specified, in that output gap weights are not explicitly stated. Secondly, the optimal approach may not hold under forward looking models though a solution to this might be, "a commitment to a specific targeting rule." For the proponents of Inflation Targeting however, the priority is price stability. Mishkin (2000: 8), in reference to the U.S. experience, argues that, "the lack of a clear mandate for price stability can lead to the time-inconsistency problem in which political pressure is put on the Fed to engage in expansionary policy to pursue short-run goals." For proponents of the dual approach, and where output stabilisation is possible in the short run, Bernanke (2003a: 10) argues,

> "The essence of constrained discretion is the general role of a commitment to price stability. Not only does such a commitment enhance efficiency, employment, and economic growth in the long run, but by providing an anchor for inflation expectations, it also improves the ability of the central banks to stabilise the economy in the short run as well."

Meyer (2001: 8) however, takes a contrasting view of long run price stability by stating that,

> "this view is misleading in a couple of respects. First, monetary policymakers should be concerned about two long run properties of the economy. One is price stability and the other is the variability of output

> around full employment. Policy has to be judged by its success in both dimensions. Second, policy is made in the short run, not the long run. The speed of return of output to its potential level is influenced by policy decisions and cannot be treated with indifference. It may just take too long and waste too many resources in the interim to rely on the self-equilibrating forces of the economy. Policymakers will therefore have to take into account, in practice, both objectives in their policy decisions."

With regard to a preference for low inflation under Inflation Targeting, a working assumption is that low inflation is always preferable to high inflation, with lower inflation possible with no loss of output. This is a characteristic of the system of equations above. This position can be contrasted with panel data evidence on IMF economies between 1960 and 1996, from Ghosh and Phillips (1998: 674), in which,

> "there are two important nonlinearities in the inflation-growth relationship. At very low inflation rates (around 2-3 percent a year, or lower), inflation and growth are positively correlated. Otherwise, inflation and growth are negatively correlated, but the relationship is convex, so that the decline in growth associated with an increase from 10 percent to 20 percent inflation is much larger than that associated with moving from 40 percent to 50 percent inflation."

It might be said that the point at which nonlinearity switches from positive and negative does not have a large empirical basis and that more research would be beneficial. Other contributors to the debate include Stiglitz (2003) on inflation targeting who suggests,

> "there is an optimal rate of inflation, greater than zero. So ruthless pursuit of price stability harms economic growth and well-being. Research even questions whether targeting price stability reduces the trade-off between inflation and unemployment."[9]

[9] See also Akerlof *et al.* (1996).

5.3.2 Real and Monetary Factors

A preference for low inflation is also related to a distinction between real and monetary factors in the economy. This relates to monetary policy being on the nominal side of the economy targeting inflation, and supply-side policies on the real side of the economy targeting unemployment. However, it need not be that supply side policies are an inherent characteristic of Inflation Targeting. According to King (1997: 6),

> "if one believes that, in the long run, there is no trade off between inflation and output then there is no point in using monetary policy to target output. You only have to adhere to the view that printing money cannot raise long run productivity growth, in order to believe that inflation rather than output is the only sensible objective of monetary policy in the long run."

An example of the constant supply side equilibrium can be illustrated by the "natural rate of unemployment" or the NAIRU being expressed in single digit form. In the system of equations above, constant supply side equilibrium is represented by a zero output gap. It may be that supply side equilibrium changes over time but this would not be because of demand side factors, but supply side variables such as the labour market. In terms of Inflation Targeting the more important issue is whether monetary policy has a long run influence on the supply side of the economy through official interest rate and aggregate demand changes. Variations of NAIRU estimates over time include Gordon (1997) in which inflation and the rate of unemployment are used to present evidence for the natural rate of unemployment. OECD estimates of the NAWRU – non-accelerating wage rate of unemployment – are also available.[10] These are over ten year time periods for various economies, and show substantial variations of the NAWRU over time for the economies under consideration.[11]

In the estimates, investment spending is the most interest rate sensitive aggregate demand variable; changes in investment expenditure in response to interest rate changes are larger than other aggregate demand variables. Under Inflation Targeting, the emphasis is on official interest rate transmission to the rate of inflation through the level of aggregate demand. Investment however, also influences the capital stock values and thus the supply side of the economy. For monetary policy to not influence the supply side in the long run, would require that the real rate of interest is on average, at equilibrium and the effects of interest rates relative to the equilibrium rate were symmetrical. However, even this would impact investment spending with the effects lasting as long as the life of the capital stock involved. This in turn implies that inflation control through deflationary monetary policy and increased interest rates would have a long run impact on the capital stock.

5.3.3 The Causes of Inflation

As equation (2) implies, monetary policy in the new consensus is based on the use of official interest rates to control demand- rather than cost-inflation. In a separate context, Gordon (1997: 17) notes that,

[11] The estimates do not cover the determinants of such changes. In addition, they are based on econometric simulations of the model.

> "in the long run inflation is always and everywhere an excess nominal GDP phenomenon. Supply shocks will come and go. What remains to sustain long run inflation is steady growth of nominal GDP in excess of the growth of natural or potential real output."

As illustrated in Clarida, Gali and Gertler (1999) for example, cost-inflation is either accommodated, or that the rate of inflation is unaffected by transitory supply shocks which are on average zero, under Inflation Targeting. An implication of Inflation Targeting therefore, is that inflation can be controlled through official interest rates acting to induce demand deflation. There is also a potential equilibrium or "natural rate" of interest which balances aggregate demand and aggregate supply so that there is a zero gap between actual and potential output. This concept of demand inflation under monetary policy, raises three questions. First, the effectiveness of monetary policy in influencing inflation through changes in aggregate demand. In Arestis and Sawyer (2002b), it is shown to be ineffective. Second, the appropriateness of monetary policy in influencing aggregate demand and demand-inflation, as implied by the Phillips curve in equation (2). Again, Arestis and Sawyer (2002b), show that it is not and that fiscal policy is the most appropriate instrument of policy. Third, the lack of importance given to sustained cost-push and other non-demand related inflation in the new consensus. In equation (2), the simple Phillips curve does not include labour and production costs such as wages and materials, or imported inflation. Any sustained rise in money wages or profit demands are not included in equation (2).[12] While this may be feasible for stochastically varying and on average zero, wage and profit margin demands, positive periods in which the error term in equation (2) would also be positive, would have more long term effects. This is

[12] Though they could be represented in the equation error term.

because the lagged inflation term in equation (3) implies a feed through effect of inflation from one period to the next. Similarly, equation (2) implies that an increase in inflation expectations induces inflation increases resulting in higher than normal rates of inflation. If inflation was to rise in a sustained fashion, say on the back of cost pressure as evidenced in the 1970s, the only solution in this framework would be to increase official interest rates and reduce inflation through reduced demand and increased unemployment.

5.4 INFLATION AND THE MONETARY TRANSMISSION MECHANISM

In the Inflation Targeting framework, inflation is targeted through equation (1) where official interest rates are determined by the monetary policy rule as in equation (3). Changes in these interest rates influence the level of aggregate demand and in equation (2), changes in the level of aggregate demand influence the rate of inflation. The magnitude, frequency and predictability of interest rate adjustments on the level of aggregate demand are important considerations. High (low) interest rates tend to reduce (increase) aggregate demand which in turn reduces (increases) the rate of inflation. However, the fact that interest rates can also be a firm cost, leading to increased inflation, is not considered. In the system of equations outlined above, a single interest rate is included and this does not account for feed through effects of the policy instrument on long term interest rates. As former Federal Reserve chairman Volcker (2002: 9) notes, monetary policy in this framework, "relies upon direct influence on the short-term interest rate and a much more fluid market situation that allows policy to be transmitted through the markets by some mysterious or maybe not so mysterious process."

The channels of monetary policy transmission are discussed in chapter three. These are the interest rate channel, the wealth effect channel, the exchange rate channel, the monetarist channel, the narrow credit channel and the broad credit channel. Central to the narrow credit and broad credit channels is the role of financial market imperfections. In particular, an assumption of credit market frictions leads to changes in financial position of borrowers and lenders, which in turn influences aggregate demand. In the narrow credit channel, known also as the bank lending channel in Hall (2001), the role of banks is key.[13] Banks finance investment and other projects through deposit demand and reserve requirements. Monetary policy decisions influence bank reserves, which in turn determine the supply of loans to borrowers. Since a substantial number of firms and households are dependent on bank finance, this has repercussions for aggregate demand and inflation.

In the broad credit or balance sheet channel, aggregate demand is affected via changes in borrower financial positions which affect loan supply.[14] Here, the supply of external funds to firms is dependent on an assumption of imperfect information. Lenders incur monitoring costs in supplying loans, which they recover through premiums charged to borrowers. In addition, the external finance premium for a firm is determined by its financial position. Thus low (high) firm gearing means high (low) internal finance and small (large) external premiums. In terms of firm cash flow, increases (decreases) in official interest rates raise (lower) gearing ratios. In other words, the amount of an investment project financed by external funds, which increases the monitoring cost premium. In

[13] Bernanke and Blinder (1988) and also Roosa (1951) consider the role of banks in further detail.
[14] See Bernanke *et al.* (1999) and also Bernanke and Gertler (1989, 1999) for further discussion.

terms of asset prices, the value of borrower collateral secured against loans is affected. The value of collateral is especially important in the presence of asymmetric information, agency costs and similar friction in the credit market. This is because if higher official interest rates induce collateral value falls (rises), say on the back of declining (rising) asset prices, then the premium for the borrower rises (falls). As a result, investment and consumption can be substantially affected by this "financial accelerator" effect. Asset price changes are also influential for the wealth effect channel, where the consumption function is determined by consumer expenditure, or wealth. Here, official interest rate decisions are transmitted to asset prices and the real value of household wealth. This results in changes in consumer expenditure.

In the interest rate and monetarist channels, the underlying assumption concerns the nature of money as a substitute for other assets. A high degree of substitutability between money and financial assets such as short term liquid instruments, means official interest rates are subject to significant influence from changes in the money supply. Also affected are real interest rates and the user cost of capital, when prices are sticky. The components of aggregate demand are considered interest rate sensitive, implying official interest rate changes have a significant influence on the level and magnitude of economic activity. "Availability" effects might also be present in the form of market interest rates not being adjusted following official interest rate changes. This may be so if financial institutions decide to engage in credit rationing as discussed in Stiglitz and Weiss (1981). Thus monetary policy indicates greater information than changes in the money supply. In the former, policy is conducted with greater certainty through an emphasis on direct manipulation of interest rates, rather than control of the money supply. A prerequisite of this however, is the provision of an appropriate monetary base. A high degree of substitutability between money, and say, real assets, means the effect of a change in the money supply is dependent on the relative changes in price. Changes in relative asset prices therefore, are key to the monetarist channel with changes in interest rate relegated to those of relative prices. Official interest rate changes affect relative "real" rates and thus the rate of interest is not considered as the instrument of monetary policy. Instead, monetary policy sets the money supply leaving interest rates an endogenous variable, with the subsequent influence on aggregate demand coming from changes in relative asset prices.

In the exchange rate channel, monetary policy decisions are transmitted to inflation through total demand and expected exchange rates. In the former, the uncovered interest rate parity assumption links interest rates to inflation. Monetary policy induced changes in domestic market interest rates relative to overseas interest rates lead to changes in the balance of payments via the exchange rate. This in turn leads to changes in the overall level of aggregate demand and thereby, the rate of inflation. In the latter, it is interest rate differentials and the price of imports. Here, a direct effect of exchange rate changes on import prices has an effect on the rate of inflation. The channels of monetary policy transmission are gauged in the section below, where the quantitative impact of interest rate changes on the level of economic activity and the rate of inflation is considered.

5.5 EMPIRICAL EVIDENCE ON INFLATION TARGETING

The empirical evidence on Inflation Targeting can broadly be categorised in terms of macroeconometric modelling and single equation techniques. Both of these approaches are considered below.

5.5.1 Inflation Targeting and Macroeconometric Modelling

Ideally, the effects of monetary policy transmission through the channels discussed above would be assessed in some quantitative manner. However, this is not possible for a variety of reasons. For example, no one channel is mutually exclusive and the effects of official interest rate changes on economic activity are determined by an interaction between the channels. Since these channels operate interdependently and simultaneously, it is difficult if not impossible to gauge the role of any single channel in the transmission of monetary policy to the rate of inflation. An additional problem concerns identifying change, magnitude and relevance of a transmission channel over time, often in the presence of other structural change taking place at the same time. Perhaps the most important issue is the fact that the effects of changes in monetary policy often take relatively long time periods to become evident, and this, together with the other problems highlighted are indicative of Kuttner and Mosser (2002: 17-18) who imply a continuously changing relationship between monetary policy and the real economy. In Boivin and Giannoni (2002a, 2002b) both VAR and structural equation approaches are adopted respectively for the U.S, between 1960 and 2001, and these point to a changing transmission mechanism of monetary policy. Simultaneity is another important issue. Monetary policy tends to adopt both loose and tight stances depending on economic developments. This is illustrated by Kuttner and Mosser (2002: 23), who ask, "how is it possible to isolate the effect of interest rates on economic conditions when interest rates are themselves a function of economic conditions." Thus an endogenous response of policy to economic developments is an obstacle in the identification and quantitative assessment of individual channels of monetary policy transmission. Any such exercise must therefore bear these issues in mind.[15]

Arestis and Sawyer (2002b) estimate the effects of interest rate changes using dynamic macroeconometric simulations. Models used in official policy making are used, namely those of the European Central Bank, the Bank of England and the U.S. Federal Reserve. These are surveyed in Bank of England (1999, 2000), Van Els *et al.* (2001), and Angeloni *et al.* (2002) respectively. The authors find limitations on permanent interest rate changes. Under interest rate parity, the influence of official interest rates on the exchange rate is significant in the sense that an interest rate differential between domestic and overseas interest rates results in a continuous change in the exchange rate. However, the authors cast doubt on the empirical robustness of this relationship because of near impossible difficulty in estimating exchange rate movements. Theoretically, interest rate variations ought to be limited by the close link between the interest rate differential and expected movements in the exchange rate. Empirically however, this does not seem to be the case, with variations in the exchange rate proving difficult to model in any theoretical specification. Secondly, model simulations for European Central Bank interest rates indicate monetary policy effects on aggregate demand are driven by significant changes in the rate of investment. The

[15] Volcker (2002) discusses the problems identified here at length.

implication is that interest rate changes affect investment activity over the long run through changes in the value of the capital stock. Thirdly, monetary policy affects the rate of inflation only moderately in that a one percentage point change in the rate of interest leads to a change in the price level of 0.41 percent in one model and 0.76 percent in another, over a five year time horizon. The greatest fall in the rate of inflation is 0.21 percent. Thus the potential influence of interest rates seems to be minimal and not theoretically robust as implied under Inflation Targeting.

5.5.2 Inflation Targeting and Single Equation Techniques

In single equation estimates of the Inflation Targeting model, the emphasis is on the performance of inflation, the credibility of monetary policy, and the sacrifice ratio. The latter point relates to reducing inflation without a substantial increase in cost. An early study is that of Leiderman and Svensson (1995) though with a small number of observations. Longer data runs are used in later studies including Bernanke *et al.* (1999), Corbo *et al.* (2001, 2002), Clifton *et al.* (2001), Arestis *et al.* (2002), Johnson (2002), and also Neumann and von Hagen (2002). The latter of these studies is a comprehensive review of empirical findings on Inflation Targeting, which support the importance of this framework. Low levels of inflation and interest rate and inflation volatility has been achieved in economies adopting the Inflation Targeting framework. As Neumann and van Hagen (2002: 144) note, "Of all Inflation Targeting countries, it is the United Kingdom that has performed best even though its target rate of inflation is higher than the inflation targets of most other countries." In addition, Bernanke (2003b: 1) states that,

> "central banks that have switched to inflation targeting have generally been pleased with the results they have obtained. The strongest evidence on that score is that, thus far at least, none of the several dozen adopters of inflation targeting has abandoned this approach."

Several shortcomings of the empirical literature surveyed in Neumann and von Hagen (2002) can be identified. First, the notion that Inflation Targeting improves the performance of inflation, the credibility of policy and lowers the sacrifice ratio is not robust. The 1990s saw a period of economic stability, or "a period friendly to price stability" as Neumann and von Hagen (2002: 129) state. Therefore at most, Inflation Targeting may have achieved little more than if another policy had been adopted. In fact Cecchetti and Ehrmann (2002), note that the experiences of non-Inflation Targeting economies have been similar to those of Inflation Targeting over the same period. Second, despite the lack of any firm consensus on the robustness of Inflation Targeting, proponents of the policy argue very strongly that Central Bank price stability is at great risk if Inflation Targeting is not adopted. For example, Bernanke *et al.* (1999) "submit a plea" for Inflation Targeting by the Federal Reserve, and Alesina *et al.* (2001) suggest European Central Bank monetary policy would be improved through a policy of Inflation Targeting. However neither of these studies provide any supporting evidence for their positions, in contrast to doubts over their appropriateness expressed by Gramlich (2000) and Duisenberg (2003) for the Federal Reserve and the European Central Bank respectively. Third, authors such as Mishkin and Posen (1997), suggest inflation has been brought under control before the introduction of Inflation Targeting in economies such as Canada, New Zealand and the United Kingdom. This implies that Inflation Targeting acts to "lock in" the gains from inflation control rather than generating it in the first instance. Bernanke *et al.* (1999: 288) for example, note that,

> "one of the main benefits of inflation targets is that they may help to "lock in" earlier disinflationary gains particularly in the face of one-time inflationary shocks. We saw this effect, for example, following the exit of the United Kingdom and Sweden from the European Exchange Rate Mechanism and after Canada's 1991 imposition of the Goods and Services Tax. In each case, the reigniting of inflation seems to have been avoided by the announcement of inflation targets that helped to anchor the public's inflation expectations and to give an explicit plan for and direction to monetary policy."

Returning the Mishkin and Posen (1997), Inflation Targeting is considered an effective "strategy" to control inflation, with evidence presented to suggest economies which adopted Inflation Targeting also experienced low rates of inflation, and low interest rate and inflation volatility. The authors do not however, show how, if at all, Inflation Targeting is more effective a monetary policy than targeting of the money supply. Between 1974 and 1998 German monetary policy targeted the money supply, and between 1980 and 1990, the U.S. Federal Reserve did not engage in monetary or Inflation Targeting. The authors also produce VAR estimates of Taylor-type monetary policy reaction functions to support a Central Bank policy of inflation control under Inflation Targeting, with an implication of price stability. The results indicate that inflation shocks become relatively more important as determinants of interest rate variations under Inflation Targeting.

With regard to the material in Neumann and von Hagen (2002), Mishkin (2002) notes that the estimated coefficients on the inflation parameter in Taylor-type reaction functions are less than one in both the short run and the long run. This implies that inflation is a very unstable process. This is because inflation increases are met by relatively smaller official interest rate increases, which in turn reduce the real rate of interest. The obvious outcome here is inflationary rather than deflationary monetary policy. The result also holds for economies where Inflation Targeting is not adopted, such as the U.S. and contrasts with Taylor (1993) in which it is greater than one for the post 1979 period in which monetary policy is considered to have performed better than the pre 1979 period.

Mishkin (2002) also notes a problem concerning VAR analysis, namely that it does not incorporate a dynamic structural model. By implication, this means that interest rate variability induced by inflation shocks, is not necessarily an interpretation of greater preference for inflation control by policymakers. The reason for this is because if interest rate variability is caused by inflation shocks under Inflation Targeting, then inflation expectations prevent deviations of inflation from target. Thus inflation control is less of a concern for monetary policy and not more. As Mishkin (2002: 150) therefore notes, "the VAR evidence in the paper, tells us little about the impact of inflation targeting on the conduct of monetary policy."

In Ball and Sheridan (2003), the Inflation Targeting experience of twenty OECD economies is considered, including seven economies in which the framework was adopted during the 1990s. The authors report little evidence supporting the view that macroeconomic performance was improved under Inflation Targeting, in terms of interest rate, inflation and output measures. This is not to say that

Inflation Targeting economies experienced better performance. Indeed, inflation fell and became stable in such economies, and output growth also stabilised. However, economies which had not adopted Inflation Targeting also experienced similar outcomes and therefore factors other than Inflation Targeting need to be considered. Improvements in economic performance were greater for Inflation Targeting economies than others, an outcome similar to that of Neumann and von Hagen (2002) in which this is considered indicative of the benefits of Inflation Targeting. The authors refer to this as "convergence" in reference to convergence on average, of Inflation Targeting economies' inflation rates to those of non-Inflation Targeting economies over the same period. However Ball and Sheridan (2003), argue that even these benefits of Inflation Targeting are doubtful. The authors cite evidence to suggest economies with high and unstable rates of inflation, experienced improvements in economic performance regardless of whether or not they adopted Inflation Targeting. The perceived benefits are thought to disappear altogether once these effects are controlled for, with the apparent success of Inflation Targeting economies considered by Ball and Sheridan (2003: 16), due to "high initial inflation and large decreases, but the decrease for a given initial level looks similar for targeters and non-targeters." The authors report a similar outcome for inflation variability and inflation persistence. With regard to the influence of Inflation Targeting on interest rates and output, Ball and Sheridan (2003) also conclude that the framework does not affect output growth or output variability, nor interest rates or interest rate variability. In a similar study of Inflation Targeting in Canada between 1980-89 and 1990-99, Bodkin and Neder (2003: 355) produce graphical evidence indicating that inflation did fall during these periods but at a substantial cost to output and inflation. The authors thus conclude with doubt over a central tenet of Inflation Targeting namely,

> "the theoretical notion of the supposed long-run neutrality of money." They also suggest that the "real effects (higher unemployment and ... lower growth) during the decade under study suggests that some small amount of inflation (say in the ranger of 3 to 5 percent) may well be beneficial for a modern economy."

5.6 CONCLUSION

This chapter has presented the close relationship between Inflation Targeting and the New Classical Macroeconomics. The theoretical foundations of the former have been outlined, together with several shortcomings. An assessment of the empirical evidence on Inflation Targeting has also been presented. Mishkin (1999: 595) when commenting on inflation reductions in Inflation Targeting economies argues that this has been "beyond that which would likely have occurred in the absence of inflation targets." However, it appears that there is very little empirical evidence or theoretical robustness behind such a stance. Rather Ball and Sheridan (2003) seem closer to the mark in noting that the recent experience of "low inflation" is the same for economies, regardless of whether or not Inflation Targeting has been adopted.

CHAPTER SIX

DATA AND RESEARCH METHOD

6.1 INTRODUCTION

This chapter sets out the variables used for the purposes of estimation and explains the methods of research adopted for them. The sections that follow, explain each of these in more detail.

6.2 THE DATASET

The Bank of England policy instrument is represented by the end of month Bank Rate (January 1970 to September 1972), the Minimum Lending Rate (October 1972 to December 1974), and the Official Bank Rate (January 1975 to June 2007).[1] Monthly data observations reflect the frequency of monetary policy committee decisions since May 1997, noting of course that the decision is often no change. Prior to operational independence, the interest rate was reviewed frequently but the only decision which was announced would be when there was a change. The series moves close to the Treasury bill rate, which is an alternative measure for the same period. The official bank rate however, is preferred over the Treasury bill rate, as it is the actual rate set by the committee and although the Treasury bill rate is consistent over the period, the rate set by the Bank of England has changed.

[1] From January 1975, observations of the policy instrument are taken from the Statistical Interactive Database of the Bank of England. Prior to this period, observations are taken from http://www.bankofengland.co.uk/statistics/rates/baserate.pdf, Pages 14-19.

Between January 1970 and September 1972, we adopt the Bank of England end of the month Bank Rate as the policy instrument. Before September 1971, the main objective of monetary policy making was to try and control the supply of credit which was made available to the private sector. In this period, another main objective of policy-making was to try and exert some influence over the level and structure of interest rates. Control over the supply of credit was achieved by imposing both quantitative and qualitative restrictions on bank lending and also by imposing strict conditions on hire purchase credit. This chapter is more concerned with the role of monetary policy in controlling the level and structure of interest rates. To this end, we are more focused on the interest rate set by the Bank of England. This was the Bank Rate. When the bank rate was in use, a surplus of funds in the money market was created by a net flow of funds from the Bank and the government to the banking sector. In addition, a shortage was created by a net flow of funds from the banking sector to the government and the Bank of England. This implied that government revenue did not equal government expenditure. As a result, the Bank of England operated in the financial markets, particularly discount houses. It did so by engaging in the sale and purchase of Treasury bills as intended to ensure that there was a balance in the banking system. Therefore, for the early part of the sample period adopted in this study, we adopt the Bank Rate as a measure of the policy instrument. This is because the Bank Rate had a direct influence on money market interest rates in the UK economy and it was also the rate at which the Bank of England in its capacity as lender of last resort used when lending to the discount markets against T-bills. In the early 1970s, the Bank Rate was also used as a reference point by clearing banks in London when determining an interest rate to be paid on deposits and deposits. It might also be noted that the Bank Rate was less influential in terms of non-resident and other banks in the UK which were more influenced from interest rates in money markets especially the interbank market. From October 1972 to December 1974, we adopt the Minimum Lending Rate. The Minimum Lending Rate (MLR) was introduced on the back of reforms to the monetary and banking system which were implemented around September 1971. The main purpose of these was to encourage greater competition amongst clearing banks. This was also a period when the rate of growth of the money stock was considered a primary objective of monetary policy making in the UK. As a result, the Minimum Lending Rate replaced the Bank Rate on 13 October 1972 as the official policy instrument.

Again, the Bank of England used the Minimum Lending Rate in its capacity as lender of last resort when lending to the discount markets against specific securities. Between October 1972 and May 1978, the Minimum Lending Rate was usually set at ½% above the average discount rate for T-bills. The average rate of discount on T-bills was determined by weekly tenders and rounded to the nearest quarter percent above an effective rate for lending purposes from the following working day. For lending purposes, the announcements were made the following day. The system however, did not include changes in the Minimum Lending Rate. This new rate became effective immediately and the usual formula was suspended until markets into line. In March 1977 there was one modification to this arrangement. This concerned a possible reduction in the Minimum Lending Rate. In case of a prospective reduction in the Minimum Lending Rate, then the Bank of England was allowed the right in exceptional circumstances to either leave the rate unchanged or to change it by an amount less than that would have resulted from the previous formula. From October 1972 to December 1974 therefore, we are adopting the Minimum Lending Rate as the instrument of monetary policy. The primary reason for adopting the Minimum Lending Rate is that it represents the implementation of monetary policy on a monthly basis. It is noted and accepted however that although the Minimum Lending Rate represents the instrument of monetary policy, the actual methods with which monetary control was achieved over a longer period include the special deposit scheme which had existed from 1961 onwards, the reserve assets ratio which existed between 1971 and 1981, and also the supplementary deposit scheme which operated between 1973 and 1980. Each of these methods had a direct influence on the money markets. For example, calls on special or supplementary deposits meant that cash was withdrawn from the banking system while reserve ratios meant that some of the short-term assets were not available to meet cash shortages. From May 1978, the Minimum Lending Rate became administered in a manner which meant that any change in the Minimum Lending Rate was announced at midday on Thursday and the new rate became effective for bank lending immediately.

Although the Minimum Lending Rate is used as a proxy for the policy instrument for the early 1970s some criticisms are also acknowledged and noted. The first is that worldwide inflation in the early 1970s was higher and more variable. Second, the growing emphasis on monetary growth in this period. Both of these were associated with higher and more volatile interest rates. Secondly, it might also be noted that during this period there were not sufficient reserves of Treasury bills for the purposes of selling to the Bank so that any shortages in the market could be funded or any surpluses could be bought in.

October 1980 saw a gradual change in the way in which the Bank of England operated in the money markets. This was largely the result of discussion papers and consultation meetings with relevant authorities. Nevertheless the exact arrangements were explained in a paper entitled "Monetary Control Provisions" which became effective in August 1981. This is when the Minimum Lending Rate was suspended. Nevertheless, the bank of England was still able to use its discretion to announce to the market beforehand the Minimum Lending Rate at which it would lend to the market. Historic records show that the Minimum Lending Rate has actually been used on several occasions for periods of one day only. This was followed by a discontinuation of the reserve ratio requirements which were replaced by the cash ratio scheme. The special deposit scheme however, continued to operate. Initially, the Bank of England aimed to keep short-term interest rates within a pre-announced region which was determined by the authorities and to establish a very specific level of official interest rates. Lending was usually above comparable market interest rates but within this band established by the monetary authorities. There existed four dealing bands ranging from band one to band four and these had maturity of between 1 to 14 days, 15 to 33 days, 34 to 63 days and also 64 to 91 days. In most cases the Bank of England operated in band one. Such ranges were used because if the Bank had a specific maturity date then the market may have had difficulty in producing sufficient paper maturing on that specific date at short notice. The Bank of England's intervention in the money markets was primarily along the lines of open market operations rather than direct lending in the bill markets. Here the Bank acted primarily through the London Discount Markets Association. The general intention of the Bank being to offset daily cash flows in either direction between the Bank itself and the money markets. The number of banks which were required to hold a minimum proportion of their eligible liabilities in the form of security deposits with members of the London Discount Markets Association was extended. This meant that during periods of extreme shortages in the money markets the discount houses would be able to perform their roles as intermediaries in an effective manner. The Bank of England in acting to supply liquidity to the market, fulfilled this role primarily through discount houses and it did this by the sale of Treasury bills and local government bank bills either outright or on a sale and repurchase treatment which allowed it to anticipate potential surpluses and all shortages. The aim of the Bank was to supply daily the necessary amount of the liquidity. The Bank has been known to operate up to three times a day depending on the size of the shortage on any given day. If this did not address the shortage then the Bank of England was able to lend on a secure basis to discount houses at the end of the day up to an amount linked to their capital.

After predetermined dealing rates had been phased out discount houses competed with one another to sell to the Bank of England including repo arrangements. In reacting to these offers the Bank of England was able to influence interest rates. For example, when the Bank was to accept these offers then it was able to ensure that sufficient amounts existed in the market and that therefore there was a balance. If however, any of these offers did not meet with the Bank of England's primary interest rate objective then these offers were not accepted. In this case the

Bank would not deal with the bill markets and could limit its dealings with discount houses who were short of cash and would inevitably need to borrow. The Bank of England was then able to set an interest rate which was consistent with the actual level that it was seeking to establish. The amount of liquidity that the Bank of England has had to supply on a daily basis has often been sizeable. especially after 1991 when changes in government financing had taken place and discount houses had generally decreased in size. To deal with this, the Bank of England introduced a twice monthly repo operation in 1994 which built on some of the temporary arrangements that had been introduced in 1992 after the UK left the exchange rate mechanism. This twice monthly repo facility was offered to banks, discount houses, building societies and guilt edged market-makers. It consisted of various different assets. In the main however, these were primarily gilt repo assets which the Bank of England would purchase from its counterparties and sell back to them at an agreed future date and price which had been set in advance. By providing such liquidity to the repo facility the Bank of England was able to reduce the amount of liquidity that was required to support its daily open market operations to an amount that was more easily manageable.

Between January 1975 and June 2008, we use the Bank of England repo rate. This came about largely because of a change in the Bank of England's open market operations which were announced during 1996. Further details are contained in the "Reform of the Bank of England's operations in the sterling money markets." The market for gilt repos was established in January 1996 and was included in the Bank of England's open market operations by February 1997. During this period, the Bank of England continued to use Treasury bills and also eligible bank and local government bills both for repo agreements alongside gilts and also for outright sale to the Bank. Also included in these were foreign currency marketable debt which took the form of Euro notes and bills issued by the government and the Bank of England, sterling denominated securities issued by EEA governments and major international institutions and also eligible Euro denominated securities including strips issued by EEA governments and also other institutions.

Inflation data begin with observations of the retail prices index spliced into the retail prices index excluding mortgage interest payments as in Nelson (2000:13), when they first become available from the Office for National Statistics in January 1976. The latter maps the initial inflation target measure under instrument independence and the series might be interpreted as *backward looking* as in equation (2.1.1) of Appendix Two, since the data relate to percentage change over the preceding twelve months. However, it is not clear from the academic literature whether this is an appropriate measure and so alternatively, *current* and *forward looking* measures might also be considered as in equations (2.1.2) and (2.1.3) of Appendix Two respectively. The latter being in effect, a *rational expectations* view of anticipated inflation. These two measures are derived from the Office for National Statistics level of retail price inflation tables, RP02[2] and RP05[3] respectively. The former runs from the beginning of the sample period, and is replaced by the latter from January 1978, which is when the level of retail price inflation is measured to exclude mortgage interest payments. In the original tables cited above, two base years are used to calculate both the price level

[2] http://www.statistics.gov.uk/downloads/theme_economy/RP02.pdf
[3] http://www.statistics.gov.uk/downloads/theme_economy/RPIX.pdf

(January 1962 and January 1974), and the price level excluding mortgage interest payments (January 1974 and January 1987). In this study, the data have been rebased to a common point at the beginning of the sample period, to ensure consistency. In other words January 1970 and January 1974 for the price level, and January 1978 and January 1987 for the price level excluding mortgage interest payments. The series are not seasonally adjusted and there are a number of reasons for this, including the non-seasonal nature of mortgage interest payments.

Unemployment enters the data set in the form of the claimant count rate as a possible factor in decision making, and also because of the role of NAIRU, though minor issues concern the reliability of this variable; unemployment figures are not subject to final revision whereas output figures are. Seasonally adjusted observations are however, available from the beginning of the sample period, though it is acknowledged that this is a narrow measure and does not correspond to the current National Statistics definition of *unemployment*.[4] Equation (2.2.1) in Appendix Two illustrates a second alternative, which is a relative claimant count rate measure. This is calculated by the difference between current period observations and a thirty-six month average. The rate of unemployment has fluctuated substantially over the entire sample period and a horizon of thirty six months compared to say, twelve months, is preferred to allow for a more meaningful understanding of the data.

A variety of output gap measures are presented in the academic literature, though without firm consensus on any particular one. Here the index of industrial

[4] The first twelve data observations for 1970 are not available from the ONS website and are archived in the Employment and Productivity Gazette, LXVIII, Jan-Dec, 1970: Page 810.

production is used since it closely approximates GDP and also reflects the frequency of monetary policy committee decisions. The series is smoothed using a Hodrick-Prescott (1997) filter from the literature on real business cycle theory, thereby making the trend more sensitive to long term rather than short term fluctuations. This adjustment is achieved by subtracting the solution to equation (2.3.2) in Appendix Three from the original industrial production series.

6.3 PERIODISATION

Periodic accounts of monetary policy development in the UK are presented by Cobham (2002: 15-20 and 23-25) and also by Nelson (2000: 15) amongst others. These cover the floating of Sterling in 1972, monetary targeting (with varying degrees of discretion) and the Medium Term Financial Strategy (MTFS) which were introduced between the mid-1970s and the mid-1980s. These are followed by Deutsche Mark shadowing in the late-1980s, and the Exchange Rate Mechanism (ERM) in the early-1990s. Inflation targeting by the Government follows from 1992, with an independent Monetary Policy Committee (MPC) taking over from 1997. Coverage of monetary policy instruments over these same periods include Competition and Credit Control in 1971 followed by the Supplementary Special Deposits Scheme (or the 'Corset') in late 1973. Monetary targeting with the public sector borrowing requirement (PSBR) and net sales of public sector debt to the private sector are also considered. Since the mid-1980s, the rate of interest has acted as the instrument of monetary policy. A firm consensus on the exact dating of policy regimes does not exist in the academic literature and studies such as Cobham *et al.* (2001: 3) for example, identify sub-periods "on the basis of an examination of how policy evolved..." The two studies cited at the beginning of this paragraph also examine the development of monetary policy, reaching broadly similar conclusions in their determination of sub-periods. It might be noted that such examinations are comprehensive in their coverage and can be referred to rather than repeated here. The general approach to identifying sub-periods might further be considered indicative of the Taylor rule as a description of monetary policy, and with this in mind, the following sub-periods might be identified for the UK.

A renewed interest in monetary policy in the UK and other countries during the 1970s offers a backdrop to January 1970 as the sample start date. As Cobham (2002: 15) notes, "...monetary policy became more important during the course of the 1970s, after the Bretton Woods system had broken down and inflation had become a more pressing issue for economic policymakers." In June 1972, the Bank of England (1972: 310) announced a floating of the exchange rate, effective the following month. On 22 July 1976, Chancellor Healey announced a growth rate target for £M3 (Bank of England, 1976: 296). The Medium Term Financial Strategy (MTFS) set £M3 targets in the March 1980 Budget, before being abandoned in October 1985 (Nelson, 2000: 15). Chancellor Lawson "...began to shadow the DM in March 1987" (Cobham, 2002: 18), or there was an "informal linking of the pound to the Deutsche Mark" (Nelson, 2000: 15). The UK "finally entered the ERM under another Chancellor, John Major, in October 1990." (Cobham, 2002: 18). This "membership of the ERM" (Nelson, 2000: 15), was followed by the introduction of an inflation target and a new relationship between the Bank of England and the Treasury, under which the former would publish a regular report on and forecast of inflation and would make formal recommendations on interest rates which the latter (that is, the Chancellor, then Norman Lamont) could accept or reject (Cobham, 2002: 19). This "period of inflation targeting in the United Kingdom prior to the Bank of England receiving operational independence" (Nelson, 2000: 15), was followed by a "decision by the incoming Labour government to hand decision-making on interest rates to a new Monetary Policy Committee at the Bank of England" (Cobham, 2002: 19). For estimations purposes then, sub-periods for estimation might be summarised as follows.

- January 1970 to June 2007: the full sample period.
- January 1970 to June 1976: from the start of the sample period to the last month of the floating of Sterling.
- July 1976 to April 1979: monetary targeting with varying degrees of discretion.
- May 1979 to February 1987: the Medium Term Financial Strategy.
- March 1987 to September 1990: Deutsche Mark shadowing.
- October 1990 to September 1992: Membership of the ERM.
- October 1992 to April 1997: Inflation targeting with Bank advising Chancellor.
- May 1997 to June 2007: Inflation targeting with instrument independence.

6.4 RESEARCH METHOD

Sheets 1 to 7 contain the results of estimates obtained using monthly observations and sheets 8 to 11 contain the results of estimates obtained using quarterly observations. In sheet 8 there is a jump in model numbers from those used in the monthly observations in sheet seven. For example, sheet seven finishes with model number 63 but sheet number eight begins with model number 73. Indeed there are similar jumps in sheet nine which begins with model 91 and sheet 10 which begins with model 109 and also sheet 11 which begins with model number 118. Where this is the case, the number of missing models is due to the fact that the number of quarterly observations were too small for the purposes of conducting an econometric analysis and therefore some observations were combined so that a great number of observations could be used to perform the analysis. We explain the following procedure using sheet number 1 as an example. The reader will notice that this sheet begins with model 1 which has with it, 4 tables. These are tables A, B, C and D for model 1. Table A for model 1 represents a VAR lag order selection criteria which was used to determine the optimal number of lags. In this case, table A for model 1 in sheet 1 suggests that the optimal lag length was a lag length of 1 and this can be seen in row 13 of sheet 1. This is followed by table B for model 1 which is in row 25 of sheet 1. This represents a Pantula (1989) principle test, in other words a cointegration test for the number of long-run parameters. The results from this are presented in table 3 for model 1 which is in a row 38 on sheet 1. In rows 52 and 53 the normalised cointegration coefficients can be seen. Once a cointegrating relationship has been identified, then a fourth table is constructed. This is table D in row 59 of sheet 1 which contains the results of a vector error correction mechanism. In other words, 4 tables are usually used for each model. The first table indicates the number of optimal lags, the second table gives the Pantula (1989) principle, the third table the results of a cointegration test and the fourth table the results of a vector error correction mechanism test. All these 4 tables for model 1, reflect the simple case where cointegration has been identified and an error correction mechanism has been adopted. The only other difference for each of the tables Appendix Three concerns cases where cointegrating or long-run relationships cannot be identified and model 2 also on sheet 1 can be used to illustrate this. In row 73 of sheet 1, the reader can see a VAR lag order selection criteria again conducted to identify an optimal lag length for model 2. Again this was shown to be 2 lags as indicated by row 85 of sheet 1. However, model 2 does not contain tables B, C and D, as one would expect for model 1. The reason for this is quite simply because a long-run relationship or cointegrating vectors were not identified for this model. Therefore model 2 was estimated in terms of a VAR in first differences and table E, which is in row 96 of sheet 1, represents this for model 2. This pattern is adopted throughout Appendix Three. To reiterate, an optimal lag length test is performed and this is followed by a Pantula (1989) principle for cointegration regression where cointegrating or long-run vectors have been identified. If they have, this is followed by a third table for normalised cointegrating coefficients and a fourth and final table contains the results of a vector error correction mechanism test. In cases where the long-run relationship has not been identified, then only tables A and E contain these results. These represent first an optimal lag length test and second a VAR in first differences.

6.5 CONCLUSION

Having described and outline the dataset and also the periods for estimation, we are now able to proceed with initial estimates. These begin with chapter seven over the page.

CHAPTER SEVEN

INITIAL ECONOMETRIC ANALYSIS

7.1 INTRODUCTION

It is important to test for the order of integration and the purpose of this is to avoid the problem of spurious regression. To do this, we will be using the ADF and TP tests. In part three, we aim to determine the appropriate lag length of the models and the purpose of this is to ensure that the error terms are Gaussian. This will be achieved by using the AIC and SBC criteria. In part four we determine the appropriate deterministic trends for model selection, in other words we decide whether to include an intercept and/or trend in the short-run model, the long-run model or both. The purpose of this is to select the most appropriate model for cointegration testing and this will be achieved using their Pantula (1989) principle. In section five we move on to determine the number of cointegrating vectors, the purpose being to determine the appropriate long-run relationship and the method used to achieve this will be the trace and maximum eigenvalue tests. In section six we test for weak exogeneity and the purpose of this is to check which of the variables are significant. This shall be performed using conventional significance tests. This is followed by testing for parameter stability in section seven, the reason being to determine the presence if any, of structural breaks and this shall be achieved using the Quandt-Andrews (Andrews, 1993 and Andrews and Ploberger, 1994) test. Finally, section eight concludes with a summary of results obtained.

7.2 TESTING FOR THE ORDER OF INTEGRATION

It was noted in the introduction that we intend to test for the order of integration and that the purpose of this was to avoid the problem of spurious regression. According to Asterious and Hall (2007: 291), "Most macroeconomic time series are trended and therefore in most cases are non-stationary." To illustrate, they cite examples of GDP, money supply and CPI inflation in the UK. The authors suggest that the problem with stationary or trended data is that standard OLS regression procedures can very easily lead to invalid estimates. Typical examples of spurious regression include very high values of R^2, often greater than 0.95 and also very high values of *t*-ratio statistics which sometimes exceed values of four. This, when there is no meaningful relationship between any of the variables. Similarly, Osterholm (2005: 218-219) notes that,

> "theoretical objections regarding the Taylor rule translate into suspicions of mis-specification. It is therefore remarkable that previous studies in the area have to a large extent ignored the time series properties of estimated reaction functions and their included variables. This is particularly serious given indications that variables in such regressions have unit roots or are at least highly persistent. Phillips (1986, 1988) showed that if variables are integrated of order one, I(1), or near integrated – that is, have roots close to unity – mis-specified static regressions in levels are likely to be spurious. Before an estimated Taylor rule is used to evaluate central bank behaviour or make statements about its preferences over time, the econometric properties of the model should be scrutinised; such statements should not be based on a model in which there are serious reasons to doubt the consistency of the estimated parameters."

The existing evidence surrounding stationarity testing seems to be mixed. The literature consists of studies which assume stationarity for reasons such as the properties of tests used or the results presented in other studies. Those that do formally test for stationarity report mixed findings, many of which differ because of the variations of the Taylor (1993) rule under consideration. Enders *et al.* (2007: 13) for example, use real time data to estimate a nonlinear Taylor (1993) rule for several sample periods, finding strong evidence of cointegration. The authors note that "...diagnostic checking indicates that the interest rate and inflation variables act as unit root processes. Specifically, Dickey-Fuller tests indicate that for all sample periods it is not possible to reject the null hypothesis of a unit root..." Costas (2006) uses monthly and quarterly data from Greece over a ten year period and is unable to determine a consistent Taylor (1993) rule because the variables do not cointegrate. Testing for stationarity following Dickey and Fuller (1979) and using the Schwarz (1978) Information Criterion (SIC) to determine the optimal lag, the interest rate is shown to be stationary whilst inflation and the output gap are non-stationary. In an alternative specification, Bueno (2005: 24) uses Markov-Switching regimes to evaluate the Taylor (1993) rule for Brazil and the USA. Monthly and quarterly data are also used in this study, including an interest rate smoothing parameter to,

> "simply assume that interest rate is stationary as in Clarida *et al.* (2000), because of the empirical plausibility of this assumption, as well as the low power of the unit root tests. Moreover, stationarity is also a property found in many theoretical models."

A more formal analysis is presented by Bunzel and Enders (2005: 1), who "conduct a thorough statistical analysis of the empirical foundations for the existence of a Taylor rule. Inflation, the output gap and the federal funds rate appear to be non-stationary variables that are not cointegrated." This paper also considers a nonlinear Taylor (1993) rule specification on the basis that macroeconomic variables may follow asymmetric paths over the business cycle.

The essential insight being nonlinearities in macroeconomic variables manifesting themselves in nonlinear Taylor (1993) type rules.

Gerlach-Kristen (2003) considers Taylor (1993) rules for the Euro area, encountering problems of instability and mis-specification. Non-stationarity in interest rates, inflation and the output gap is treated with a cointegration approach to capture short-term nominal interest rate movements. In a first specification, the cointegrating vector links the official interest rate to inflation, output and the long interest rate. In a second specification, a unit coefficient on inflation allows the real short-term rate to respond to the output gap in the long run and the long interest rate. Gerlach-Kristen (2003: 7) notes that,

> "given that the time series properties of the data will play an important role ... it is worth noting that all series display unit root characteristics ... The unit root hypothesis is rejected for the first differences of these variables, but not for their levels, whether or not we include a time trend. While interest rates, inflation and the output gap are likely to be stationary in large samples, the results suggest that in order to draw correct statistical inference, it is desirable to treat them as non-stationary in the relatively short sample studied here."

In a guide to monetary policy, Nelson (2000), estimates a series of Taylor-type rules for the period 1972 to 1997 in the UK. The study begins with a full sample estimate of the Taylor (1993) rule using UK data, though an initial consideration of the underlying time series properties of model parameters is not presented. The full sample estimate is shown to suffer from mis-specification and is subsequently split into five sub-periods, under which inflation and nominal interest rates are treated as I(0) variables within each regime. This is on the basis of supporting evidence from VAR estimates in Batini and Nelson (2000: 35-36). Hence, cointegration testing following Johansen (1991) is not adopted. Similarly, in their estimated reaction function for the United States, Clarida *et al.* (2000: 154) maintain an,

> "assumption that both inflation and the nominal interest rate are stationary. We view this assumption as reasonable for the post-war United States, even though the null of a unit root in either variable is often hard to reject at conventional significance levels, given the persistence of both series and the well-known low power of unit root tests."

In further testing, Clarida *et al.* (2000: 159) use alternative measures of inflation and the output gap as robustness analysis against the initial specification. However, the underlying time series properties of these variables are not accounted for.

To illustrate, the inflation rate variable can be treated as stationary, if its mean and variance are constant over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed.[1] In other words, if the inflation rate is a stationary variable then its mean, variance and covariance at various lags remain the same, regardless of the time at which they are measured. Stationary variables can generally be identified from a diminishing correlogram as the number of lags increases. For a non-stationary variable, the theoretical correlogram will not tend towards zero. A visual inspection however, has the drawback of near unit root variables exhibiting autocorrelation functions (ACF) which are the same as those of an actual unit root variable. Since an apparently

[1] To be precise, this is known as *weak* stationarity.

unit root variable might be confused with a stationary one, a more formal approach is required. To illustrate, consider the following AR(1) model:

$$y_t = \emptyset y_{t-1} + u_t \tag{1}$$

where u_t is a white noise process and the stationarity condition is given by $|\emptyset|<1$. This implies three general cases. That the series is stationary as in $|\emptyset|<1$, that the series is an exploding process as in $|\emptyset|>1$, and that the series exhibits a unit root as in $\emptyset = 1$ and is therefore non-stationary. Thus if $\emptyset = 1$ then the variable exhibits a unit root. Subtracting y_{t-1} from both sides of equation (1) above, gives:

$$\begin{aligned} y_t - y_{t-1} &= y_{t-1} - y_{t-1} + e_t \\ \Delta y_t &= e_t \end{aligned} \tag{2}$$

where e_t is a white noise process and Δy_t is a stationary variable. Thus stationarity is achieved by differencing y_t. More formally, a variable y_t is integrated of order one or exhibits a unit root when y_t is non-stationary and Δy_t is stationary. In the general case, a non-stationary variable y_t might be differenced more than once before it is stationary. d orders of differencing implies that the variable is integrated of order d.

It was noted earlier that a formal approach to testing for the presence of a unit root is necessary in order to overcome some of the drawbacks associated with a visual inspection of the ACF. To this end, we introduced the well known Dickey and Fuller (1981, 1979) test for non-stationarity. This method essentially tests for the presence of a unit root and can be illustrated in terms of a simple AR(1) model:

$$y_t = \emptyset y_{t-1} + u_t \tag{3}$$

Here, a unit root exists when $\emptyset$ is equal to one. Hence the null hypothesis is $H_0 \colon \emptyset = 1$ and the alternative hypothesis is $H_1 \colon \emptyset < 1$. Subtracting y_{t-1} from both sides of equation (3) above gives:

$$y_t - y_{t-1} = \emptyset y_{t-1} - y_{t-1} + u_t$$
$$\Delta y_{t-1} = (\emptyset - 1)y_{t-1} + u_t$$
$$\Delta y_{t-1} = \gamma y_{t-1} + u_t \tag{4}$$

where $\gamma = (\emptyset - 1)$. The null hypothesis is therefore $H_0 \colon \gamma = 0$ and the alternative hypothesis is $H_a \colon \gamma < 0$, where if $\gamma = 0$ and then y_t is a random walk process. The Dickey and Fuller (1979) method can be adapted for the purposes of identifying a unit root in the presence of a constant in random walk models:

$$\Delta y_{t-1} = \alpha_0 + \gamma y_{t-1} + u_t \tag{5}$$

An implication here is that a trend exists when $\gamma = 0$, as in the notion of trended macroeconomic variables. A non-stochastic time trend in the model can also be represented in terms of:

$$\Delta y_{t-1} = \alpha_0 + \alpha_2 t + \gamma y_{t-1} + u_t \tag{6}$$

Evidently, the Dickey Fuller method is a conventional t-test applied to the coefficient of the lagged dependent variable. The distribution of this test however, is not conventional and the appropriate critical values are tabulated by MacKinnon (1991). Once again, the test examines whether $\gamma = 0$ and the test statistic is the t-statistic for the lagged dependent variable. When this is smaller than the critical value in absolute terms it can be concluded that the null hypothesis of a unit root is rejected and that the variable y_t is stationary. Since the error term is unlikely to be a white noise process, the Augmented Dickey Fuller test (ADF) contains extra lagged terms of the dependent variable so as to eliminate serial correlation. The lag length of the extra lagged terms is normally determined by the Akaike (1974) Information Criterion (AIC) or the Schwarz (1978) Bayesian Criterion (SBC). Alternatively, the residuals of the ADF regression can be inspected for serial correlation using a conventional LM test. Three representations of the ADF method are:

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t \tag{7}$$

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t \tag{8}$$

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + a_2 t \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t \tag{9}$$

The distinction between equations (7), (8) and (9) above can be explained in terms of the deterministic terms α_0 and $a_2 t$, where the critical values are the same as those of the DF test. An obvious question is how to estimate the most appropriate version if the actual data generating process is unknown. Doldado *et al.* (1990) suggest a method that begins with equation (9), which is an estimate of the most general specification. It might be noted that this is a helpful suggestion but not one which is expected to be applied in a formal manner. To supplement the Dickey and Fuller method, we also introduce the Phillips and Perron test for the purposes of complementarity. The Phillips and Perron method can be contrasted with the Dickey and Fuller approach in the sense that the DF method assumes statistically independent error terms with constant variance. This implies that the error terms must be uncorrelated and with a constant variance when applying the ADF test. The Phillips and Perron (1988) method can be thought of as a generalisation of the ADF test in that it incorporates less restrictive assumptions about the distribution of errors. To illustrate, the Phillips and Perron test can also be presented in terms of an AR(1) model:

$$\Delta y_{t-1} = \alpha_0 + \gamma y_{t-1} + e_t \tag{10}$$

The difference is, that the ADF test eliminates higher order serial correlation by including lagged differenced terms on the right hand side of the equation, while the Phillips and Perron tests accounts for serial correlation by making a correction to the *t*-statistic of the γ coefficient in the AR(1) model. Hence the PP test adapts the *t*-statistic in the ADF method in a manner which is less restrictive about the error process. Both the ADF and the PP *t*-statistics share the same asymptotic distribution, which means that MacKinnon (1991) critical values can again be used. Both the ADF and PP test can be applied for models which include a constant, a constant and linear trend, or neither a constant or linear trend.

For each variable, stationarity testing proceeds as follows. These tests are for the full sample period, which implies that monetary policy is being treated as a single regime. In the UK of course, monetary policy has passed through several regimes during this period. This is an issue that we will return to later. First we test for the presence of a unit root in levels with an intercept included in the test equation. The lag length is selected automatically using the Akaike (1974) Information

Criterion or AIC, following Akaike (1974). This is then repeated for a trend and intercept in the test equation and also for neither a trend or intercept. The procedure is repeated using the Schwarz Information Criterion or SIC, following Schwarz (1978). The Phillips-Perron test procedure is the same as that of the ADF method, except that lag length is replaced by a spectral estimation method, for which we accept the default Bartlett (1937) kernel, and bandwidth, which we select automatically using the Newey-West (1986) method.

The results of ADF tests (AIC criterion) for the interest rate, the rate of inflation and the output gap are presented in table 7.2.1 at the end of this chapter. These are for all three test equations discussed earlier. Also included are the results of the tests for an interest rate smoothing parameter and also for the Deutschmark variable. In the top half of the table, the results are presented first in the levels of each variable and then in their first differences. The results suggest that each variable is non-stationary when defined in levels. However, first differencing removes non-stationarity for all variables and the null hypothesis of non-stationarity is clearly rejected at the 5% level of significance. This suggests that each variable is integrated of order one. An exception here concerns the output gap as measured by relative unemployment and also by industrial production. These are shown to be stationary when measured in levels and this is not surprising given their prior construction. Table 7.2.2 then presents the results of ADF tests from these same variables using the SBC criterion. These also confirm the results of the previous table where the AIC criterion was used. Table 7.2.3 contains the results of the Phillips-Perron tests and these are not fundamentally different from the ADF results. At this stage, the results from both ADF and PP tests in the levels of the variables clearly point to the presence of a unit root in all cases except for relative unemployment and industrial production measures of the output gap. After first differencing each variable, the results strongly reject the null hypothesis of the presence of a unit root and suggest therefore that each variable is integrated of order one.

In Table 7.2.1, forward looking inflation does not reject the null hypothesis of stationarity, when a constant and trend are included in the test equation. This anomaly is not apparent in Tables 7.2.2 or 7.2.3 and may be due to the well-known property of diminishing power of the ADF test. This is also noted by Zivot (undated: page 132), who points out that,

> "...the power of unit root tests diminish [es] as deterministic terms are added to the test regressions. That is, tests that include a constant and trend in the test regression have less power than tests that only include a constant in the test regression."

Similarly the Phillips-Perron test in Table 7.1.3 does not reject the null hypothesis of stationarity for relative unemployment when a constant and also a constant and trends are included in the test equation. The findings here contrast with Osterholm (2005: 226-227), who finds little firm evidence of stationary Taylor-type variables. Only the output gap for the full sample period is found to be stationary. Osterholm (2005: 226-227) argues that all three parameters (official interest rate, inflation rate and output gap) should be stationary. The output gap is expected to be stationary around zero and the inflation rate stationary around target. A stationary inflation rate variable is said to imply stationarity of interest rates in terms of the Fisher hypothesis. Empirical persistence in the variables however is said to be considered sufficient enough to represent unit root behaviour in the variables. This study uses ADF and KPSS unit tests for several countries and sub-samples. For the United States, both tests suggest that the Federal Funds rate is an integrated of order one variable for one sub-sample, though they reach conflicting conclusions for three further sub-samples. The unit root hypothesis is supported for the rate of inflation which is found to be integrated of order one for two out of four sub-samples. The output gap is shown to be stationary for the full sample period, though conflicting results are reported for different sub-sample periods. For example, the ADF test does not reject the null hypothesis of a unit root and the KPSS test does not reject the null hypothesis of stationarity. Using further data for Australia, the output gap is reported as an integrated of order one variable according to both tests. The results differ for the rate of inflation, for which the ADF test does not reject the null hypothesis that it is an integrated of order one variable, whilst the KPSS test does not reject the null hypothesis of stationarity. For Swedish data the repo rate and the output gap are found to be integrated order one variables according to both tests, though conflicting results are reported for the rate of inflation. Given that each series is now integrated of order one over sub-sample periods, it is possible to proceed with cointegration analysis.

7.3 SETTING THE APPROPRIATE LAG LENGTH

We now move on to a discussion of cointegration, which builds on the idea discussed earlier that the presence of trends in macroeconomic variables may lead to invalid estimates. The procedure of differencing to achieve stationarity was also illustrated and applied. To illustrate, a set of two variables $\{Y, X\}$ integrated of order one can be considered. We assume a vector $\{\theta_1, \theta_2\}$ which gives a linear combination of $\{Y, X\}$ which is stationary. This can be written as:

$$\theta_1 Y_t + \theta_2 X_t = u_t \sim I(0) \tag{11}$$

In equation (11) above, the variable set $\{Y, X\}$ can be termed the cointegration set and the vector of coefficients $\{\theta_1, \theta_2\}$ can be termed the cointegration vector. Here, we are interested in determining the long-run relationship for Y_t, which is:

$$Y_t^* = \beta X_t \tag{12}$$

To show how this is derived from the cointegration method, equation (12) above can be normalised for Y_t which gives:

$$Y_t = -\frac{\theta_2}{\theta_1} X_t + e_t \tag{13}$$

where $Y^* = -(\frac{\theta_2}{\theta_1})X_t$ is the long-run or equilibrium value of Y_t given the value of X_t. In the academic literature, cointegration theory is closely attributed to the work of Granger (1981) and Engle and Granger (1987), though Engle and Yoo (1987), Philips and Ouliaris (1990), Stock and Watson (1988), Phillips (1987 and 1986) and Johansen (1995, 1991, 1988) are also well known works. For the case of one cointegrating vector, Engle and Granger (1987) describe the presence of cointegration between two variables in terms of both series being integrated of order *d*, and there existing a linear combination of these variables which is integrated of order $d-b$. The vector $\{\beta_1,\beta_2\}$ therefore, is the cointegrating vector. From an empirical perspective, we are interested in transforming the variables to achieve stationarity using the cointegrating vector. In other words, when $d = b$ and the cointegrating coefficients are identified as parameters in the long-run relationship between the variables. An extension of cointegration analysis concerns the Error Correction Mechanism (ECM), which we now describe. It was noted earlier that non-stationary variables are prone to spurious estimates. If for example, Y_t and X_t, are both integrated of order one, then the regression:

$$Y_t = \beta_1 + \beta_2 X_t + u_t \tag{14}$$

does not produce satisfactory estimates of $\hat{\beta}_1$ and $\hat{\beta}_2$. One solution to this, is to difference the variables to achieve stationarity. As a result, $\Delta Y_t \sim I(0)$ and $\Delta X_t \sim I(0)$, which means that the estimated model is:

$$\Delta Y_t = a_1 + a_2 \Delta X_t + \Delta u_t \tag{15}$$

In this instance, the estimates of $\hat{a}_1$and $\hat{a}_2$ are correct and the problem of spurious regression has been avoided. Note however, that equation (15) above is simply a short-run relationship and in the long-run, ΔY_t does not offer any information about the long-run behaviour of the model. Since we are interested in determining long-run relationships, the issue of cointegration and ECM is relevant. To illustrate, it was noted earlier that Y_t and X_t are both integrated order one. If there exists a linear combination of Y_t and X_t which is stationary, then Y_t and X_t are cointegrated variables. This being so, the estimated model in equation (14) is not subject to spurious estimates, which also gives the following linear combination connecting Y_t and X_t in the long-run:

$$\hat{u}_t = Y_t - \hat{\beta}_1 - \hat{\beta}_2 X_t \tag{16}$$

If therefore, Y_t and X_t are cointegrated then $\hat{u}_t \sim I(0)$ and the relationship between Y_t and X_t can be expressed in terms of the following ECM specification:

$$\Delta Y_t = a_0 + b_1 \Delta X_t - \pi \hat{u}_{t-1} + Y_t \tag{17}$$

This model now contains both long-run and short-run terms. b_1 for example, is the short-run effect which represents the immediate impact of a change in X_t on a change in Y_t. π on the other hand is a feedback or adjustment effect which represents the extent to which the disequilibrium is being corrected. In other words, the extent to which any disequilibrium in the previous period affects any adjustment in Y_t. Note that $\hat{u}_{t-1} = Y_{t-1} - \hat{\beta}_1 - \hat{\beta}_2 X_{t-1}$, which means that β_2 is also the long-run parameter. Equation (17) therefore represents the basic approach for cointegration and error correction. The issue of spurious estimation exists because of non-stationary data, though in equation (17) above the variables are stationary. Also, the change in X and Y is stationary because of the assumption of integrated of order one variables and the residual from the levels specification in equation (16) is stationary given the assumption of cointegration. Therefore equation (17) meets the assumptions of the CLRM and is conducive to OLS estimation. We select an ECM specification citing four advantages. First, that it is a convenient means of measuring the correction from disequilibrium in the previous time period, thus allowing for a meaningful economic interpretation. Second, in the presence of cointegration, the first difference specification of the

ECM helps to eliminate the trends from variables thereby removing the problem of spurious regression. Third, the ECM can very easily be adapted in a general-to-specific econometric modelling process. This is actually the most parsimonious ECM which gives the best fit to the data. Fourth, the disequilibrium error term is a stationary variable given cointegration. An important implication of this is that there exists some adjustment process which minimises errors in a long-run relationship. We now illustrate cointegration and the error correction mechanism using a two-variable ARDL model as follows:

$$Y_t = \mu + \sum_{i=1}^{n} a_i Y_{t-i} + \sum_{i=0}^{m} \gamma_i X_{t-i} + u_t \tag{18}$$

$$\begin{aligned} Y_t = \mu + a_1 Y_{t-1} + \cdots + a_n Y_{t-n} + \gamma_0 X_t + \gamma_1 X_{t-1} + \cdots \\ + \gamma_m X_{t-m} + u_t \end{aligned} \tag{19}$$

The objective is to determine a long-run solution, or in other words, the point at which Y_t and X_t reach constant steady state levels. That is to say:

$$Y^* = \beta_0 + \beta_1 X^* \tag{20}$$

assuming X^* constant. Inserting this identity into equation (18) gives the following long-run solution:

$$\begin{aligned} Y^* &= \frac{\mu}{1 - \sum a_i} + \frac{\sum \gamma_i}{1 - \sum a_i} X^* \\ Y^* &= \frac{\mu}{1 - a_1 - a_2 - \cdots - a_n} \\ &\quad + \frac{(\gamma_1 + \gamma_2 + \cdots + \gamma_m)}{1 - a_1 - a_2 - \cdots - a_n} X^* \end{aligned} \tag{21}$$

or

$$Y^* = \beta_0 + \beta_1 X^*$$

which means that Y^* can be defined given a constant value of X at time t. This is the relationship with cointegration discussed earlier. If e_t is the equilibrium error term, then this gives:

$$e_t \equiv Y_t - Y^* = Y_t - \beta_0 + \beta_1 X_t \tag{22}$$

Here we need to be able to estimate the parameters β_0 and β_1. Naturally β_0 and β_1 can be derived by estimating equation (18) using OLS and calculating $A = \mu/(1-\sum a_i)$ and $B = \sum \gamma_i/(1-\sum a_i)$. However this method is not ideal because any calculation of the standard errors is difficult. These difficulties are overcome by the ECM specification as follows. Model twenty-three below is a re-parameterisation of equation (18) above in which $n = 1$ disappears as the second term on the left hand side:

$$\Delta Y_t = \mu + \sum_{i=1}^{n-1} a_i \, \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma_i \, \Delta X_{t-i} + \theta_1 Y_{t-1} \\ + \theta_2 X_{t-1} + u_t \tag{23}$$

It can be seen that:

$$\theta_2 = \sum_{i=1}^{m} \gamma_i \tag{24}$$

is the numerator of the long-run parameter, β_1. Furthermore;

$$\theta_1 = -(1 - \sum_{i=1}^{n} a_i) \tag{25}$$

so the long-run parameters are $\beta_0 = 1/\theta_1$ and $\beta_1 = -\theta_2/\theta_1$. Therefore the level terms of Y_t and X_t in the ECM specification provide exclusive information about the long-run parameters. Therefore the ECM can be written as follows:

$$Y_t = \mu + \sum_{i=1}^{n-1} a_i \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma_i \Delta X_{t-i} + \theta_1 \left(Y_{t-1} - \frac{1}{\theta_1} - \frac{\theta_2}{\theta_1} X_{t-1} \right) + u_t \tag{26}$$

$$Y_t = \mu + \sum_{i=1}^{n-1} a_i \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma_i \Delta X_{t-i} - \pi \left(Y_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 x_{t-1} \right) + u_t \tag{27}$$

where $\pi = 0$. In addition, $Y_{t-1} - \hat{\beta}_0 - \hat{\beta}_1 x_{t-1} = e_t$ is the equilibrium error which means that equation (26) above can be re-written as:

$$\Delta Y_t = \mu + \sum_{i=1}^{n-1} a_i \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma_i \Delta X_{t-i} - \pi \hat{e}_{t-1} + \varepsilon_t \tag{28}$$

It is important here to be able to interpret π. This is the error correction coefficient for the adjustment mechanism which indicates the extent of adjustment towards equilibrium in each time period. In other words how much of the equilibrium error is being corrected. To illustrate, if π equals one then this implies that all of the adjustment occurs within a period or that it is instant or complete. Similarly, if π equals 0.5, half of the adjustment occurs in each time period. If π equals zero, then no adjustment takes place and Y_t^* is not a long-run component of Y_t. Of importance here is to demonstrate the relationship between the ECM and cointegration. Given cointegration, $\hat{e}_t \sim I(0)$ and $\hat{e}_{t-1} \sim I(0)$. Therefore in equation (28) above, the model represents an ECM specification were each variable is stationary or integrated of order zero. This allows for the most important feature of the ECM to be used, namely long-run information and short-run disequilibrium dynamics.

We now select an appropriate method for undertaking cointegration analysis. The work of Granger (1981) is well known in the academic literature for identifying the relationship between non-stationary variables and long-run equilibrium. This is cointegration as discussed earlier and further developed by Engle and Granger (1987) in terms of a test for identifying cointegration for long-run equilibrium between variables. This can be illustrated briefly using two variables as follows. If $Y_t \sim I(0)$ and $X_t \sim I(0)$, then every linear combination of these two variables;

$$\theta_1 Y_t + \theta_2 X_t \tag{29}$$

will produce a series which will be integrated of order one or non-stationary. This is because the non-stationary variable will influence the stationary variable. If both X_t and Y_t are integrated order one then a linear combination of both variables such as equation (29) will also be integrated of order one. Although this is quite realistic it is also possible that a combination of equation (29) above exists which is integrated of order zero. This being so, X_t and Y_t are cointegrated of order (1,1). The objective then becomes an estimation of the long-run parameters and to identify whether or not cointegration exists. The Engle and Granger method proposes the following solution. First, to determine the order of integration of each variable using conventional DF and ADF tests to determine the number of unit roots. If both variables are integrated of order zero, conventional estimation methods can be applied. If the variables are integrated of different orders then it can be inferred that cointegration does not exist. If both variables are integrated of the same order then a long-run or possible cointegrating relationship can be estimated as follows and the residuals obtained:

$$Y_t = \beta_1 + \beta_2 X_t + e_t \tag{30}$$

If cointegration does not exist, then the estimated equation is spurious. If however, the variables are cointegrated, any subsequent estimates of the cointegrating parameter $\hat{\beta}_2$ will be super-consistent. The next step is to determine the order of integration of the residuals. If a cointegrating relationship actually exists, the estimated sequence of residuals can be denoted as $\hat{e}_t$. This is the series of estimated residuals from the long-run relationship. If these deviations from long-run equilibrium are stationary, then X_t and Y_t are said to be cointegrated. The order of integration of the residuals is simply a conventional DF test of the form;

$$\Delta\hat{e}_t = a_1\hat{e}_{t-1} + \sum_{i=1}^{n} \delta_i \Delta\hat{e}_{t-i} + v_t \tag{31}$$

Since $\hat{e}_t$ is a residual, a constant or time trend are not included. The critical values also differ somewhat from their ADF counterparts and are typically more negative, taking values of approximately -3.5. If $\hat{e}_t \sim I(0)$, the null hypothesis of no cointegration between and can be rejected. This is also the case for a single equation specification consisting of two or more explanatory variables. When cointegration does exist the residuals from the estimated equilibrium regression can be used to derive an Error Correction Model which makes it possible to interpret the long-run and short-run effects of the variables. The adjustment coefficient can also be determined and this is the coefficient of the lagged residual terms in the long-run relationship identified above.

An appealing feature of the Engle-Granger method is that it is relatively easy to implement. There are however some important drawbacks which also need to be considered. The first concerns the order of variables. In the long-run relationship, one variable appears on the left hand side with the remaining variables acting as regressors. This estimation method does not determine which of the variables might be used as regressors and why. Second, when more than two variables are used, there may exist more than one cointegrating relationship. Since the Engle-Granger method uses single equation residuals, it cannot account for this possibility. In other words the Engle-Granger method does not identify the number of cointegrating vectors. Third, the Engle-Granger method is based upon a two step estimation procedure. In the first step, a residual series is estimated and in the second step, a regression is estimated to determine stationarity. As a result, if an error is introduced in the first step, this will be carried forward into the second step. Given such drawbacks, we elect to apply the Johansen method in preference to the Engle-Granger approach. This can be illustrated as follows. It was noted earlier, that more than one cointegrating vector may exist when there are more than two variables in a model. In other words, multiple equilibrium relationships may exist. In general, $n - 1$ cointegrating vectors will exist for n number of variables. For example, if $n > 2$ and it is assumed that only one cointegrating relationship exists, when in fact there are actually two or more relationships, then this is a serious problem which the Engle-Granger method does not address. To illustrate, we assume three endogenous variables, or Y_t, X_t and W_t. This is similar to the dynamic two variable model in equation (18) above. This can be re-formulated into a Vector Error Correction Model (VECM) using matrix notation as follows:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \cdots + \Gamma_{k-1} \Delta Z_{t-k-1} + \Pi Z_{t-1} + u_t \tag{32}$$

where $\Gamma_i = (I - A_1 - A_2 - \cdots - A_k)(i = 1, 2, \dots, k-1)$ and $\Pi = -(I - A_1 - A_2 - \cdots - A_k)$. Here we have a three by three Π matrix which gives information about long-run relationships. This can be decomposed into $\Pi = \alpha\beta'$ where α represents the speed of adjustment to equilibrium while β' represents the long-run matrix of coefficients. The term $\beta' Z_{t-1}$ therefore is equivalent to the error correction mechanism $Y_{t-1} - \beta_0 - \beta_1 X_{t-1})$ for a single equation model where $\beta' Z_{t-1}$ now represents up to $(n - 1)$ vectors in the multivariate system. For simple illustration, $k = 2$ for two lagged terms. The model is therefore:

$$\begin{pmatrix} \Delta Y_t \\ \Delta X_t \\ \Delta W_t \end{pmatrix} = \Gamma_1 \begin{pmatrix} \Delta Y_{t-1} \\ \Delta X_{t-1} \\ \Delta W_{t-1} \end{pmatrix} + \Pi \begin{pmatrix} Y_{t-1} \\ X_{t-1} \\ W_{t-1} \end{pmatrix} + e_t \tag{33}$$

or

$$\begin{pmatrix} \Delta Y_t \\ \Delta X_t \\ \Delta W_t \end{pmatrix} = \Gamma_1 + \begin{pmatrix} a_{11} \, a_{12} \\ a_{21} \, a_{22} \\ a_{31} \, a_{23} \end{pmatrix} \begin{pmatrix} \beta_{11} \, \beta_{21} \, \beta_{31} \\ \beta_{12} \, \beta_{22} \, \beta_{32} \end{pmatrix} \begin{pmatrix} Y_{t-1} \\ X_{t-1} \\ W_{t-1} \end{pmatrix} + e_t \tag{34}$$

To determine the error correction term for the first equation, or for ΔY_t on the left-hand side, we now have:

$$\begin{aligned} \Pi_1 Z_{t-1} = ([a_{11}\beta_{11} + a_{12}\beta_{12}] \;\; [a_{11}\beta_{21} \\ + a_{12}\beta_{22}] \;\; [a_{11}\beta_{31} \\ + a_{12}\beta_{32}]) \begin{pmatrix} Y_{t-1} \\ X_{t-1} \\ W_{t-1} \end{pmatrix} \end{aligned} \tag{35}$$

where Π_1 represents the first row of the Π matrix. Re-writing equation (35) above gives:

$$\begin{aligned} \Pi_1 Z_{t-1} = a_{11}(\beta_{11} Y_{t-1} + \beta_{21} X_{t-1} + \beta_{31} W_{t-1}) + \\ a_{12}(\beta_{12} Y_{t-1} + \beta_{22} X_{t-1} + \beta_{32} W_{t-1}) \end{aligned} \tag{36}$$

which clearly shows both cointegrating vectors and their respective speed of adjustment parameters a_{11} and a_{12}. This multiple equation approach thus derives estimates for both cointegrating vectors in equation (36) above, compared to the simple equation which gives only a linear combination of both long-run relationships. In addition, if there exists just one cointegrating vector instead of two, the multiple equation approach means that all three speed of adjustment coefficients $(a_{11}\ a_{21}\ a_{31})'$ can be determined. When $a_{21} = a_{31} = 0$ and one cointegrating vector is identified then the multiple equation approach reduces to the single equation method. As a result, there is no loss when the determinants of ΔX_t and ΔW_t are not modelled. It might also be noted here that when $a_{21} = a_{31} = 0$, then this is the same as X_t and W_t being weakly exogenous variables. To summarise then, the single equation approach only provides the same estimates as the multivariate method when all right hand side variables are weakly exogenous.

Returning to the Johansen method outlined above, we can now illustrate the Π matrix in further detail. If Z_t is a vector of non-stationary or integrated of order one variables, then ΔZ_{t-1} are integrated of order zero and ΠZ_{t-1} must also be integrated of order zero in order to have $u_t \sim I(0)$. In a general sense, ΠZ_{t-1} maybe integrated of order zero in three instances. First, when each variable in Z_t is stationary. This implies no spurious estimates and a simple VAR in levels can be used. Second, if cointegration does not exist and the Π matrix is an *n x n* matrix of zeros given an absence of linear relationships between the Z_t. Here, a VAR model in first differences can be adopted without long-run terms since a long-run relationship does not exist. Third, if there exist up to (*n* – 1) cointegrating vectors of the form $\beta' Z_{t-1} \sim I(0)$. Here, $r \leq (n-1)$ cointegrating vectors exist in β. This implies that *r* columns of β form *r* linearly independent combinations of the variables in Z_t, each of which is stationary. Since $\Pi = \alpha\beta'$ this implies that in the last point above the matrix is *n x n* and the α and β matrices will be *n x r*. Therefore a rank of *r* can be imposed on the Π matrix. In other words, this imposes r linearly independent rows in the matrix. Therefore the complete Π matrix includes a restricted set of r cointegrating vectors given by $\beta' Z_{t-1}$. This method is known as reduced rank regression and is associated with Johansen (1988) in the analysis of non-stationary data. Returning to the three points above, the following observations might be made about the rank of the Π matrix. First, when Π consists of a full rank. In other words there exist $r = n$ linearly independent columns. In this case the variables in Z_t are integrated of order zero. In the second case, the rank of Π is zero. In other words there do not exist any linearly independent columns, which means that a cointegrating vector is not present. Third, Π consists of a reduced rank. In other words $r \leq (n-1)$ linearly independent columns. Therefore we have $r \leq (n-1)$ cointegrating relationships. The Johansen (1988) method tests for the rank of Π and gives estimates of α and β through reduced rank regression.

It was noted in the introduction that determination of the appropriate lag length was an important requirement for ensuring that the error terms are Gaussian. In other words, that they are standard normal error terms which do not suffer from non-normality, autocorrelation, or heteroscedasticity and so on. In this section, we determine the optimal lag length by estimating a VAR model based on a levels specification of the variables. The model is estimated for a large number of lags then reduced down successively through re-estimation until zero lags are reached. For each model, the values of the AIC and SBC criteria are inspected, along with the results of conventional diagnostic testing. Overall, we aim to select that model which minimises the AIC and SBC as the one with an optimal lag length. In addition, the model must also conform to conventional diagnostic tests. As an example, Table 7.3.1 at the end of this chapter suggests an optimal lag length of four when modelling the nominal interest rate as a function of (backward-looking) inflation and the output gap.

In both the monthly and quarterly datasets, the optimal lag length ranges between one and three lags, although there are some models were the optimal lag lengths is four or five. It might also be noted here, that the Schwarz criterion often reports a lower lag length than the AIC criterion as is well known in the academic literature. In such instances, Akaike's final prediction error and the Hannan-Quinn (1979) criterion can also be used.

7.4 DETERMINISTIC TRENDS FOR MODEL SELECTION

At this stage, the nominal interest rate, the rate of inflation and the output gap are integrated of order one variables, and the appropriate lag length of four has also been established. In order to determine the appropriate deterministic trends for model selection, in other words whether or not to include an intercept and/or trend in the short-run model, the long-run model or both, we are now able to introduce and apply the Pantula (1989) principle, which helps to select the most appropriate model for the purposes of cointegration testing.[2] To illustrate, a general vector error correction model which includes all options can be specified as follows:

[2] See also, Berger and Sinclair (1984) for a similar treatment of the issue.

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \cdots + \Gamma_{k-1} \Delta Z_{t-k-1} + \alpha \begin{pmatrix} \beta \\ \mu_1 \\ \delta_1 \end{pmatrix} (Z_{t-1} \ 1 \ t) \\ + \mu_2 + \delta_1 t + u_t \tag{37}$$

We might elect for a constant and/or trend in the long-run model. This is the cointegrating equation. Alternatively, we might elect for a constant and/or trend in the short-run model. This is the VAR specification. At this stage, five distinct models can be considered. We do not consider the first and last of these to be realistic for the purposes of estimating a Taylor (1993) type monetary policy reaction function. Nevertheless, we include both for the purposes of illustrating the Pantula (1989) principle. In a first model then, we might exclude an intercept or trend in the cointegrating equation or VAR. This implies that there are no deterministic components in the data or in the cointegrating relationships. In a second model, we assume an intercept but no trend in the cointegrating equation and no intercept or trend in the VAR. This implies that there are no linear trends in the data and that therefore, the first differenced series have a zero mean. In this instance, the intercept is restricted to the long-run model or the cointegrating equation. Model three assumes an intercept in the cointegrating equation and VAR but no trends. This implies that there are no linear trends when the data are specified in levels form. Nevertheless, both specifications are allowed to drift around an intercept. In this specification, the intercept in the cointegrating equation is assumed to be cancelled out by the intercept in the VAR which leaves just one intercept in the short-run model. Model four assumes an intercept in the cointegrating equation and VAR, a linear trend in the cointegrating equation but no trend in the VAR. This implies a trend in the cointegrating equation as a trend stationary variable, which accounts for exogenous growth. In this instance, both specifications allow for an intercept but no trend in the short-run relationship. Model five includes an intercept and quadratic trend in the cointegrating equation and an intercept and linear trend in the VAR. This implies linear trends in the short-run model and therefore quadratic trends in cointegrating equation. In this final model therefore, all parameters are unrestricted but remain difficult to interpret from an economic point of view. Hence the question is which of these five models is the most appropriate for the purposes of testing for cointegration.

It was noted earlier that models one and five are very unlikely representations of monetary policy rules and that they are also somewhat implausible in terms of economic theory. Therefore, the choice reduces to models two, three or four. At this point we follow Pantula (1989) who suggests a test of the joint hypothesis of both the rank order and the deterministic components. This involves an estimation of models two and three and presentation of their results from the most restrictive hypothesis first. In other words, where r is equal to the number of cointegrating relations which in turn is equal to zero or model one, through to the least restrictive hypothesis where r is equal to the number of variables entering the VAR, less one. This is equal to n -1 and model four. The model selection procedure then involves moving from the most restrictive model, at each stage comparing the trace test statistic to its critical value and stopping only when we are unable to conclude for the first time that the null hypothesis of cointegration is not rejected. The results in Table 7.4.1 at the end of this chapter point to an assumption of no deterministic trend in the data or model 2.

7.5 DETERMINING THE NUMBER OF COINTEGRATING VECTORS

In determining the number of cointegrating vectors, we follow Johansen (1988) and also Johansen and Juselius (1990). Both methods involve the estimation of a $k \times k$ matrix with a rank r, for which the test procedure is as follows. In the first method, the null hypothesis that the rank of the $k \times k$ matrix is equal to r or the number of cointegrating vectors, is tested against the alternative that the rank is $r + 1$ vectors. In other words, the null hypothesis is that there exist cointegrating vectors and that there are up to r cointegrating relationships. The alternative hypothesis suggests the existence of $r + 1$ vectors. The test statistics in this method are based on maximum eigenvalues determined from the estimation procedure. The maximum eigenvalue test statistic is:

$$\lambda_{max}(r, r+1) = -T \ln (1 - \hat{\lambda}_{r+1}) \qquad (38)$$

The second method is based on the likelihood ratio test concerning the trace of the $k \times k$ matrix, in other words a trace statistic. This method considers whether or not the trace is increased through the addition of eigenvalues beyond the rth eigenvalue. Here, the null hypothesis that the number of cointegrating vectors is less than or equal to r. The test statistic for the trace test is as follows

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln (1 - \hat{\lambda}_{r+1}) \qquad (39)$$

critical values for both the maximum eigenvalue and trace test statistics are obtained following Johansen and Juselius (1990). Preliminary results from a cointegration test are presented in Table 7.5.2 at the end of this chapter and are somewhat disappointing. The estimated rule does not include an intercept and although the long-run response coefficients for both (backward-looking) inflation and the output gap are positively signed, they are statistically insignificant.

We now proceed to a discussion of the estimated results for each of the sub-sample periods under investigation. For the first sub-period, we estimate nine different specifications of a Taylor-type monetary policy rule, the parameters of which have been explained in Chapter 6. Optimal lag length testing for this sub-period suggests an optimal lag ranging from one to two. When the Taylor rule is modelled using contemporaneous inflation and relative unemployment, a lag length of three is suggested. Similarly, when backward looking inflation and contemporaneous inflation are included with an industrial production measure of the output gap. Beginning with the first model in this subset, we perform a cointegration test using a lag length of one and with an assumption of no deterministic trend and restricted constant. The results in Table C indicate the presence of two cointegrating equations at the 5% level of significance. Model six is estimated using an optimal lag length of two and also with the assumption of no deterministic trend. This returns one cointegrating equation at the 5% level of significance. Both models one and six are thus estimated in terms of an Error Correction Mechanism, whilst the reaming seven models in this first subset do not indicate the presence of any cointegrating vectors. Hence each of these are estimated in first differences in the form of a VAR. For the second sub-period, we identify an optimal lag length of one for all nine models. With the exception of model seventeen and eighteen, which combine contemporaneous and forward looking measures of inflation with industrial production respectively. Each of these are estimated under an assumption of no deterministic trend. Models seventeen and eighteen are estimated by allowing for a linear deterministic trend in the data. We identify the presence of one cointegrating vector for specification one of the Taylor rule and also for three further specifications which combine all three measures of inflation with the industrial production measure of the output gap.

When the relative unemployment measure of the output gap is combined with backward and forward looking measures of inflation, we find two cointegrating vectors. Again these are modelled in terms of an error correction mechanism with the remainder estimated in terms of a VAR in first differences. Interestingly, the third sub-period suggests an optimal lag length of one when industrial production is included with various measures of inflation. For the remaining models, an optimal lag length is four and five when forward looking inflation is combined with the unemployment rate in which case the optimal lag length is five. For each of these nine models in this third sub-period, we include an assumption of no deterministic trend in the data. An exception being contemporaneous and forward looking inflation combined with the rate of unemployment, in which case a linear deterministic trend in the data is allowed for. Additionally, a linear deterministic trend is also included for backward and contemporaneous measures of inflation and industrial production. All nine models in this third sub-period indicate the presence of cointegrating vectors. These can be seen in the Appendix Three where the number of cointegrating vectors ranges from one to three. As a result, we estimate each model in this third sub-sample in terms of an error correction mechanism. For the fourth sub-period, we again estimate nine specifications of the Taylor rule, again identifying an optimal lag length of one to two. Models twenty eight, thirty one and thirty two are estimated assuming no deterministic trend in the data. Each of these suggest the presence of one cointegrating vector and are again modelled in terms of an error correction mechanism. Once more, the reaming nine models are estimated in terms of a VAR in first differences. For the fifth sub-period an optimal lag length of one is identified for each of models thirty seven through to forty five. We estimate models thirty seven, thirty eight and thirty nine and also models forty two, forty three and forty five under an assumption of no deterministic trend in the data. The results in Appendix Three suggest the presence of between one and two cointegrating vectors. Each of these are also estimated in terms of an error correction mechanism with the remainder taking the form of a VAR in first differences.

For the sixth sub-period, the optimal lag length again ranges from one to two and the assumption of no deterministic trend in the data is held. An exception being models fifty two and fifty four, where we allow for a linear deterministic trend. Again one cointegrating vector is suggested for each of these models, with two cointegrating vectors suggested for model fifty three. Again, these follow an Error Correction Mechanism with the remainder modelled in terms of a VAR in first differences. Finally, for the seventh sub-period we find that the optimal lag length ranges from three to five. An assumption of no deterministic trend is used for models fifty six, fifty eight, fifty nine and sixty, each of which suggest the presence of one cointegrating vector for error correction mechanism analysis. The setup for quarterly data is essentially the same as the discussion of the monthly sub-periods outlined above. For the first quarterly sub-sample, the optimal lag length ranges from one to three. Cointegration testing assumes no deterministic trend except for model seventy three, where a linear deterministic trend is assumed. In both instances the data suggest the presence of one cointegrating vector. For the second quarterly sub-sample, we find an optimal lag length ranging from one to four, which is not surprising given our quarterly observations. Again an assumption of no deterministic trend in the data is incorporated with an exception being model ninety eight, which assumes both no deterministic trend in a first specification and a linear deterministic trend in the second specification. We identify between one and three cointegrating vectors for this second quarterly sub-sample. An exception being models ninety two and ninety three for which the presence of cointegration is not determined. For subsamples four and five, the optimal lag length is predominantly one and two, an exception being three lags for model one hundred and twenty four. For both these sub-samples, we assume no deterministic trend in the data. As Appendix Three illustrates, we are able to identify between one and two cointegrating vectors for which the corresponding models are estimated in terms of an error correction mechanism. The remainder follow a VAR in first differences specification.

7.6 TESTING FOR WEAK EXOGENEITY

Having determined the number of cointegrating vectors, the next step is to test for weak exogeneity. The $k \times k$ matrix above contains information about the long-run relationships where alpha represents the speed of adjustment coefficients and beta represents the matrix of long-run coefficients. Therefore when there exist $r \leq n - 1$ cointegrating vectors in beta, then this implies that there are at least n - R columns of alpha which are equal to 0. In other words, having determined the number of cointegrating vectors, we are now able to determine which of the variables are weakly exogenous. A feature of the Johansen approach to cointegration testing is that it allows for a test of restricted forms of cointegrating vectors. For example,

$$\begin{pmatrix} \Delta Y_t \\ \Delta X_t \\ \Delta W_t \end{pmatrix} = \Gamma_1 \begin{pmatrix} \Delta Y_{t-1} \\ \Delta X_{t-1} \\ \Delta W_{t-1} \end{pmatrix} + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{23} \end{pmatrix} \begin{pmatrix} \beta_{11} & \beta_{21} & \beta_{31} \\ \beta_{12} & \beta_{22} & \beta_{32} \end{pmatrix} \begin{pmatrix} Y_{t-1} \\ X_{t-1} \\ W_{t-1} \end{pmatrix} + e_t \qquad (40)$$

equation (40) above amounts to testing for weak exogeneity in terms of the long-run parameters and this amounts to testing which of the rows of alpha are equal to 0. We define a weakly exogenous variable as one which is a function of lagged variables and the parameters of the equation generating that variable are independent of the parameters which generate the other variables in the system. If we find a variable to be weakly exogenous, we can consider dropping it as an endogenous component of the system. As a result, this means we can drop the whole equation for that variable although it will continue to feature on the right-hand side of other equations.

7.7 TESTING FOR LINEAR RESTRICTIONS

Another important issue here concerns testing for linear restrictions in the cointegrating vectors and this is a feature also included in the Johansen approach. This allows for estimation of the coefficients of the matrices alpha and beta, before proceeding with a test for possible linear restrictions. Further applications of linear restrictions in the Johansen cointegration approach are contained in Enders 1995 and also Harris (1997). In this instance, we apply the following restrictions. The first that the coefficient on the inflation parameter is equal to 1.5 and second that the coefficient on the output gap is equivalent to not 0.5 as in the original Taylor (1993) rule. Table 7.7.1 at the end of this chapter reports summary results from the VECM and some basic diagnostics about the residuals of the error-correction equation. It contains the coefficients and the corresponding *t*-statistics for the error-correction component, for which the interest rate is correctly signed and statistically insignificant. Both (backward-looking) inflation and the output gap are statistically significant but incorrectly signed. The insignificance of these parameters can also be interpreted as a sign of their being weakly exogenous to the model.

7.8 TESTING FOR PARAMETER STABILITY

We now apply the Quandt-Andrews (Andrews, 1993 and Andrews and Plobeger, 1994) breakpoint test for one or more unknown structural break points in the full sample period. The Quandt-Andrews (Andrews, 1993 and Andrews and Plobeger, 1994) test applies a single Chow breakpoint test at every observation between two dates or observations. The test statistics from these Chow tests are then summarised into one test statistic and tested against a null hypothesis of no break points between two dates or observations. This procedure tests for the presence of a structural break in all of the initial regression parameters. For each individual Chow break point test, two statistics are retained and these are the Likelihood Ratio *F*-statistic and the Wald *F*-statistic. The Likelihood Ratio *F*-statistic compares the restricted and unrestricted sum of squared residuals. The Wald *F*-

statistic on the other hand is estimated from a standard Wald test on the restriction that the coefficients on the equation parameters are the same in all subsamples. Since we are estimating a linear equation, it is to be expected that both of these two statistics will be the same.

The individual test statistics which make up the Quandt-Andrews (Andrews, 1993 and Andrews and Plobeger, 1994) test can be illustrated in terms of three separate statistics. The first is a Sup or Maximum statistic; the second is an Exp statistic, and the third is an Ave statistic. The Maximum statistic is quite simply the maximum of the individual Chow F-statistics. The Ave statistic can be illustrated in terms of a simple average of the individual F-statistics. The test statistics do not follow a standard distribution and their approximate asymptotic values can be derived from Hansen (1997) and also from Andrews (1993).

In practice, the ends of the equation sample are not included in the testing procedure because the distribution of these statistics is reduced as one approaches the beginning of the equation sample for the first subset or the end of the equation sample for the second subset. In general, a standard level for this "trimming" is 15% which excludes the first and last 7.5% of the observations. Table 7.8.1 at the end of this chapter indicates that all three of the summary statistic measures have failed to reject the null hypothesis of no structural breaks within the 322 possible dates tested. The maximum statistic was in July 1988 and this is the most likely breakpoint location. As noted earlier, since the original equation was linear both the LR F-statistic and the Wald F-statistic are identical.

7.9 CONCLUSION

This chapter completes the process of initial econometric analysis of the data. Chapter eight overleaf now discusses the implications of these and further results for monetary policy.

Table 7.2.1 **Augmented Dickey-Fuller test results (January 1970 to June 2008)** **AIC Criterion**

Variables		Constant	Constant and trend	None
Unit-root tests in levels				
Interest rate	*(Rt)*	-2.030	-2.826	-0.915
Inflation rate	*(Pt^1)*	-1.840	-2.981	-1.251
	(Pt^2)	-2.007	-3.142	-1.348
	(Pt^3)	-1.971	-3.479*	-1.229
Unemployment rate	*(Ut)*	-2.414	-2.440	-0.817
	(Ut^2)	-4.274*	-4.989*	-4.274*
Industrial production	*(IPt)*	-6.379*	-6.374*	-6.385*
Smoothing parameter	*(SPt)*	-2.033	-2.824	-0.911
Unit-root tests in first differences				
Variables		*Constant*	*Constant and trend*	*None*
Interest rate	*(ΔRt)*	-18.850*	-18.843*	-18.870*
Inflation rate	*(ΔPt^1)*	-5.810*	-5.795*	-5.814*
	(ΔPt^2)	-4.745*	-4.736*	-4.748*
	(ΔPt^3)	-4.707*	-4.703*	-4.717*
Unemployment rate	*(ΔUt)*	-3.708*	-3.813*	-3.713*
	(ΔUt^2)	-3.863*	-3.860*	-3.867*
Industrial production	*(ΔIPt)*	-7.357*	-7.346*	-7.365*
Smoothing parameter	*(ΔSPt)*	-18.867*	-18.861*	-18.887*

*Notes: * Denotes significance at the 5% level and rejection of the null hypothesis of stationarity. Critical values obtained from Fuller (1976) are -2.868, -3.420 and -1.942 for the first, second and third test equations respectively. Optimal lag lengths chosen automatically using the AIC.*

Table 7.2.2 **Augmented Dickey-Fuller test results (January 1970 to June 2008)** **SBC Criterion**

Variables		Constant	Constant and trend	None
Unit-root tests in levels				
Interest rate	*(Rt)*	-2.037	-2.826	-0.915
Inflation rate	*(Pt^1)*	-1.671	-2.664	-1.129
	(Pt^2)	-2.132	-3.166	-1.340
	(Pt^3)	-2.129	-3.059	-1.468
Unemployment rate	*(Ut)*	-1.915	-1.934	-0.850
	(Ut^2)	-3.403*	-3.802*	-3.407*
Industrial production	*(IPt)*	-7.784*	-7.775*	-7.792*
Smoothing parameter	*(SPt)*	-2.033	-2.824	-0.911
Unit-root tests in first differences				
Variables		*Constant*	*Constant and trend*	*None*
Interest rate	*(ΔRt)*	-18.850*	-18.843*	-18.870*
Inflation rate	*(ΔPt^1)*	-6.665*	-6.652*	-6.671*
	(ΔPt^2)	-9.542*	-9.530*	-9.552*
	(ΔPt^3)	-9.507*	-9.495*	-9.516*
Unemployment rate	*(ΔUt)*	-4.057*	-4.145*	-4.061*
	(ΔUt^2)	-4.131*	-4.126*	-4.135*
Industrial production	*(ΔIPt)*	-26.503*	-26.474*	-26.532*
Smoothing parameter	*(ΔSPt)*	-18.867*	-18.861*	-18.887*

*Notes: * Denotes significance at the 5% level and rejection of the null hypothesis of stationarity. Critical values obtained from Fuller (1976) are -2.868, -3.420 and -1.942 for the first, second and third model respectively. Optimal lag lengths chosen automatically using the SBC.*

Table 7.2.3 **Phillips-Perron test results (January 1970 to June 2008)**

Unit-root tests in levels				
Variables		*Constant*	*Constant and trend*	*None*
Interest rate	*(Rt)*	*-2.030*	*-2.858*	*-0.912*
Inflation rate	*(Pt^1)*	*-2.027*	*-3.098*	*-1.281*
	(Pt^2)	*-1.939*	*-2.953*	*-1.289*
	(Pt^3)	*-1.938*	*-2.839*	*-1.360*
Unemployment rate	*(Ut)*	*-1.252*	*-1.241*	*-0.590*
	(Ut^2)	*-2.271*	*-2.394*	*-2.272**
Industrial production	*(IPt)*	*-8.025**	*-8.017**	*-8.033**
Smoothing parameter	*(SPt)*	*-2.064*	*-2.805*	*-0.940*
Unit-root tests in first differences				
Variables		*Constant*	*Constant and trend*	*None*
Interest rate	*(ΔRt)*	*-18.833**	*-18.809**	*-18.852**
Inflation rate	*(ΔPt^1)*	*-14.605**	*-14.596**	*-14.618**
	(ΔPt^2)	*-14.006**	*-13.993**	*-14.019**
	(ΔPt^3)	*-13.822**	*-13.808**	*-13.835**
Unemployment rate	*(ΔUt)*	*-14.273**	*-14.595**	*-14.281**
	(ΔUt^2)	*-25.244**	*-25.233**	*-25.255**
Industrial production	*(ΔIPt)*	*-29.692**	*-29.653**	*-29.730**
Smoothing parameter	*(ΔSPt)*	*-18.850**	*-18.827**	*-18.870**

*Notes: * Denotes significance at the 5% level and rejection of the null hypothesis of stationarity. Critical values obtained from Fuller (1976) are -2.868, -3.420 and -1.942 for the first, second and third model respectively. Optimal lag lengths chosen using the Bartlett kernel, bandwidth selected automatically using Newey-West.*

Table 7.3.1 **VAR Lag Order Selection Criteria (January 1970 to June 2008)**

Endogenous variables: INTR INFL UNEM
Exogenous variables: C
Sample: 1 464
Included observations: 454

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3562.446	NA	1330.325	15.70681	15.73402	15.71753
1	-389.4435	6290.093	0.001177	1.768473	1.877322	1.811359
2	-277.7639	219.9153	0.000748	1.316140	1.506625	1.391190
3	-231.1297	91.21405	0.000634	1.150351	1.422472	1.257565
4	-192.4484	75.14725	0.000556*	1.019597*	1.373354*	1.158975*
5	-188.6299	7.367908	0.000569	1.042422	1.477816	1.213965
6	-176.1762	23.86505	0.000561	1.027208	1.544238	1.230914
7	-165.8205	19.70781*	0.000557	1.021236	1.619902	1.257106
8	-162.7009	5.895625	0.000572	1.047140	1.727443	1.315175

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 7.4.1 The Pantula Principle for the Taylor Rule, k = 4 (January 1970 to June 2008)

H_0	r	$n-r$	*Model 2*	*Model 3*
λ max test				
	0	3	35.06115	35.05097
	1	2	10.76640*	10.75948
	2	1	1.680593	1.642065
λ trace test				
	0	3	47.50814	47.45251
	1	2	12.44700*	12.40155
	2	1	1.680593	1.642065

*Note: * indicates the first time when the null hypothesis is not rejected at the 95% significance level.*

Table 7.5.2 Cointegration Test Based on Johansen's Maximum Likelihood Method, k = 4 (January 1970 to June 2008)

Null hypothesis	Alternative hypothesis		Critical Value (95%)
λ max rank tests		λ max rank value	
H_0: $r = 0$	H_a: $r > 0$	35.05097	21.13162
H_0: $r \leq 1$	H_a: $r > 1$	10.75948	14.26460
H_0: $r \leq 2$	H_a: $r > 2$	1.642065*	3.841466
λ trace rank tests		λ trace rank value	
H_0: $r = 0$	H_a: $r = 1$	47.45251	29.79707
H_0: $r = 1$	H_a: $r = 2$	12.40155*	15.49471
H_0: $r = 2$	H_a: $r = 3$	1.642065	3.841466

Normalised cointegrating coefficients (standard errors in parentheses):
INTR = 0.326207(0.08983)*INFL + 0.909211(0.14937)*UNEM

*Notes: 464 observations from 1970M1 to 2008M6. *indicates rejection of the null hypothesis at 5%.*

Table 7.7.1 Summary Results from the VECM and Diagnostic Tests (January 1970 to June 2008)

	ΔINTR	ΔINFL	ΔUNEM
ECM	0.004	-0.004	-0.0007
	(1.554)	(-2.230)	(-2.539)
R^2	0.065	0.231	0.556
S.E. of Regression	0.602	0.523	0.075

*Note: * Rejects null hypothesis at 5% significance level. t-statistics in parentheses.*

Table 7.8.1 Quantdt-Andrews Unknown Break-Point Test Results (January 1970 to June 2008)

Statistic	Value	Prob.
Maximum LR F-statistic (July 1988)	117.6630	0.0000
Maximum Wald F-statistic (July 1988)	117.6630	0.0000
Exp LR F-statistic	56.01058	1.0000
Exp Wald F-statistic	56.01058	1.0000
Ave LR F-statistic	55.76582	1.0000
Ave Wald F-statistic	55.76582	1.0000

Note: probabilities calculated using Hansen's (1997) method.

CHAPTER EIGHT

IMPLICATIONS FOR MONETARY POLICY

8.1 INTRODUCTION

In Nelson (2001: 2) it is noted that,

> "it may not be feasible to model all historical breaks in policy regime, so information about the quantitatively important breaks in policy behaviour is useful. The estimates in the present paper indicate which are the quantitatively most important shifts in policy and so can aid future work on structural modelling of the UK economy."

Goodhart (1989: 330-331) notes an, "unhelpful dichotomy, between the theory and the reality of Central Bank operations." With regard to Keynes and Friedman, he notes "practical policy matters concerning the level of short term interest rates...had no doubts that these were normally determined by the authorities, and could be changed by them, and were not freely determined in the market..." In contrast however, Goodhart (1989) also acknowledges the analysis of monetary policy decisions in terms of a growth rate for money. This bears similarities with the work of Barro (1977) on monetary policy rules. According to the MPC (1999: 69), of which Goodhart was a member, "for each path of the official rate given by the decisions of the MPC, there is an implied path for the monetary aggregates." In contrast, Nelson (2001) argues that the description of central bank behaviour in terms of a money-growth policy rule hinders many of the challenges facing the MPC. In reality, central bank decisions are more to do with changes in the level of official interest rates given information on economic activity. Leaving official interest rates unchanged for example, does not lead to constant money growth since the rate of money growth given the official interest rate. will not differ as a result of shocks to the economy. Therefore the rate of money growth does not overlap with official interest rates, which are the central bank's chosen variable. Nelson (2001: 3) further argues that much work in monetary economics before the 1990s failed to accurately describe the actual behaviour of central banks. regardless of the type of instrument and policy rules in use.

From an empirical perspective, estimates of structural economic parameters calls for an accurate characterisation of central bank decisions. This also applies to actual monetary policy over time. It might be noted, that much of the empirical evidence on monetary policy pre-dating the 1990s falls short of adopting such an approach. In many studies, the rate of money growth is included in policy rules as a dependent variable. When the emphasis of monetary policy on interest rates in policy rules became apparent, it took the form of narrowly defined official interest rates as in Poole (1970). Johnson (1972: 233), notes that "the tradition of British central banking and monetary theory...identified monetary policy with the fixing of the level of interest rates." In contrast however, this measure was often incorporated into economic models in terms of fixed interest rate levels regardless of economic activity. In Kaldor (1982) for example, monetary policy decisions are specified in terms of a fixed official interest rate at which the nominal supply of money is perfectly elastic. Goodhart (1987: 253) argues such a description of monetary policy at monthly or quarterly observations is problematic. He argues that, "I will dispute the repeated claim that the UK authorities have operated implicit interest rate targets...I cannot recall a period of open-loop fixed targets in the UK in the last eighteen years, during in which I was personally involved." As an alternative, Goodhart (1987) suggests that monetary policy was modelled in terms of closed-loop targets for official interest rates, which are adjusted in response to changes in economic activity. Such an approach is illustrated in Goodhart and Bhansali (1970). Therefore Goodhart (1987) argues that actual monetary policy decisions are not specified in terms of policy rules, which do not incorporate money-growth or narrow official interest rates. In fact, Goodhart (1987) suggests a monetary policy rule in which the official interest rate is adjusted with the aim of achieving economic stability. There is an enormous variety of policy rule specifications in the academic and empirical literature. In the Goodhart (1987) specification, an appropriate policy rule captures some of the characteristics identified by Poole (1970) such as shocks in money demand which do not lead to variability in output and inflation. Similarly, it is the stock of money rather than the official interest rate which rises as a result of a permanent fall in velocity. In addition, the appropriate policy rule does not allow for rapid money growth if for example, official interest rates are held below their natural value. According to Goodhart (1992: 324), 'I have sometimes wondered whether, starting from a presumed equilibrium with zero inflation and 3% nominal interest rates, there should not be a presumption that such interest rates should rise by one and a half percent for each one percent that inflation rises above zero, that the Governor should be asked, say twice a year, to account for any divergence from that "rule."

Goodhart (1992: 324) further notes that "in order to raise real interest rates, nominal interest rates must be raised significantly more than the prior increase in the annualised rate of growth of the RPI." In a similar vein, Taylor (1993) suggested that the official interest rate responds to annual inflation and the output gap as advocated by Goodhart (1992) in that the official interest rate responds to inflation by a magnitude of 1.5. The Taylor (1993) rule however. also incorporates a response of the output gap which is not present in Goodhart's (1992) approach. Nelson (2001), suggests that this may have been due to an appropriate measure of real aggregate demand which can be obtained on a timely basis and measured with a degree of reliability. As Orphanides (1999) argues, accurate real-time estimates of GDP are important considerations in setting official interest rates. Nelson (2001) suggests that the output gap may be missing in Goodhart's (1992) specification because of an expectation that attempts to stabilise inflation may cause output to remain close to potential. This seems consistent with the Governor of the Bank of England's (2001: 126) approach to inflation targeting as one which aims, "to keep overall demand in the economy growing broadly in line with supply side capacity." It may also be consistent with the fact that variations in the output gap may have been the result of decisions which induced large increases in inflation as was the case for example during the Lawson boom. Alternatively, this may be due to attempts to use monetary policy to control inflation after periods of excess demand as in the downturns of the early 1980s and early 1990s. Nelson (2001) argues that a response to the output gap therefore is not necessary since inflation targeting would contribute to output gap stability. Nevertheless, the Taylor (1993) rule has generated much renewed interest in estimated monetary policy reaction functions, seemingly moving the debate in the direction proposed by Goodhart (1992). This can be seen from Ireland (2001), who points out that,

> "following the publication of Taylor's (1993) original essay...Monetary economists have come to appreciate that most central banks...conduct monetary policy by managing short-term nominal interest rates rather than some measure of the nominal money supply; in addition monetary economists have come to appreciate that most central banks...systematically adjust their nominal interest rate instruments in response to output and inflation."

For empirical purposes, we treat the Taylor (1993) rule as an approximate description of central bank behaviour, which seeks to characterise a complex process using a small number of variables. The rule can also be compared to other variants such as optimal and real time rules. Therefore it is not a strict requirement that policy rule coefficients take values of 1.5 and 0.5 for inflation and the output gap respectively as in the original specification. In fact, estimates of the Taylor rule in various different formats have regularly reported higher values for one or both of the feedback coefficients in the original rule. A general observation might be, that the long-run coefficient on inflation does not ideally exceed one, such that the rule can be used to ensure that inflation equals its target value on average. This is actually a key characteristic of the policy rule advocated by Goodhart (1992) and also Woodford (2001) who calls it "the Taylor principle." The original Taylor (1993) rule emphasises a graphical match with official interest rate decisions. It has been further extended by Clarida *et al.* (2000, 1998) and Judd and Rudebusch (1998). The main findings of these studies is a large, positive coefficient on lagged values of the dependent variable. This is often considered indicative of the costs involved in adjusting money balances. However, the central bank is able to adjust official interest rates with relative ease in the short-term, making the adjustment-cost of these money demand studies applicable to an estimation of monetary policy reaction functions. Instead, the coefficient of the lagged dependent variable has been treated as an interest rate smoothing parameter where the long-run solution of such a model follows that of Taylor (1993).

8.2 JANUARY 1970 to JUNE 1976

We estimate nine separate specifications for the first sub-period of monetary policy. This consists of 78 observations. We identified two and one cointegrating vectors respectively for models one and six. The long-run estimated response to inflation in model one is 0.86 and in model six it is 0.40. However both are statistically insignificant. These contrast with long-run estimated response coefficients of 0.12 in Nelson (2001), 1.5 in Goodhart (1992) and 1.5 in Taylor (1993). Similarly the output response coefficient in model one is large and significant, taking a value of 4.77. Again this contrasts with a response coefficient of 0.57 in Nelson (2001) for the same period. In model six, the response coefficient is small and insignificant. These results do not corroborate descriptions of monetary policy during this period as outlined by Campbell (1993: 471) or Goodhart (1997: 403). In this period, the government of Edward Heath argued that it could stimulate output through the use of expansionary monetary and fiscal policies, whilst using wage and price controls to manage inflation. It might be argued that the Labour government of 1974 thought inflation in the 1970s was largely the result of autonomous changes in wages and prices and that therefore policy ought to influence the prices of individual products without resorting to monetary policy measures. Examples of non-monetary policy responses to controlling inflation include the incomes policy of the Heath

Government in 1972, the voluntary incomes policy of 1974. food subsidies in the same year and also reductions in indirect taxes. As a further example. Sir Edward Heath (1998: 405) argued that "our policy of expanding demand was essential to growth and employment and therefore broadly non-inflationary on which basis inflation resulted largely from wage settlements." The estimates for this sub-period of monetary policy are imprecise and difficult to interpret. It is difficult therefore to determine whether monetary policy was used in response to past period changes in real aggregate demand or inflation. Model seventy-three represents an estimate of a similar rule using quarterly data. Here, the long-run estimated response to inflation and the output gap is large and insignificant. Furthermore, a constant is not included. In models seventy-four and seventy-five, the long-run estimated response to inflation is 1.27 and 0.44 respectively, though both again are insignificant. Similarly for model seventy-eight, the long-run response to inflation is small and insignificant while the long-run response to output is large, but insignificant.

Estimates from the Vector Error Correction Models VECM(s) show that the coefficients and their corresponding *t*-statistics for the error correction components. These again show that the parameters for estimated policy rules are incorrectly signed and statistically insignifinicant. Thus each parameter being insignificant may also indicate that the ratio between the official interest rate and inflation and the output gap, is weakly exogenous for this model. In addition, the estimated parameter response, does not include a constant term. A second VECM reports a positively signed and significant long-run response to (forward looking) inflation and the relative unemployment measure of the output gap. Again however, both coefficients are small in size and the model does not include a constant term. For the first sub-period therefore, we are unable to identify an estimated monetary policy reaction function which conforms in any way to the Taylor principle.

The discussion now turns to a consideration of the period including monetary targeting. Overleaf is presented further evidence on the estimated long-run response parameters.

8.3 JULY 1976 to APRIL 1979

This period begins with the announcement of £M3 targeting, finishing with the month before the election of the new conservative Government. The sample consists of 34 observations estimated in models ten to eighteen. For model ten we find that the estimated long-run response to inflation and the output gap is large and insignificant and large and significant respectively. Similarly for model thirteen we find that the estimated long-run response to inflation and the output gap is 1.66 and 6.60 respectively. Although the output gap is large and significant, the inflation parameter is negatively signed and insignificant. Model fifteen shows that the long-run response to inflation and the output gap is large and correctly signed. However inflation is insignificant. For model sixteen, both long-run response coefficients are incorrectly signed and statistically insignificant. Models seventeen and eighteen do not contain a constant and their signs and magnitude remain difficult to interpret. It is therefore difficult to interpret the stance of monetary policy during this period. This sub-sample is characterised by aggressive cuts in the nominal interest rate by over 900 basis points between late 1976 and early 1978 which preceded a fall in inflation between 1977 and 1978. The estimated results for models ten to eighteen above make it difficult to determine whether or not this had any effect on controlling inflation. Similarly, inflation bottomed out at 7.6% in October 1978 before rising to 21% in May 1980. Again this is difficult to interpret on the basis of the estimates presented here. Another feature of this sub-period is the average level of interest rates. Since the Bank of England adjusts nominal interest rates, it is able to influence the short-run behaviour of real interest rates. The dataset indicates that the real rate of interest is not positive until June 1978 and that the ex-poste real interest rate only becomes positive in the same month, averaging -3.4% between 1976 and 1979. This is higher than the ex-poste real interest rate of -5.72% between 1972 and 1976. However it is again difficult to say whether or not this indicates a preference for holding nominal interest rates below actual and expected inflation for this period. For the same period using quarterly data, the results are broadly the same. Model ninety-five for instance, shows that the long-run response coefficients on the inflation and output gap are 0.25 and 0.35 respectively. Again, both parameters are statistically insignificant. The best characterisation of this period seems to be that monetary policy responds to expected (forward-looking) inflation, with a small response of the long-run coefficient on the output gap. The long-run inflation response in Nelson (2001) is 0.62 which is four times greater than the estimated response for the 1972 to 1976 period, though it is not being suggested that monetary policy was especially tight during this period. We also find that the long-run response coefficient in this sub-period does not does not rise compared to the previous sub-period. Ideally, we would like to use this finding to suggest that this might have been due to aggressive cuts in nominal interest rates amounting to over nine-hundred basis points between late 1976 and early 1978, followed by a fall in inflation from mid-1977 to late 1978. However, the parameter coefficients remain statistically insignificant and incorrectly signed. The long-run response on (backward-looking) inflation remains negatively signed and statistically insignificant and the output gap as measured by relative unemployment is positive and significant. The long-run response coefficient for industrial production however, is negatively signed and insignificant. A VECM model for this period further reinforces the lack of a viable Taylor (1993) type monetary policy rule, for which the coefficients on (backward-looking) inflation and unemployment are both positively signed but small in magnitude. Although the inflation parameter appears significant, the VECM does not include a constant.

8.4 MAY 1979 to FEBRUARY 1987

In this sub-period, ninety-four monthly observations cover the period in which the conservative government was elected and the Louvre Accord on exchange rates was agreed. The estimates for this time period do not shed any light on inflation control as an objective of monetary policy, nor on the largely floating exchange rate. It might be argued that this period should commence with the announcement of the Medium Term Financial Strategy in March 1980 and end with the abandoning of £M3 targeting in October 1985. However, substantial overshoots of the £M3 target existed as early as mid 1980, and the MTFS was revised in 1982. It also seems to be the case, that £M3 misses were tolerated before 1985 as long as other measures of monetary conditions did not suggest a loose policy stance. According to Nelson (2001), it might therefore be suggested that the 1979 to 1987 period be treated as single policy regime rather than being divided to allow for £M3. For model nineteen, the estimated long-run response to inflation is 5.52 and to the output gap it is 26.18. Both are significantly positive. Although this might be treated as the '*best*' model for this dataset, it is not corroborated by model one-hundred-and-ten, which is an estimation using quarterly data. Here, the estimated long-run response to inflation is 0.95, positively signed and statistically insignificant. Similarly the output gap is low, negatively signed and statistically insignificant. The results do not explain falls in inflation over much of the 1979 to 1987 period, by which it was down to 3.7%. The estimated models above cannot be interpreted in terms of a disinflation which was achieved by a response of the nominal interest rate to inflation of less than one. Interestingly, existing studies such as Clarida *et al.* (2000), suggest disinflation represents periods were the response of nominal interest rates to inflation is greater than one. According to the dataset, monetary policy during the early 1980s seems to point towards disinflation. Real interest rates in the same period appear high and the Taylor (1993) rule often assumes that the average real rate of interest over a period of time is equal to its steady state level. This is often assumed to range between 2% and 4%. For the 1979 to 1987 period however, ex-poste real interest rates were on average 4.66% or approximately 750 basis points above their 1976 to 1979 level. This implies that changes in nominal interest rates in response to inflation between 1979 and 1987 were less pronounced and that the average level of interest rates was conducive to a restrictive monetary policy stance. This is supported by Clarida *et al.* (1998: 1054) who argue that, "Monetary policy boiled down to keeping real rates steadily high over this period even when inflation was low during the mid 1980s." For the 1979 to 1987 sub-period, we are again unable to capture the Taylor (1993) principle. Nelson (2001), reports an estimated long-run response to inflation of 0.34 which is significantly positive and below unity. The long-run output gap response is 0.26. The estimated results in this chapter are again problematic, because inflation fell over much of 1979 and 1987, falling down to 3.7% by February 1987. This disinflation may have been the result of nominal interest rates responding to inflation with a magnitude of less than one as reported by Nelson (2001). Although Clarida *et al.* (2000) characterise this disinflation as being greater than one, we are not able to corroborate either of these findings on the basis of estimated results. An obvious question is why monetary policy achieved disinflation in the early part of this sub-period, but the estimates reported in this chapter are unable to cast any light on this. For the 1980s, monetary policy appears to be more successful in controlling inflation. This is indicated by Nelson (2001), who reports a long-run response of nominal interest rates to inflation of below unity, until the inflation targeting period of 1992.

8.5 MARCH 1987 to SEPTEMBER 1990

The next sub period consists of fourty-three monthly observations between March 1987 and September 1990. This is the period in which the pound was informally linked to the Deutschmark. More accurately, Deutschmark shadowing was adopted between 1987 and 1988 and monetary policy in the UK continued to follow German monetary policy between 1988 and 1990. According to Lawson (1992: 951), the UK "immediately followed" the German interest rate in October

1989. The estimates presented here for both monthly and quarterly data follow Clarida *et al.* (1998) and Nelson (2001), in that the UK nominal interest rate responds to the German nominal interest rate, inflation and the output gap. In model twenty-eight, the long-run response to inflation is 2.17, to the output gap it is 0.56 and to the German mark it is 1.80. Although each of these coefficients are positively signed, their *t*-statistics show that they are statistically insignificant. We found similar results for models twenty-nine to thirty-three. For models thirty-four to thirty-six, we could not identify a cointegrating vector. Once again, the results do not give an indication as to whether German monetary policy acted as a nominal anchor for the UK. Similarly, it is not possible to infer whether economic conditions in the UK remain important. This contrasts with the estimates of Nelson (2001) and Clarida *et al.* (1998), who estimate long-run responses of UK to German interest rates of 1.11 and 0.60 respectively. There is obviously a large discrepancy here and the long-run response in Clarida *et al.* (1998) could be lower because their sample period of 1979 to 1990 includes a period in which German nominal interest rates did not exert a major influence on UK monetary policy. This was the period 1979 to 1987. The second part of this sample runs from 1987 to 1990, when German nominal interest rates were of greater importance for UK monetary policy. In the late 1980s of course, inflation increased rapidly in the UK rising by over five points between 1987 and 1990. It is not known from the estimates presented here, whether this is due to an increase in money growth or some other factor.

8.6 OCTOBER 1992 to APRIL 1997

The next sub-period covers the years 1992 to 1997, in which the UK saw a shift to inflation targeting after an exit from the ERM. The long-run response coefficients reported by Nelson (2001) are also wrongly signed and insignificant. Nelson (2001) argues that a more plausible specification would be a forward-looking version of the Taylor (1993) rule. This in fact satisfies the Taylor (1993) principle with an estimated long-run coefficient on inflation and the output gap of 1.27 and 0.47 respectively. These are of course very close to the values 1.5 and 0.5 as reported by Taylor (1993) and similar to the rule proposed by Goodhart (1992). These results suggest that inflation was perhaps now better controlled. In contrast, the estimates reported in this chapter indicate the long-run response coefficient on (backward-looking) inflation is positive, but insignificant. Similarly, the long-run response coefficients on (current) inflation and unemployment are negatively signed and insignificant. Fifty-five monthly observations represent this period. Model forty-five suggests that the long-run response to inflation is 1.29 and 0.30 to the output gap. Once again, both coefficients appear statistically insignificant and the estimates do not shed any light on inflation targeting with official interest rates.

This is the period in which a new policy target was set, namely a target rate of inflation within the range of 1% to 4%. The estimates reported in this study do not indicate a long-run relationship between the nominal interest rate and the rate of inflation which mirrors this target range of between 1% and 4%. From a methodology perspective, it is interesting to note that inflation during this policy regime was measured by the 12-month increase in the RPI X which is the variable used for this period. For the 1995 period, when the inflation target became 2.5% or less we are again unable to find a long-run relationship to this effect. Given the repeated failure of the Taylor (1993) rule in this period, it might be worth considering whether other factors were at play. For example. targeting of the monetary base or sterling M3. This period also coincides with the adoption of inflation targeting in several other small open economies. It is difficult to determine whether inflation proved harder to control in this sub-period than monetary aggregates. Given the failure of the policy rule to identify any meaningful long-run relationship between the nominal interest rate and the rate of inflation, it might be worth noting that Mervyn King (1994: 123), who has been the chief economist at the Bank of England, talked about institutional changes designed to bolster the credibility of the commitment to low inflation. This may also be interpreted as a classic example of the general nature of Taylor (1993) type monetary policy rules, in the sense that for this period an emphasis on transparency and credibility may also be taken into consideration.

Since the estimates presented in this study yield little information on the nature of monetary policy, we might turn to the rate of inflation in the dataset. In September 1992, the 12 month RPIX which was the target rate of inflation, was 4% and down from the previous peak of 9.2% in November 1998. It continued to fall to around 2% in September 1994 and for most of 1995 and 1996, hovered around 2.8% before rising to 3.3% in October 1996. A further point worth noting is the fact that the time period for this sub-sample is relatively short and therefore the role of inflation expectations may also be considered. According to the Bank of England, inflation expectations suggest that short-term expectations continued to fall with regard to market interest rates after Black Wednesday, rising over most of 1994 and declining over 1985 and part of 1996. As a general remark, it might be said that this period of inflation targeting notes that monetary policy decisions were ultimately made by the Chancellor of the Exchequer, though for the purposes of credibility allowed for publication of the views by the Bank of England.

Several other developments in monetary policy making between October 1992 and April 1997 may be worth noting, which the estimates in this study failed to capture. It might be argued that the government was willing to raise the official interest rate in late 1994 and early 1995 as a means of stimulating the economy towards controlling inflation. In the summer of 1995 however, it might also be argued that the government was unwilling to raise official interest rates. Additionally, we can consider that there were cuts in the nominal interest rate between December 1995 and June 1996. It may be argued that this was in part to do with the forthcoming election. Finally it may also be argued that between December 1996 and April 1997, the government repeated repeatedly ignored advice from the Bank of England to raise interest rates. Although it has not been suggested that these observations are empirically true, nevertheless it may be argued that the data shows that it cannot be shown to be untrue either.

This period of monetary policy also saw the introduction of new arrangements for monetary policy making, which distinguish between four separate approaches. This is according to King (1997), who was an executive director at the Bank of England during this sub-period. According to King (1997), this sub-period between October 1992 and April 1997 was a relatively open one in which monetary policy was considered to be credible and predictable. In addition, the presence of any inflation target might be interpreted as an incentive to monetary policy in terms of following the first best state contingent rule. According to King (1997), some have gone further and proposed changes to give an even greater role to the Bank of England. Similarly, "a decade of growth through stability" and

> "a result of our own technical incompetence or some failure of the political process. In the latter case you may find that the Bank of England had been made independently accountable to decisions about monetary policy but that is the subject for in the lecture."

The results presented in this study might be compared to the findings of Cobham *et al.* (2001). The authors find a cointegrating vector between what they call a credibility index and the differential between UK and German interest rates. The idea here is that as credibility falls as a result of differences between the government and the Bank of England, the spread period on UK bonds over German bonds rise. Another monetary policy reaction function for this sub-period is presented by Adam *et al.* (2001), which reports a short-run parameter on the lagged dependent variable of 0.45 and an equation standard error of 0.16%. An interpretation therefore is that monetary policy was responding to factors other than the rate of inflation and the output gap.

Overall it might be noted that for this period the rate of inflation remained within a target of between 1% and 4%, achieving 2.5% during the spring of 1997 before rising again. The estimates presented in this study cannot be used to determine whether this new monetary policy regime represents an improvement on previous policy frameworks.

8.7 MAY 1997 to JUNE 2008

The final sub-period characterises the current UK monetary framework, namely inflation targeting with Bank of England operational independence. This sub-period runs from May 1997 to June 2008 and offers one hundred and thirty four monthly observations. We find that the long-run estimated response to inflation is 0.61 and to the output gap it is 1.69 in model fifty-six. Both coefficients however, are incorrectly signed. Similarly the remainder of this sample period does not produce plausible estimates for UK monetary policy and the results are largely corroborated by estimates using quarterly data. We find that the long-run response coefficients on (current and forward-looking) inflation are both correctly signed, but statistically insignificant. Similarly both unemployment and relative unemployment measures of the output gap are also insignificant and incorrectly signed. Relative unemployment however is large and significant when modelled with (backward-looking and current) inflation. Again however, this long-run response coefficient is incorrectly signed.

In this study, the Taylor (1993) rule has been treated as more of a simple estimate of the monetary policy reaction function. In the original study, Taylor (1993) uses it as a guide for policy. In other studies, the reaction function has been tested for its feasibility as a guide for monetary policy. While it might be accepted that the Taylor (1993) rule is a simple estimate of monetary policy as operated by many central banks, the estimates in this study do not support the view that these are robust descriptions of monetary policy. There are some obvious advantages for describing monetary policy in terms of a Taylor (1993) type of rule. For example, the use of simple parameters of variables based on data which is relatively easy to obtain. However the Taylor rule as estimated in this study fails to be able to explain the development of monetary policy in the UK since 1970. Studies in the academic literature do suggest that monetary policy has largely succeeded in controlling inflation. Again this cannot be confirmed on the basis of estimates presented in this study. It may be that small adaptations of the rule such as forward versus backward looking behaviour help to improve what is considered to be a simple monetary policy reaction function. The specifications in this study include backward looking, current and forward looking policy rules. However these are not able to cast any light on the robustness of the policy rule. Perhaps a similarity with Goodhart, is that monetary policy rules often break down when they are used for the purposes of controlling inflation. However, it is well-known that central banks do not set interest rates on the basis of Taylor (1993) type policy rules alone. Therefore it is difficult to determine the robustness or otherwise of the estimates presented in this paper. Some attempts in the academic literature do try and determine the robustness of monetary policy rules by including tests of statistical properties under different model assumptions such as backward looking versus forward looking models. In this regard Taylor (2001) suggests that policy rules work very well. Again the differing model assumptions of backward versus forward looking measures of inflation for example do not confirm this view. It is interesting to note that McCallum (2000: 23) argues that if the Taylor rule is valid then we can "arm a clerk with a calculator in place of a monetary policy maker. " Similarly Svensson (2001) argues that simple policy rules are inappropriate descriptions of monetary policy making. Given the failure of monetary policy reaction functions presented in this paper, it might be argued that the inflation targeting methods adopted by many central banks are a broader commitment to the targeting of a rule. Interestingly, it might seem useful to present a critical review of the Taylor (1993) rule. Perhaps it could be argued that the fate of monetary policy reaction functions are somewhat on an uncritical acceptance of the notion that there has been an improvement in monetary policy. The estimates presented in this paper may be interpreted as support for this to some extent, in terms of the attention given to the fit of estimated policy rules. A further observation relates to backward looking specifications which do not reject parameter stability. This being despite the fact that monetary policy has not been stable during some of the sample periods . The backward looking model estimated in chapter seven does not reject parameter stability and therefore does not support this position. Similarly, the operating procedures of monetary policy have undergone substantial change between October 1979 and December 1982. Nevertheless this does not violate the Chow test for parameter stability for the full sample period. Sims (2006) argues that this is due to the fact that differences in interest rate behaviour are well within the range of sampling errors. Although Sims (2006) criticises the assumption that monetary policy may have improved, he also suggests that the Taylor rule might be interpreted as a stable summary of central bank behaviour even when monetary policy is unstable and changes to monetary policy making lead to interest rate volatility. The results presented in this chapter however, are unable to support this assertion. Another observation is that if reliable estimates of Taylor (1993) type monetary policy functions were obtained, then the Taylor (1993) rule may break down as a description of central bank behaviour. This is because, economic activity would be at potential output and inflation would be on target. Therefore changes in the official interest rate would not be related to deviations of inflation from target of the output gap. In fairness, it may be argued that Taylor (1993) type rules are useful for central banks who are not able to identify and offset shocks. For example, Mervyn King (1999) has suggested that "central banks that have been successful appear ex post to have been following a Taylor rule even if they had never heard of that concept when they were actually making decisions." Of course in a Taylor (1993) type policy rule, the nominal interest rate is adjusted in response to expected deviations of inflation from target and the output gap. Nevertheless there is quite a difference between the use of estimated monetary policy reaction functions to describe the past behaviour of central banks compared to their use of it before as a forecasting device for future decisions.

8.8 CONCLUSION

This section aimed to characterise the behaviour of monetary policy making in the UK between 1970 and 2008, using Taylor-type monetary rules. We estimated six separate regimes using both monthly and quarterly data. A summary of these results are presented in Appendix Three. It can be seen that the results do not fit with the original Taylor (1993) rule and do not correspond to similar estimates in other studies. The first sample sub-period for example, is characterised by high inflation as illustrated by the original dataset. According to Nelson (2001), there is also a near-zero response of official interest rates to the rate of inflation. This represents a Taylor (1993) rule principle in which inflation is controlled when this response is greater than one. The estimates presented here show that monetary policy reaction functions do not capture such behaviour. In addition, the estimates presented here do not identify a Taylor (1993) rule which corresponds to the period of no inflation from 1992. In other words, the estimates here do not show a response greater than unity. Furthermore, these estimates do not conform to those suggested by Goodhart (1992). Similarly we did not find periods of restrictive monetary policy where the response of the nominal interest rate to inflation was greater than one. In addition, the effects of contractions in monetary policy in 1979 which resulted in increases in average real interest rates were not identified. This contraction is not captured by the increase in an estimated inflation response parameter. The results here are of relevance to Goodhart (1992) who has also been involved in monetary policy making at the Bank of England from the early 1970s to the mid 1980s. Goodhart (1992) is known for his criticisms of monetary analysis in the 1970s and 1980s. The results here are therefore relevant in the sense that they might also be interpreted as a response to some of these criticisms. Furthermore, much of the sample period used in this chapter covers the development of monetary policy in the UK between the early 1970s and the late 1990s. In 1997 of course, the Monetary Policy Committee was established and Goodhart contributed to decision making. More specifically, Goodhart served as a member of the MPC between 1997 and 2000. Therefore the estimates presented in this chapter extend the previous analysis of Nelson (2001) by covering this period. Inflation between 1972 and 1990 was generally high and monetary policy non-optimal. A further disadvantage of the estimates presented in this chapter is that they do not identify some of the structural features of price and output in the

UK economy. An example of this is the Smets and Wouters (2001) study, which decomposes inflation in the Euro Zone for the period 1973 to 1998. This study specifies a policy rule as part of a structural model which allows the parameters to be disentangled from those representing price and spending.

CHAPTER NINE

INTEREST RATE PASS THROUGH IN THE UK

9.1 INTRODUCTION

Overall, the transmission of official interest rates to the wider economy varies from economy to economy but depends to some extent on the differences in institutional setups as highlighted by Britton and Whitley (1997). The main transmission of the nominal interest rates in the UK is through demand and to a lesser extent the price of imports. The transmission of official interest rates to demand in the economy takes place through wealth effects, exchange rates and the cost of credit. The primary link between nominal interest rates and the wider economy is the transmission of official interest rate decisions to market interest rates. This includes bank loans, asset prices and savings accounts. The exact nature of this relationship is far from clear and an objective of this chapter is to try and determine the extent of interest-rate pass through. A more formal explanation of the transmission of nominal interest rates to market interest rates is provided by Dale and Haldane (1993: 3). The authors show that changes in nominal interest rates actually represent changes in the rate at which banks are able to access liquidity. According to Mervyn King (1994: 264), "the bank supplies base money on demand at its prevailing interest rate, and broad money is created by the banking system." For the sample period under consideration in this chapter, the Bank of England has used the gilt repo rate for buying and selling government bonds. According to the Bank of England (1997), these are typically for fourteen-day securities. Changes in the gilt repo rate are transmitted to market interest rates through short-term money markets and expectations. A key question in the interest-rate pass through literature is the exact impact of official interest rates on market interest rates, with the resulting impact on the effectiveness of monetary policy. Another obvious question is how to determine an appropriate relationship between nominal and market interest rates. This is all the more interesting for the current time period adopted in this study which reflects, a more open emphasis on the transmission of nominal interest rates to market interest rates relative to previous monetary policy regimes. As discussed in chapters two and eight, monetary policy in the UK over the last three to four decades has focused on money and credit growth. In the early 1980s for example, monetary targets were an explicit policy objective. The current monetary policy committee set-up still observes the growth rate of credit when deciding on adjustments in the official interest rate.

One such explanation of this is offered by Mariscal and Howells (2002). In terms of a flow of funds identity, which decomposes changes in money stock into credit counterparts and changes in bank lending into non-bank private sector which is the primary source of monetary growth. If an increase in the nominal interest rate is passed through to retail banks, say for example in the form of an increase in interest rates on loans, then we move up the demand curve for bank loans and the flow rate of new loans and therefore deposits is hence reduced. It seems that banks have in most cases generally passed on such changes since the early 1970s. There are however, exceptions to this as well as some technicalities such as loan demand elasticity. Prior to competition and credit control, retail banks paid interest on a subset of deposits and even here at rates which were lower than non-money liquid assets. As a result, an increase in retail bank interest rates was transmitted more easily into the interest rate on loans and to interest rates on non-money assets rather than to money itself. Although the 1970s brought increased competition between banks for wholesale deposits, this relationship held for the 1970s albeit less strongly. A second observation is that an increase in retail bank interest rates also increases the opportunity cost of money, thereby leading to a change from money to non-money assets. In the 1980s of course, the banking system was characterised by deregulation which led to increased competition between banks and building societies for retail deposits. In relation to these changes over the decades, it is interesting to note Goodhart (1984), who comments that,

> "it is not that the demand for lending has become less sensitive to changes in relative interest rates. If anything, it has become more so. The problem lies in the increasing inability of the authorities to cause changes in relative rates by changing the level of absolute rates."

9.2 LITERATURE REVIEW

In this section, we present a review of the empirical literature on interest-rate pass through and discuss the implications of these findings for monetary policy making. The empirical evidence suggests that interest-rate pass through is incomplete, especially in the US. It also seems that a limited degree of interest-rate pass through has an effect on the so-called Taylor (1993) principle. When interest-rate pass through is complete, an implication of the Taylor (1993) principle is that the official interest rate increases by more than unity in response to an increase in expected inflation. If interest-rate pass through is not complete, then official interest rates should respond by an amount greater than unity. The importance and relevance of interest-rate pass through lies in the fact that monetary policy has an effect on the economy through multiple channels of transmission. One such channel is of course the interest-rate channel, where changes in the official interest rate have an effect on short-term market rates, which in turn have an effect on market rates such as mortgage interest rates in the medium to long term. The focus of this chapter is on the relationship between the official interest rate and mortgage interest rates (both bank and building society), loan rates and also deposit rates. In keeping with chapter eight, the objective is to survey the literature in order to develop an understanding of the degree to which interest-rate pass through takes place, and to then consider some of the implications of this for monetary policy. The empirical literature on interest-rate pass through is large. Studies suggest that the adjustment in bank rates is not complete when market rates change. The literature also seeks to explain the reason for this incompleteness. Allen and Gale (2000) for example, suggest that this may be interpreted as an implicit contract between retail banks and their customers, which is the result of a long-run relationship. In other words, banks which have close or long-standing relationships with their customers are able to offer relatively stable interest rates which help to protect them from volatile market interest rates. According to Hofmann (2004), incomplete interest-rate pass through may be the result of adjustment costs such as labour, computing or menu costs, which cause retail banks to adjust interest rates only relatively infrequently. Even then, only when the expected gain exceeds the associated cost. A further explanation for incomplete interest-rate pass through relates to asymmetric information and moral hazard. The idea here is that retail banks have little incentive to raise retail interest rates because borrowers who accept such offerings are likely to be of poor quality, more likely to engage in risky projects and decrease the expected value of the amount repaid. Another view. is that incomplete interest-rate pass through allows banks to absorb all volatility in the sector. Hence incomplete interest-rate pass through might pose problems for the stability objective of monetary policy. This suggests that changes in short-term market interest rates as a result of changes in the official rate are not completely transmitted to the economy and that incomplete interest-rate pass through also changes the so-called Taylor principle. Whether this is an important requirement for economic stability is unknown. At least two approaches to interest-rate pass through can be identified from the empirical literature. According to Sander and Kleimeier (2004), these are the "cost of funds approach" and be the "monetary policy approach" The former is concerned with the pricing decisions of banks and is largely concerned with the opportunity cost to banks for issuing loans under the costs of financing deposits. An important characteristic of this approach is the maturity of retail interest rates. de Bondt (2005) for example, argues that there must be some degree of maturity between retail banks and mortgage interest rates. For example, mortgage loans are more usefully explained in terms of long-term rather than short-term interest rates. In contrast, the monetary policy approach is more concerned with the effect of official interest rate decisions on retail interest rates and does not include any other explanatory variables. The main emphasis of this on determining the relationship between retail interest rates and official interest rates. According to Cottarelli and Kourelis (1994), empirical estimates of interest-rate pass through in the literature can be explained in terms of the following equation:

$$\Delta r_t = c + \sum_{j=0}^{n} \alpha_j \Delta i_{t-j} + \sum_{k=1}^{m} \beta_k \Delta r_{t-k} + \gamma(r_{t-1} - i_{t-1}) \quad (1)$$

where r_t represents retail bank interest rates, i_t represents official interest rates and Δ represents the difference term. A general observation from the empirical literature, is that retail interest rates and official interest rates are integrated of order one. It is therefore appropriate to estimate the equation above in first differences so that spurious regression can be avoided. This issue has also been covered in chapters seven and eight. Returning to the existing evidence, changes in retail bank interest rates are explained by changes in official interest rates, the persistence of changes in retail bank interest rates and also error correction mechanisms which account for long-run relationships between retail bank interest rates and official interest rates. The optimal number of lags are selected according to the AIC, which has also been explained in chapters seven and eight. Briefly therefore, the objective for estimating the above equation is to determine the degree of interest-rate pass through which is given by α_v. This represents the response of retail bank interest rates to a change in the official interest rate for a given time period. λ represents the long-run multiplier as explained in equation to and also in chapter seven. This represents the amount of change in retail bank interest rates in response to a change in the official interest rates by 100 basis points. The long-run multiplier can be denoted as:

$$\lambda = \frac{\sum_{j=0}^{n} \alpha_j}{1 - \sum_{k=1}^{m} \beta_k} \quad (2)$$

where α_j and the β_k represent the coefficients on the official interest rate and the retail bank interest rate respectively. In addition, n and m represent the number of lags selected when estimating equation 1. If the long run interest-rate pass through coefficient returns a high value, this might be the result of direct effects which are passed through from official interest rates to retail bank interest rates, or a high degree of persistence in retail bank interest rates. If, when λ =1 equals one, interest-rate pass through is said to be complete and in the long-run, changes in official interest rates up to the full extent are transmitted to retail bank interest rates. Since there is a close movement between official interest rates and retail interest rates such as the three-month money market rate, money market rates are also used to represent official policy rates. Also, official interest rates might be said to be relatively constant for longer periods of time, changing only when monetary policy decisions are made. It might be argued that this makes them less suitable for the purposes of interest-rate pass through but there is no firm consensus. As a result, some studies use money market interest rates rather than official interest rates. According to the empirical literature, interest-rate pass through seems to give differing results depending on the type of retail interest rate that is selected. For example, the interest rates on deposit accounts with a maturity of less than three months appear relatively constant with a low degree of pass through. On the other hand, interest rates on time deposits with a maturity of less than two years, seem to track money market interest rates more closely. Evidence from retail lending rates seems to report a similar picture. Interest rates to households for the purposes of loans do not appear to fluctuate significantly, thus reflecting a low degree of interest-rate pass through. Interest rates on short-term loans to businesses however, move closely with money market interest rates.

Therefore these differences in the extent of interest-rate pass through depending on the type of retail interest-rate which is used, are a common finding in the literature. For example, Mojon (2000), Sander and Kleimeier (2004), de Bondt (2005) and Kwapil and Scharler (2006) suggest that deposit rates with short term maturities have lower interest-rate pass through compared to deposit rates with longer maturities, such as time deposits. In addition, Sander and Kleimeier (2004), de Bondt (2005) and Kwapil and Scharler (2006), also find that interest rates on short-term loans to businesses indicate a higher degree of interest-rate pass through compared to medium and long-term interest rates. In addition most of the studies in the empirical literature uses monthly data. This might be interpreted as implying that the immediate interest-rate pass through is a reflection of the response of retail bank interest rates to changes in money market interest rates within the same month. There are of course some exceptions, such as Mojon (2000) reports a response exceeding three months, and also Kaufmann and Scharler (2006) who use quarterly data. In this latter study, the response of interest-rate pass through takes place within the first quarter. It might also be worth noting, that there does not exist a firm consensus in the empirical literature as far as econometric methodology is concerned. For example, most of the authors and studies cited above, estimate interest-rate pass through using different time periods and data sources. In addition, some use aggregate variables while others use averages, with still some others using proxy variables. Therefore in terms of the studies cited above, the evidence might more accurately be interpreted as a range of interest-rate pass through coverage rather than in the long-run estimates of official interest rate or retail bank interest rate variables. Nevertheless, an observation of the above studies seems to be that responses of retail bank interest rates to changes in money market interest rates takes place with time lags and does not happen instantaneously. This may be due to the fact that interest-rate pass through in the short-term is smaller than interest-rate pass through in the long-run. This seems to be particularly the case for deposit interest rates and lending interest rates. Another observation of the above studies, is that short-run interest-rate pass through seems to be less than 0.6 for each study. This implies that just more than half of the change in market interest rates is immediately passed through to retail bank interest rates. For interest-rate pass through in the long-run, the range of estimates is larger. Nevertheless, the results seem to suggest on the whole, that interest-rate pass through in the long-run is less than one and therefore incomplete. There are of course exceptions to this finding, so a preliminary interpretation of this may be that retail banks seek to absorb such changes as a result of volatility in market interest rates. In keeping with the discussion presented in chapter eight, an interesting question is the implications of interest-rate pass through for monetary policy. This is especially relevant, since interest-rate pass through appears to be incomplete according to the empirical literature. For example, retail banks matter for the purposes of monetary policy transmission, especially given their role in financial intermediation. A further observation however, is that if interest-rate pass through is limited or incomplete, then this implies that monetary policy is effective in so far as official interest rate changes are not fully passed through to short-term market interest rates and therefore the economy.

Again, in keeping with chapter eight, the Taylor (1993) principle implies that official interest rates must respond by an amount greater than unity in response to changes in the rate of inflation. In other words, if the official interest rate does not adjust accordingly, then an expected rise in inflation will result in a decrease in the real interest rate, which stimulates aggregate demand. If aggregate demand increases, then the result is an increase in inflation. To illustrate this point, we can return to the Taylor (1993) rule as a description of monetary policy, presented in chapter five. In the original equation, i_t represents the nominal or official interest rate targeted by the central bank, ρ represents the extent of monetary policy inertia and k_n and k_y represent the response of monetary policy to changes in inflation π_t and the output gap y_t respectively. Here, the Taylor (1993) principle is satisfied if k_n is greater than one. Conversely, an increase in the rate of inflation leads to an increase in the official interest rate by an amount which is less than unity, thus leading to a reduction in the real interest rate. However, Kwapil and Scharler (2006) note that even when monetary policy is sufficiently restrictive, retail interest rates will not respond such that real interest rates become stable. In this instance, the authors suggest a modified Taylor (1993) principle where λ represents the long-run interest-rate pass through to retail interest rates. To illustrate, when the value of λ is low there is no change in the official interest rate, which is generally absorbed by the banking sector. Therefore if expected inflation increases, monetary policy is tightened in order to stabilise aggregate demand. When λ equals one, interest-rate pass through to retail interest rate is complete in the long-run, which helps to derive the Taylor (1993) principle.

As noted earlier, an objective of this chapter is to determine the implications of interest-rate pass through for monetary policy. The studies surveyed above suggest that interest-rate pass through from official interest rates to retail bank interest rates in the long-run appears to be higher for the U.S compared to the Euro zone. In addition, retail interest rates and therefore the banking sector as a whole, have a relatively minor influence on aggregate demand for the U.S. See for example Allen and Gale (2000).

9.3 DATA AND MODEL SPECIFICATION

An objective in this section then is to estimate the relationship between the official interest rate and a series of retail bank interest rates. There are many studies in the academic literature which suggest that official interest rates are integrated of order one variables. See for example Hall *et al.* (1992). This was also confirmed in the empirical estimates presented in chapter seven earlier. For our first model, we begin with a consideration of lag structure, in particular the lag length criteria required for an estimation of the interest-rate pass through equation. We select a default lag length of eight when performing the lag order selection test for the VAR, which returns an optimal lag length of two as indicated in Tables 9.5.1 below. A similar result is obtained for model two which includes a standard variable rate mortgage as provided by building societies compared to banks. Having determined an optimal lag length of two, we are able to prepare for cointegration testing again beginning with model one. For deterministic trend selection, we again apply the Pantula (1989) principle as discussed in chapter seven. This suggests a cointegration test be performed using a deterministic trend assumption whereby we include an intercept but no trend in the cointegrating equation and no intercept in the VAR. The results are presented in 9.6.1 and 9.6.2 below. For our first model, the trace test indicates one cointegrating equation at the 5% level of significance and this is also confirmed by the maximum eigenvalue test. For our second model, we were unable to identify a cointegrating vector according to both trace and maximum eigenvalue statistics. We present a normalised cointegrating equation in table 9.7.1 below which suggests that the long-run response coefficient on standard variable rate mortgages from banks is 1.3. Although this is correctly signed and large, it remains statistically insignificant. We observed similar patterns for the loans variable which reports a long-run response coefficient of 0.098 which again is statistically insignificant. The long-run response coefficient on bank deposits is negatively signed where the point estimate is 0.323 and again statistically insignificant. Table 9.7.2 reports the results of a vector error correction model for our first equation. Here we find that the standard variable rate mortgage as offered by banks and deposit interest rates are positive, small in magnitude and statistically significant. Returning to our second equation where the official interest rate responds to changes in standard variable rate mortgages as offered by building societies, interest rates on deposits and interest rates on loans, it was noted earlier that we were not able to identify a cointegrating vector. Therefore the analysis proceeds along the lines of an unrestricted VAR in first differences. This is estimated as:

*INTR = 1.21748756185*INTR(-1) - 0.295496069439*INTR(-2) + 0.314168293514*SVRS(-1) - 0.247631739456*SVRS(-2) - 0.00432710961534*DPST(-1) - 0.0138003070358*DPST(-2) + 0.0228795023071*LOAN(-1) - 0.0196754671605*LOAN(-2) - 0.0423896709931*

The results from this VAR suggests that the standard variable rate mortgage variable responds with a magnitude of 0.3 at one lag. The t-statistic on this variable is 2.64 and statistically significant. At two lags, the standard variable rate mortgage building societies is negatively signed. The deposit rate at both lags one and two is again negatively signed, small and statistically insignificant. We also find that the loan rate variable is small, positive at one lag, negative at two lags and statistically insignificant in both cases.

9.4 ESTIMATION AND RESULTS

Table 9.4.1 Kwiatkowski-Phillips-Schmidt-Shin test results (January 1995 to December 2007)

Unit-root tests in levels

Variables		*Constant*	*Constant and trend*
Interest rate	*(Rt)*	*0.865*	*0.185*
Bank mortgage rate	*(BRt)*	*0.677*	*0.176*
Building society mortgage rate	*(SRt)*	*0.783*	*0.210*
Personal loan rate	*(LRt)*	*1.314*	*0.246*
Deposit rate	*(DRt)*	*0.619*	*0.229*

Unit-root tests in first differences

Variables		*Constant*	*Constant and trend*
Interest rate	*(Rt)*	*0.103*	*0.076*
Bank mortgage rate	*(BRt)*	*0.136*	*0.064*
Building society mortgage rate	*(SRt)*	*0.192*	*0.073*
Personal loan rate	*(LRt)*	*0.170*	*0.062*
Deposit rate	*(DRt)*	*0.179*	*0.052*

*Notes: * Denotes significance at the 5% level and rejection of the null hypothesis of stationarity. Critical values obtained from Fuller (1976) are 0.463 and 0.146 for the first and second model respectively. Optimal lag lengths chosen automatically using the AIC.*

Table 9.4.2 **Augmented Dickey-Fuller test results (January 1995 to December 2007)** **AIC Criterion**

Unit-root tests in levels

Variables		*Constant*	*Constant and trend*	*None*
Interest rate	*(Rt)*	*-2.382*	*-2.799*	*-0.456*
Bank mortgage rate	*(BRt)*	*-2.689*	*-2.706*	*-0.497*
Building society rate	*(SRt)*	*-2.448*	*-2.322*	*-0.650*
Personal loan rate	*(LRt)*	*-2.499*	*-1.826*	*-1.753*
Deposit rate	*(DRt)*	*-2.546*	*-2.285*	*-0.956*

Unit-root tests in first differences

Variables		*Constant*	*Constant and trend*	*None*
Interest rate	*(Rt)*	*-4.237**	*-4.172**	*-4.250**
Bank mortgage rate	*(BRt)*	*-3.388**	*-3.499**	*-3.395**
Building society rate	*(SRt)*	*-3.265**	*-3.431**	*-3.264**
Personal loan rate	*(LRt)*	*-4.108**	*-4.453**	*-3.848**
Deposit rate	*(DRt)*	*-3.640**	*-3.822**	*-3.646**

*Notes: * Denotes significance at the 5% level and rejection of the null hypothesis of stationarity. Critical values obtained from Fuller (1976) are -2.881, -3.441 and -1.943 for the first, second and third model respectively. Optimal lag lengths chosen automatically using the SBC.*

9.5 LAG LENGTH DETERMINATION

Table 9.5.1 **VAR Lag Order Selection Criteria (January 1995 to December 2007)**

Endogenous variables: INTR SVRB LOAN DPST
Exogenous variables: C
Sample: 1995M01 2007M12
Included observations: 148

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-399.4680	NA	0.002742	5.452271	5.533276	5.485183
1	420.4992	1584.531	5.24e-08	-5.412151	-5.007123	-5.247589
2	492.7661	135.7447*	2.45e-08*	-6.172516*	-5.443464*	-5.876304*
3	506.8397	25.67468	2.52e-08	-6.146482	-5.093408	-5.718620
4	515.7666	15.80306	2.78e-08	-6.050900	-4.673802	-5.491388
5	526.5462	18.50005	2.99e-08	-5.980353	-4.279233	-5.289192
6	540.7842	23.66592	3.08e-08	-5.956543	-3.931400	-5.133732
7	555.9677	24.41676	3.14e-08	-5.945510	-3.596343	-4.991049
8	572.6538	25.93114	3.14e-08	-5.954782	-3.281592	-4.868671

* indicates lag order selected by the criterion

Table 9.5.2 **VAR Lag Order Selection Criteria (January 1995 to December 2007)**

Endogenous variables: INTR SVRS LOAN DPST
Exogenous variables: C
Sample: 1995M01 2007M12
Included observations: 148

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-434.1201	NA	0.004379	5.920542	6.001547	5.953454
1	320.8785	1458.984	2.02e-07	-4.065926	-3.660897	-3.901363
2	412.5911	172.2710	7.25e-08*	-5.089069*	-4.360018*	-4.792857*
3	426.7525	25.83483	7.44e-08	-5.064222	-4.011148	-4.636361
4	434.2515	13.27529	8.36e-08	-4.949344	-3.572247	-4.389833
5	445.4306	19.18578	8.96e-08	-4.884197	-3.183077	-4.193036
6	466.5013	35.02294*	8.41e-08	-4.952720	-2.927577	-4.129909
7	482.0158	24.94903	8.53e-08	-4.946160	-2.596993	-3.991699
8	496.6996	22.81941	8.77e-08	-4.928373	-2.255184	-3.842263

* indicates lag order selected by the criterion

9.6 DETERMINISTIC TRENDS

Table 9.6.1 **The Pantula Principle for Interest Rate Pass Through, $k = 2$ (January 1995 to December 2007)**

H_0	r	$n-r$	*Model 2*	*Model 3*
λ max test				
	0	3	32.26728*	32.02747
	1	2	12.39316	12.37313
	2	1	8.471204	8.395329
	3	0	6.231944	3.685051
λ trace test				
	0	3	59.36358*	56.48098
	1	2	27.09631	24.45351
	2	1	14.70315	12.08038
	3	0	6.231944	3.685051

*Note: * indicates the first time when the null hypothesis is not rejected at the 95% significance level.*

Table 9.6.2 The Pantula Principle for Interest Rate Pass Through, $k = 2$ (January 1995 to December 2007)

H_0	r	$n-r$	Model 2	Model 3
λ max test				
	0	3	16.43155	16.14362
	1	2	13.18791	13.18521
	2	1	8.664019	6.145208
	3	0	3.494319	3.394192
λ trace test				
0	3	41.77780	33.86823	
1	2	25.34625	22.72461	
	2	1	12.15834	9.539400
	3	0	3.494319	3.394192

*Note: * indicates the first time when the null hypothesis is not rejected at the 95% significance level.*

9.7 COINTEGRATING VECTORS

Table 9.7.1 Cointegration Test Based on Johansen's Maximum Likelihood Method, $k = 2$ (January 1995 to December 2007)

Null hypothesis Value (95%)	Alternative hypothesis	Critical
λ max rank tests		λ max rank value
H_0: $r = 0$	H_a: $r > 0$	32.26728*
H_0: $r \leq 1$	H_a: $r > 1$	12.39316
H_0: $r \leq 2$	H_a: $r > 2$	8.471204
H_0: $r \leq 3$	H_a: $r > 3$	6.231944
λ trace rank tests		λ trace rank value
H_0: $r = 0$	H_a: $r = 1$	59.36358*
H_0: $r = 1$	H_a: $r = 2$	27.09631
H_0: $r = 2$	H_a: $r = 3$	14.70315
H_0: $r = 3$	H_a: $r = 4$	6.231944

Normalised cointegrating coefficients (standard errors in parentheses):
INTR = -4.735233 (0.43116)*C + 1.301327 (0.08923)*SVRB + 0.098562 (0.01270)*LOAN – 0.323015 (0.11152)*DPST

*Notes: 464 observations from 1970M1 to 2008M6. *indicates rejection of the null hypothesis at 5%.*

Table 9.7.2 Summary Results from the VECM and Diagnostic Tests (January 1995 to December 2007)

	ΔINTR	ΔSVRB	ΔDPST	ΔLOAN
ECM	0.135096	0.194622	0.171733	-0.301074
	(1.46171)	(5.54998)	(2.75719)	(-1.44201)
R^2	0.293081	0.883699	0.550087	0.153644
S.E. of Regression	0.129883	0.049280	0.087530	0.293409

*Note: * Rejects null hypothesis at 5% significance level. t-statistics in parentheses.*

9.8 CONCLUSION

The results here might be contrasted with existing empirical studies such as Mizen and Hofmann (2002). In this study, initial unit root tests suggest that non-stationarity cannot be rejected according to the ADF and Phillips-Perron tests. This is followed by a cointegration test after Johansen as illustrated above. The VAR specifications in this study also restrict the constant thus assuming that there is no deterministic trends in the interest rate variable. The optimal lag length is also determined in a similar manner to that used in this chapter, namely a SBC information criteria. In keeping with the results presented in this chapter, Mizen and Hofmann (2002) also find that a lag order of two for and deposits and mortgage rates, although they find a lag order of three for building society retail interest rates. The authors find that the null of no cointegration is rejected in all cases. The hypothesis in each case here, is that the long-run pass through is complete, in other words that the long-run coefficient on base rates equals one. This hypothesis is rejected for bank mortgage interest rates but imposed in all other cases. The authors also found that according to t-statistics, the official interest rate is considered to be weakly exogenous. This is illustrated by the fact that the adjustment coefficient of the base rate to the long-run relationship is always insignificant. Authors such as Johansen (1995) and Boswijk (1996) note that if a model parameter is weakly exogenous, then this implies that the long-run relationship is excluded from the marginal process and a model consisting of the remaining endogenous variables can be used to estimate the parameters. The authors use Johansen's weak exogeneity test to determine whether or not the base rate is exogenous and whether retail interest rates are endogenous variables. This is confirmed in the Mizen and Hofmann (2002) study. A second test by the authors to confirm cointegration, includes the use of an ARDL model to estimate long-run coefficients. This incorporates a series of unit root test statistics of long-run residuals obtained from conventional Phillips-Perron tests and also the *t*-statistics of error correction coefficients. The authors show that the results obtained from ARDL estimates are very similar to those provided by the Johansen cointegration approach.

In conclusion, it might be noted that monetary policy operates through changes in official interest rates which are then used to influence short term interest rates. An assumption in the academic literature seems to be that there exists a complete transmission of official interest rate changes to short term interest rates within a short period of time. If interest-rate pass through is complete, then monetary policy is more efficient in controlling inflation. Models of interest-rate pass through in the academic literature test for this relationship using a variety of approaches including linear or asymmetric adjustment processes. This chapter has sought to apply a conventional OLS time series approach using cointegration and error correction methods. Preliminary estimates of the relationship between the level of each type of retail interest rate suggests that complete interest-rate pass through is not the long run norm for mortgage interest rates offered by either banks or building societies, or for loans and deposits.

CHAPTER TEN

CONCLUSION

10.1 INTRODUCTION

This final chapter presents a conclusion to the thesis. It begins with a re-statement of aims and objectives in section two below, followed by a discussion of the conclusions drawn from the research. These can broadly be defined in terms of the theoretical readings and policy analysis. The former relate to the development of monetary policy, money in an endogenous framework, inflation targeting and monetary policy rules The latter relate to initial econometric analysis of the time series properties of Taylor (1993) monetary policy reaction functions, their implications for central bank decision making and the extent of pass through from official interest rates to market instruments. Section three outlines the original contributions made to existing knowledge from stationarity, cointegration and error correction estimates, and also discusses some of the shortcomings associated with the techniques adopted in this regard. Section four summarises the chapter with an overall conclusion.

10.2 RE-STATEMENT OF AIMS AND OBJECTIVES

Returning to the introduction and outline plan of study in chapter one, the aim of this study was to present an overview of monetary policy in the UK over the last three to four decades. It sought to do this in terms of an analysis of expansionary monetary and fiscal policies and also competition and credit control measures. It further aimed to determine the theoretical origins of monetary policy as well as the various types of monetary policy targets and rules adopted. In addition the thesis aimed to analyse inflation targeting and instrument independence at the bank of England. A further aim was to develop the theoretical basis of research and this was done with readings in endogenous money theory. The objective here being to discover the new consensus in monetary policy as well as the transmission channels. The thesis also aimed to look at endogenous money from a Keynesian perspective and a further objective was to introduce monetary policy rules as a means of estimating Taylor type reaction functions in forthcoming chapters and these are presented in chapter four. The objective here was to determine some of the modelling issues that may or may not be encountered in chapters seven, eight and nine. A further objective was to consider inflation targeting in the new consensus framework and the objective here was to further discover theoretical aspects such as the nominal anchor, real and monetary factors, the causes of inflation and also inflation and the monetary policy transmission mechanism. The objective here was to introduce further empirical evidence on inflation targeting which covered macro-econometric modelling and also inflation targeting in terms of single equation techniques. The next objective was to determine the data and research method to be used for this study. This included various different measures of Taylor type policy parameters, the important issue of periodisation or breaking the data into manageable regimes, and the use of descriptions from the academic literature as well as econometric techniques such as structural break analysis. The aim then was to present an initial econometric analysis in chapter seven, the objective being to determine the underlying time series properties of Taylor (1993) type policy rules as applied to the UK. This was followed by a discussion of the implications of such findings for monetary policy. Here it was noted that the estimation of Taylor type monetary policy rules for the sub-periods under consideration is problematic and that therefore any conclusion that may be drawn on the behaviour of central bank policy making is subject to doubt. The next aim was to determine the extent of interest-rate pass through in the UK and the objective here was to review the literature and provide some further analysis. This suggested that interest-rate pass through is not complete in the UK.

10.2.1 CONCLUSIONS DRAWN FROM RESEARCH

It has been shown from chapter two, that the theoretical origins of monetary policy targets can be traced back to analyses by Friedman (1960), Poole (1970), Friedman (1975), Simons (1936), Friedman (1948 and 1953), Phelps (1967), Friedman (1968), Lucas (1972), Kydland and Prescott (1977). In each of these studies the debate concerns the rate of growth of the money supply being constant and equal to the underlying rate of productivity growth as in Friedman (1960). Poole (1970) on the other hand places greater importance on income stability relative to the control of inflation, and Simons (1936) argued that monetary policy rules exist to prevent monetary policy being subject to political bias. Friedman (1948, 1953) furthered debate by introducing the importance of policy lags as a means of destabilising discretionary monetary policy and Phelps (1967) and also Friedman (1968) who suggested that monetary policy is only effective in the short run. For Lucas (1972) it was argued that monetary policy is not effective even in the short run whereas Kydland and Prescott (1977) argued strongly for the use of monetary policy rules or targets using a time inconsistency approach. More contemporary conclusions were offered by Bean (1998) and suggested that an operationally independent central bank is a solution to the problem of time inconsistency. A further outcome was that three specific types of pre-announced monetary policy targets were adopted in the UK over the last 30 years and these were monetary, exchange rates and inflation rate targets as illustrated by Cobham (2002). The second set of findings drawn from the research concern monetary policy rules. Here monetary rules were defined as "instrument rules" which allow for changes in the monetary policy instrument in response to economic events. This definition was attributed to Svensson (1999) and illustrated by McCallum (1988) using the monetary base growth as an example of achieving a target level of nominal income. A further outcome regarding monetary policy rules was the importance of controlling the monetary base, a policy not adopted in the UK but as Goodhart (1994) noted, a risky policy prescription. In addition, the Taylor (1993) rule is perhaps the most popular monetary policy rule of recent times in which the policy interest rate responds to deviations of inflation from target and of output from trend. The conclusion of this section was that the Taylor (1993) rule has subsequently been adopted and modified in a variety of studies, examples being Clarida *et al.* (1999) and Ball (1999). Critiques and assessments of this rule include Svensson (2000) and Nelson (2001). The next set of outcomes concern the development of monetary policy in the UK between 1975 and 2008. The main conclusion here was that the UK has experienced a variety of monetary policy regimes over this period. These include monetary targeting, boom and bust, Deutschemark shadowing, membership of the ERM, and inflation targeting. A further point on inflation targeting was the fact that policy was initially adopted by the government in 1992 with operational independence being granted to the Bank of England in 1997. The overall conclusion of chapter two is that a large number of monetary policy regimes have been experimented with in the UK, each with varying degrees of success.

The next objective was to consider the role of monetary policy in controlling inflation in an endogenous money framework. The importance of money in a Keynesian framework was illustrated in terms of this variable being bank money rather than an exogenously controlled stock. More importantly, the role of endogenous money as an illustration of the current inflation targeting framework in the UK was illustrated. Here the new consensus and the Keynesian approach to bank money were represented as two schools of thought treating money as endogenous. The main difference between the two was illustrated in terms of the endogeneity of money, namely that money is created endogenously in the new consensus framework, the stock of money being a residual based on the demand for money, and the stock of money not having a causal relationship with inflation. The rate of interest on the other hand is bank rather than market determined. Conversely, in the Keynesian approach money was shown to be determined by the banking sector in the sense that the central bank determines the discount rate and supplies reserves to commercial banks. Such loans are then supplied by commercial banks with a markup over the discount rate, this being determined by several factors including the market power of banks, liquidity preference and also risk assessment. In contrast to the new consensus approach, the Keynesian method was shown to emphasise the importance of loan and deposit creation and removal, and also the causal relationship between investment spending and loan creation, and inflation and the creation of money. In both schools of thought monetary policy is interest-rate oriented however with some differences in interpretation between the two. The new consensus model following Meyer (2001) was shown to be based on several assumptions. Firstly that the stock of money is not a model parameter though its nature was illustrated in an equation which relates the stock of money to output, the rate of interest and inflation. This raised the further question of how to determine money in terms of the money stock having an effect on economic activity. On the other hand, it was also noted that money might be reinstated in terms of three further assumptions these being that money is one of several wholesale market assets, that money has wealth effects and that many also includes credit frictions. Having said this, it is also important to note that the new consensus analysis of Meyer (2001) does not indicate the value of monetary growth. For example, it was noted that the amount of money in circulation is determined by the demand for money and that this in turn depends on past and contemporaneous values of prices incomes and so on. Therefore, it might be argued that the stock of money is not a significant variable unless the demand for money is a function of expected future prices and incomes. This being so the stock of money may hold information which reflects such expectations. A further conclusion was noted in terms of McCallum (2001) which reflects the volume of money required to complete the monetary policy rule in the new consensus framework. A difference being that the new consensus framework should be interpreted to allow for some central bank control over the one period nominal interest rate since it is able to control the quantity of base money in the economy. The difference between McCallum (2001) and Meyer (2001) therefore, is the inclusion of a fourth money demand equation with some further modifications. A further conclusion of this chapter was that endogenous money may be distinguished from exogenous money by splitting endogenous money into passive and active variables. Here, passive money is consistent with the original new consensus framework, but the stock of money is a residual which does not determine output or inflation. Similarly interest rates are the instrument of monetary policy. It was also noted however that this approach might be somewhat uncertain given Hendry's (1995) observation that this approach to money may well be deficient since it includes a "non-trivial passive element to money's role in that mechanism." A further conclusion of this chapter was the interpretation of endogenous money in terms of the relationship between asset prices and real economic activity, with an emphasis on frictions in the credit markets and the balance sheet channel of monetary policy transmission. This approach following Bernanke and Gertler (1995) gives importance to two ratios, namely capital-to-asset and debt-to-asset. A further assumption is that credit markets display friction in the form of "problems of information incentives and enforcement in credit relationships." The main conclusion of this approach was that borrowers with strong financial credentials would be able to access credit more easily and at a lower cost than those who are not as credible. In this situation it was also noted that frictions in credit markets mean that cash flow and balance sheet positions are more important in determining the ability of individuals to borrow and lend. As a result of such frictions it was noted that the supply of collateral to borrowers results in external finance becoming prohibitively expensive to obtain relative to internal finance. This phenomenon was defined as the "external finance premium " which represents the difference in cost between borrowing externally and the opportunity cost of borrowing from internal firm funds. Returning to the Keynesian perspective on endogenous money, four further conclusions were reached and these concern questions over the ability of official interest rates to actually reduce an economy wide equilibrium where demand and supply are in balance and inflation is on target. First, it was noted that the equilibrium rate of interest may be either positive or negative but still low enough to be unattainable. This is similar to the liquidity trap except that market rates are low and prices are high in the liquidity trap and thereby dissuade bond purchases in case of capital loss. The second point was the fact that interest rates may only have a very small influence on the levels of saving and investment, thereby making monetary policy relatively ineffective in balancing the two. It was also noted that there is a lack of consensus in the empirical literature over the sign and relationship between savings and the rate of interest. The effect of interest rates on investment was also questioned following Bernanke *et al.* (1999). A third conclusion was that domestic interest rates may not be compatible with international interest rates or may at least pose some difficulties for the current account of the balance of payments. For example, in terms of interest rate parity the domestic to international interest rate differential will equal the expected rate of change of the exchange rate. The most appropriate domestic interest rate that is required for international capital movements however might be a market determined interest rate which is set with reference to the official interest rate. The lack of empirical consensus on interest-rate parity was illustrated, however on the other hand, it was also noted that there may be some relationship between domestic relative to international interest rates and exchange rates. A fourth conclusion was the difficulty in determining an official "equilibrium rate " of interest given the lack of information, a constantly changing inflation target or even issues relating to competence and credibility. A further assumption of monetary policy in an endogenous money framework, was that the macro economy is viewed somewhat differently in the Keynesian perspective relative to the new consensus framework. As noted earlier inflation may be determined by factors such as cost push considerations in the Keynesian position such as wages, import prices, income levels or productive capacity. In the new consensus framework however inflation may be the result of excess demand and expected inflation in the economy. A further distinction was that in the Keynesian approach the macro economy is subject to supply and demand shocks and also fluctuations in the level of overall economic activity over the business cycle. Overall then it was noted that the central bank determines the official interest rate in an endogenous money framework. This in turn leads to a transmission effect on market interest rates where the stock of money is determined endogenously and independently of the central bank. The role of interest-rates as an instrument of monetary policy was also discussed since this raised questions over the effectiveness of monetary policy. Here, limitations in the use of interest rates were acknowledged especially the fact that they can become negative and constrained by the level of international interest rates.

The main conclusion from chapter four concerning monetary policy rules, was the fact that central banks can quantify the response of monetary policy decisions to changes in the level of economic activity in a variety of ways. More specific conclusions drawn from this research relate to preliminary modelling issues or in other words problems that may or may not be encountered when estimating Taylor type monetary policy rules. These include the various differences in measuring inflation, estimating the equilibrium real interest rate and also potential output. It was further noted that the robustness of estimated rules would also be vulnerable to sensitivity in data selection. A further outcome was the fact that the timing of data availability from the central bank may influence the monetary policy reaction function specifications and therefore their estimated outcomes. Additionally, inflation and the output gap may be modelled as contemporaneous observations in interest-rate rules but also as lagged variables. It was also shown that revised data is a common component in estimated policy rules especially those tracing historical developments, though real-time data has also been used. Furthermore, it was also shown that the Taylor (1993) formulation, maybe adapted to include error correction mechanism terms which capture central bank interest rate smoothing. This was represented by Judd and Rudebusch (1998). Such monetary policy rules can also be adapted to include a forward-looking element and this was illustrated by McCallum (2001) and also Kozicki (1999). Many Taylor type monetary policy rules use single equation techniques which are not necessarily robust given small changes in their underlying properties such as the measurements used for inflation or potential output. It was shown that these may lead to wide variations in policy recommendations. On the other hand it was not noted that despite such problems monetary policy rules of this nature are generally useful descriptors of the behaviour of monetary policy. A further conclusion was that the channel of monetary policy transmission specified in any interest rate reaction function plays a key role in the construction of policy rules. This was because the parameters of an optimal rule are subject to influence from price and output persistence, interest rate elasticity of demand, transparency, expectations, and also the identification of such channels of transmission is a prerequisite to an efficient instrument rule. This was illustrated in terms of a backward looking structural model identified by Ball (1999). With regard to the specification of monetary policy rules and their parameters, the research showed that a reasonable assumption in model specification is that central banks determine official interest rates based on expectations of future economic activity. This may be reflected in either a forward-looking or forecast based specification of monetary policy rules which may be preferred over backward looking or contemporaneous specifications. To this end we use the example of Batini and Haldane (1999). The exchange rate may also play a role in monetary policy reaction function specifications, as illustrated by Ball (1997) and the stability condition is also important for Taylor type monetary policy rules as illustrated by Woodford (2002). It was shown that this may be modelled in terms of a forward-looking IS/Phillips curve model.

The overall conclusion of chapter four then, was that modelling Taylor type monetary policy reaction functions, require that the official interest-rate is a function of deviations in contemporaneous inflation from a pre-selected target and also deviations of contemporaneous real output from the potential level of output. The size of the interest rate response to shocks was determined by the relative weights which may be assigned to the inflation and output gap parameters of the rule concerned. It was shown that monetary policy reaction functions are simple and tractable, though they do nevertheless describe the essential workings of monetary policy in central banks. This chapter showed that estimates of Taylor type rules are not robust for a variety of reasons, including as mentioned earlier, estimated relative weights for model parameters, the changing nature of monetary policy and the availability and treatment of data. In chapter five, the main conclusion was the close relationship between inflation targeting and the new consensus macroeconomics as theoretical and policy parameters. The chapter notes that inflation targeting is advocated for monetary policy. For example, Mishkin (1999). A further conclusion of this chapter, is that the importance of inflation targeting as a theoretical and policy measure is illustrated by the fact that it has been adopted in over twenty countries as illustrated by Fracasso *et al.* (2003). Further outcomes of this chapter are that the theoretical basis of inflation targeting can be deconstructed, the mechanisms through which inflation targeting is used to control inflation are subject to reservations, and that the empirical evidence on inflation targeting adopts structural macroeconomic, as well as single equation models to measure Taylor type policy rules. We now look at each of these in turn. An outcome of inflation targeting was that official inflation targets and ranges are announced publicly, and low and stable levels of inflation are acknowledged as their primary concerns of monetary policy in the long run. It was shown that an advantage of this framework is the presence of clear communication between the central bank and also public-private and market agents which allows for a disciplined, accountable, transparent and flexible approach to monetary policy. The primary objective of price stability is supported by three further additional objectives, which are trust, flexibility and an optimal response to unanticipated shocks. Inflation targeting can be achieved through "constrained discretion" where inflation targeting can be used as a nominal anchor for monetary policy. A further implication of this was the fact that inflation targeting can be used to reduce the possibility of deflation. Additional conclusions of this chapter were that fiscal policy is not treated as an instrument of macroeconomic policy, given its sensitivity to slow and uncertain legislative issues. Also, low and stable inflation rates are preferred since they induce strong rates of economic growth, with monetary policy being used to achieve this. In terms of the theoretical aspects of inflation targeting, it was shown that there exists an argument for combining monetary and fiscal policy to measure economic outcomes rather than inflation targeting as a stand-alone measure. Problems with using inflation targeting as a standalone policy include the arguments by Palley (2003). Furthermore, the role of the monetary policy committee in inflation targeting may prove controversial as argued by Blinder (1998) where the main issue was that a chairman who needs to build consensus may have to move more slowly than if he were acting alone. A further outcome concerns the role of the nominal anchor which was criticised for leaving very little room for stabilising output and that although this is feasible in the short run it is not a requirement in the long run since output returns to equilibrium. The next finding in this chapter concerns real and monetary factors and here it was shown that a preference for low inflation is also related to a distinction between real and monetary factors in the economy. In other words, monetary policy being on the nominal side of the economy targeting inflation, with supply-side policies of the real side of the economy targeting unemployment. However, a further implication here was that supply-side policies do not necessarily need to be an inherent characteristic of inflation targeting as illustrated by King (1997). A further conclusion of this section concerns the causes of inflation and here it was shown that inflation might be controlled through official interest rates which act to induce demand deflation. This concept of demand deflation then raised three further questions. Firstly, that the effectiveness of monetary policy in influencing inflation through aggregate demand may be ineffective as argued by a Arestis and Sawyer (2002). Secondly, the appropriateness of monetary policy in influencing aggregate demand and demand inflation in terms of the Phillips curve equation was also questioned with Arestis and Sawyer (2002) showing that this may pose problems with fiscal policy presented as the most appropriate instrument of policy. The third outcome being the lack of importance given to sustain cost-push and other non-demand related inflation in the new consensus. The next set of findings concern inflation and the transmission mechanism of monetary policy. Here it was noted that a single interest rate does not account for feed through effects of the policy instrument on long-term interest rates as argued by former chairman of the Federal reserve Volcker (2002). With regard to the empirical evidence on inflation targeting, it was shown that this can broadly be defined in terms of macroeconometric models and single equation techniques. We discuss both of these broad conclusions in further detail below.

The first conclusion here was that the effects of monetary policy transmission through conventional channels cannot always be measured in a quantitative manner. A primary reason for this was the fact that no single transmission channel is mutually exclusive and also that the effects of official interest rate changes on economic activity are determined by an interaction of such channels. Since these channels operate interdependently and simultaneously, any determination of the effects of monetary policy on the rate of inflation becomes difficult to measure. In addition, the identification of change, magnitude or relevance of transmission over time can be explained in a similar vein to inflation targeting and macroeconometric models, where the relatively long time taken for monetary policy transmission effects to become apparent were discussed by

Kuttner and Mosser (2002). The authors illustrated the continuously changing relationship between monetary policy and the real economy. A further conclusion relates to inflation targeting in single equation models with the main outcome here being that of all the major economies adopting inflation targeting, the UK was shown to have the best performance even though its rate of inflation was higher than the inflation target of most other countries. The overall conclusion of chapter five is that there is a close relationship between inflation targeting and the new consensus macroeconomics. The theoretical foundations of the latter were shown to have several shortcomings. The empirical evidence on such models was shown to be varied and lacking in consensus.

The main outcome of the data and research method in chapter six is that the Taylor (1993) rule is a generalised description of central bank behaviour and that therefore the variables that might be used for estimation are not fixed. To this end several disparate versions of the policy instrument, the rate of inflation and the output gap can be used. This is followed by a series of more specific conclusions which include use of the bank rate, the minimum lending rate, and the official bank rate as measures of the policy instrument. Primarily, it was shown that the purpose of using monthly data observations was to reflect the fact that monetary policy committee decisions are often made on a monthly basis though sometimes there is no change. For the rate of inflation, the retail price prices index was adopted and modified to excluding mortgage interest payments when they became available. The aim here being to map the initial inflation target measure under the regime of instrument independence. An initial conclusion here was that inflation might be interpreted as backward looking in the sense that the data relate to percentage changes in the variable over the preceding 12 months. It was noted however that there is no firm consensus in the academic literature whether this is the most appropriate measure of inflation. Alternatively therefore, contemporaneous and forward-looking measures of inflation were also adopted to reflect rational expectations views of anticipated inflation, as well as a forward-looking specification. For the output gap parameter, the main conclusion was that unemployment might be included by using the claimant count rate though it was acknowledged that there may be minor concerns relating to the reliability of this variable. For example, unemployment figures not being subject to final revision whereas output gap figures are. To overcome this it was also noted that an alternative relative claimant count measure might be used which was calculated by taking the difference between current period and thirty-six month moving-average period observations. As far as the output gap is concerned, the main conclusion here was that a variety of specifications are presented for this variable in the academic literature without any firm consensus on any particular one. In this study therefore, the main conclusion of the output gap was that the variable representing industrial production may be used since it is a close approximation to GDP and also the variable which reflects the frequency of monetary policy committee decisions. This was smoothed using a Hodrick-Prescott filter to help make the trend more sensitive to long-term rather than short-term fluctuations. The next conclusion from this chapter relates to determining the most appropriate periods for time series analysis. To this end, two periodic descriptions were used to illustrate the fact that changes in monetary policy regime are widely described in the academic literature, two examples being Cobham (2002) also Nelson (2001). These cover regimes where the exchange rate was floated, monetary targeting was adopted with various degrees of discretion, the medium term financial strategy, Deutschemark shadowing, exchange rate mechanism membership and also inflation targeting. As a result of these periodic considerations of monetary policy, a outcome of the research was that eight specific policy regimes were identified for the purposes of estimation. These represent the full sample period, the start of the sample period up until the last month of the floating of the exchange rate, monetary targeting with various degrees of discretion, the medium term financial strategy, Deutschemark shadowing, membership of the ERM, inflation targeting, and inflation targeting with instrument independence.

The further conclusion from this chapter considers the research methods, in other words the process of estimation using the data concerned. The first implication of this section is that a smaller number of quarterly observations are available for the purposes of estimating Taylor type policy rules. As a result, some of the time periods need to be combined to offer a longer data run. Furthermore, an implication for the research method is that a VAR lag order selection criteria can be used to determine the optimal number of lags as a starting point for the estimation procedure. This is followed by the Pantula (1989) principle, in which a cointegration test for the number of long run parameters is performed and the normalised cointegrating coefficients determined. In addition, a vector error correction mechanism was also applied where required.

In chapter seven, the main conclusion surrounds the importance of testing for the underlying time series properties of the variables concerned since these have been overlooked substantially in the academic literature. To this extent, a preliminary outcome is that the order of integration has been determined to avoid the problem of spurious regression and it was shown that ADF and Phillips-Perron tests may be appropriate for achieving this. The chapter also illustrated the importance of determining an appropriate trend for model selection, in other words whether an intercept or trend should be included in the short run model, the long run model or both. It was noted that this is a key ingredient for cointegration testing. From a modelling perspective, cointegrating vectors or long run relationships can be determined using trace and maximum eigenvalue tests and that these might be consolidated with further tests of weak exogeneity, parameter stability and structural break tests. The overall summary to this section being that a thorough series of underlying econometric time series properties tests are required. More specific conclusions for chapter seven are as follows and these begin with testing for the order of integration. It was shown that the majority of macroeconomic time series are trended and therefore often non-stationary. This position was illustrated with reference to Asterious and Hall (2007) and also Osterholm (2005) who noted the theoretical objections regarding Taylor type monetary policy rules and how these translated into suspicions of mis-specification. In addition, the empirical literature on the stationarity of Taylor type monetary policy variables does not benefit from any firm consensus, with some studies finding widely differing results for these variables. Nevertheless, a formal modelling procedure was identified in terms of testing for stationarity and cointegration. Also, it was shown that forward-looking inflation does not reject the null hypothesis of stationarity when a constant and trend are included in a Taylor type monetary policy rule. This anomaly was discussed with regard to the possible diminishing power of the ADF test. Overall however, the main conclusion of ADF testing in this chapter is that each variable is non-stationary when defined in levels. After taking first differences however, the non-stationarity component is removed and the null hypothesis of non-stationarity is clearly rejected at the 5% level of significance. As a result, the implication here is that each variable is integrated of order one. A further outcome was that the output gap as measured by relative unemployment and also industrial production, were stationary when measured in levels though this was not surprising given their prior construction. Also, ADF testing was confirmed using Phillips-Perron tests which were not fundamentally different from ADF results. Therefore, an implication here is that tests clearly point to the presence of unit roots in all cases except for relative unemployment and industrial production measures of the output gap. After taking first differences the null hypothesis of stationarity was rejected and each variable was shown to be integrated of order one. Chapter seven also discussed determination of the appropriate lag length for cointegration. Here the main finding was that an ECM or error correction mechanism was developed and selected for specific reasons, these being that it is a convenient measure for determining the correction from disequilibrium from a previous time period and that therefore this allows for a meaningful economic interpretation. The ECM method was also adopted because in the presence of cointegration a first difference specification of the ECM have helped to eliminate trends from the variables and therefore removed spurious regression. Thirdly the ECM was easily adapted to fit the general to specific approach used in this study and this related very well to the generalised nature of monetary policy reaction functions. Finally the disequilibrium error term was shown to be a stationary variable given cointegration with an implication of this being the existence of some adjustment process which minimises errors in the long relationship. In addition, cointegration and the error correction mechanism could be modelled using a two-variable ARDL specification.

The next conclusion for chapter seven concerns the selection of deterministic trends for model estimation. The main finding here was that five separate models were available for determining the presence of trends in estimated models. These were then reduced down to three models which were used for the purposes of analysis. This was achieved using the Pantula (1989) principle which allowed for a move from the most restrictive model, at each stage comparing trace test statistics to their critical values and stopping only when it was not possible to conclude for the first time that the null hypothesis of cointegration was not rejected. A further outcome of the research considers the determination of the number of cointegrating vectors and here it was shown that the Johansen maximum likelihood test was the most appropriate means of determining this. The main implications here are that nine different specifications of a Taylor type monetary policy rule were estimated, the parameters of which are explained chapter six. Furthermore, an optimum lag length ranging from one to two was determined. When different Taylor type variables were used, such as contemporaneous inflation and relative unemployment, the lag length was shown to be three and when a backward looking inflation and contemporaneous measure of inflation with industrial production were used, the optimal lag length was also three. Similar findings were obtained using quarterly data. A further outcome relates to testing for weak exogeneity and also linear restrictions. Hence when applying the following restrictions on the coefficient of the inflation parameter of

1.5 and a linear restriction of 0.5 on the output gap to mimic the original Taylor rule we were able to determine that these variables were statistically insignificant and weakly exogenous to the models being estimated. With regard to tests for parameter stability using the Quandt-Andrews approach, the summary statistics failed to reject the null hypothesis of no structural breaks within all the possible dates tested.

For chapter eight, the overall conclusion and implication for monetary policy, is that Taylor type monetary policy reaction functions do not adequately capture the behaviour of central bank monetary policy making. There appear to be several reasons for this including those cited in the empirical literature by Nelson (2001), Goodhart (1989), Barrow (1977) and others mentioned in chapter eight. Some of the reasons for this may be the fact that historical breaks in policy regime are difficult to model. A chapter finding which meets with the empirical literature is that Taylor type monetary policy reaction functions can only be described as approximate representations of central bank behaviour which are aimed at trying to characterise a very complex process using only a small number of variables.

We now offer a series of conclusions relating to the individual policy regimes estimated in chapter eight. For the first regime which runs from January 1970 to June 1976, the main outcome is that there exists a very weak and statistically insignificant long run estimated response to inflation. We observe similar findings for the second monetary policy regime which runs from July 1976 to April 1979. In this regime a vector error correction model was also used to try and ratify results which showed that a backward looking Taylor type monetary policy rule appeared both positively signed but small in magnitude. For the next monetary policy regime which runs between May 1979 and February 1987 inclusive it is again empirically not possible to determine whether inflation control is an objective of monetary policy. For the March 1987 to September 1990 monetary policy regime, the main conclusion again is that a Taylor type monetary policy raise rule does not capture the behaviour of central bank policy making. For inflation targeting beginning in 1992 and also inflation targeting with operational independence, it might be argued that one would expect a closer representation of monetary policy in terms of a Taylor type monetary policy rule. Again, the main conclusion of this section is that it is difficult to find an estimated long run response to inflation and the output gap, which mirrors the behaviour of central bank decision-making. A further conclusion of this chapter is one which reinforces a previous point, namely that Taylor type monetary policy rules are better treated as simple estimates of monetary policy reaction functions rather than actual descriptions of central bank behaviour. Overall then, the main conclusion from chapter eight is that the empirical analysis aimed to characterise the behaviour of central bank monetary policy making between 1970 and 2008 using a variety of specifications and data sets of monthly and quarterly data. The main outcome of these is that the results do not correspond to an original Taylor (1993) type monetary policy rules and do not correspond with similar estimates in other studies.

The overall conclusion from chapter nine is that the essential link between official interest rates and the rest of the wider economy is the transmission of base rates to market interest rates. This includes bank loans, asset prices and savings accounts where the exact nature of the relationship is unclear. Furthermore, an appropriate relationship between nominal and market interest rates can be determined following Mariscal and Howells (2002). The concept of the flow of funds identity, which decomposes changes in the money stock into credit counterparts and changes in bank lending, into non-bank private sector which is a primary source of monetary growth. Also, an observation from the empirical literature is that the degree of base rate pass through is incomplete. In addition, a limited degree of interest rate pass through has some effect on the so-called Taylor (1993) principal. When complete interest-rate pass through is achieved then a further implication of the Taylor principle was that official interest rates increase by more than unity in response to an increase in expected inflation. When base rate pass through was not complete, official interest rates responded by an amount greater than unity. It might be noted again that the focus of chapter nine was on the relationship between official interest rates and market interest rates, such as bank and building society interest rates on mortgages, loan rates and also deposit rates. The chapter also identified two further approaches to interest-rate pass through and these were the cost of funds approach following Sander and Kleimeier (2004) and also the monetary policy approach. In the cost of funds approach, it was shown that the pricing decisions of banks are largely concerned with the opportunity costs associated with issuing loans and the costs of financing deposits. Under the monetary policy approach on the other hand, the emphasis was shown to be more on official interest rate decisions and their impact on retail interest rates without a major focus on other explanatory variables. A further outcome was that retail interest rates and official interest rates are generally integrated of order one, which necessitates a modelling process in first differences so as to avoid the problem of spurious regression. The chapter explains changes in the retail bank interest rates in terms of changes in official interest rates, persistence in the changes of retail bank interest rates and also error correction mechanisms which accounted for long run relationships between retail bank interest rates and official base rates. From an empirical perspective, a further conclusion regarding the data and model specification was that the default lag lengths for estimating base rate pass through was eight when performing a lag order selection using a VAR model. This in turn became an optimum lag length of two as indicated in the tables in chapter nine. A similar conclusion was reached for the standard variable rate mortgage for building societies compared to banks. The next conclusion from the modelling sequence was that the cointegration procedure included a deterministic trend assumption which includes an intercept but no trend in the cointegrating equation and no intercept in the VAR. The estimation procedure identified one cointegrating relationship at the 5% level of significance which was also confirmed by the maximum eigenvalue test. In a further model, a cointegrating vector was not identified using trace and maximum eigenvalue tests. As a result, a normalised cointegrating equation was estimated to determine the long response coefficient on standard variable rate mortgages from banks. This was this was shown to have a magnitude of 1.3 which is correctly signed and large, but statistically insignificant. A further conclusion relates to the loans variable which was shown to report a long response coefficient of less than 0.1 which was again statistically insignificant. When the standard variable rate mortgage parameter for banks and deposit interest rates were estimated, they were shown to be positive, small in magnitude and statistically significant. The overall conclusion from chapter nine on interest-rate pass through is therefore: one, that the empirical evidence can be compared with existing studies such as Mizen and

Hofmann (2002), which suggests that non-stationarity cannot be rejected using conventional tests. As a result, cointegration testing restricted the constant and assumed no deterministic trends in the interest-rate variable. An overall lag order of four for deposit and mortgage interest rates was found, and an overall like order of three for building society interest rates. In summary then, it might be noted that monetary policy decisions impact short-term interest rates through changes in official interest rates. The academic literature assumes a complete transmission of official interest rates to short-term interest rates within a short period of time. Here, the assumption being that complete interest-rate pass through implies efficient monetary policy in controlling inflation. The chapter aimed to apply OLS time series methods using or cointegration and error correction techniques to each type of retail interest rate, which suggested that interest-rate pass through is not complete in the long-running for mortgage interest rates offered by either banks or building societies. A similar conclusion being reached for deposits and loans.

10.3 ORIGINAL CONTRIBUTIONS TO EXISTING KNOWLEDGE

This thesis provides an up-to-date overview of the main historical developments concerning monetary policy in the UK over the last three to four decades. In particular, the theoretical origins of monetary policy targets and also the development of monetary policy rules in the UK. A greater emphasis has also been placed on the nature of inflation targeting in the UK, particularly with regard to inflation targeting and operational independence. Secondly, it contributes to the debate on monetary policy in an endogenous money framework by presenting further evidence on the new consensus model of monetary policy, which includes the transmission channels of monetary policy and also the relationship between monetary policy and aggregate demand. It also extends the debate by considering endogenous money in a Keynesian framework.

Perhaps the greatest contributions to existing knowledge of this thesis come from the discussions on monetary policy rules and inflation targeting, which form the basis of the three original chapters. To this end, another major contribution concerns that of issues and concerns relating to the modelling of Taylor type monetary policy rules. This thesis has contributed by demonstrating that there exist a variety of ways in which Taylor type monetary policy rules may be measured, for example, the nature of contemporaneous measures of inflation and the output gap compared to lagged data used by central banks. It has also been shown that as far as optimal monetary policy rules are concerned, then there exist significant trade-offs and shocks from demand and supply and that there are also issues concerning the nature of stability and the output gap in Taylor type monetary policy rules. A further contribution to existing knowledge comes from the data and research method adopted in this study. For example, whether the data is a real time or another measure. Secondly, there are also technical shortcomings in some of the estimation methods used. For example, unit root tests that have been used in this study have also been shown to be sensitive to structural change over long sample periods as discussed in chapter seven. Determining the appropriate lag length for cointegration testing was also covered in this chapter using a variety of methods. For example, the Hannan-Quinn criterion, the Akaike Information Criterion or the Schwarz criterion. Although these are well-known and respected measures of optimal lag order, there are studies in the empirical literature which suggest that these might also be sensitive to sample size and the variables included. Indeed it has also been shown in Appendix Three that such measures of lag order are not always consistent. A further shortcoming concerns the use of deterministic trends for model selection. Although the Pantula (1989) principle was adopted to determine the number of trends required it is also acknowledged here that this is not the only measure available in the empirical literature and that other methods may also be used. Similarly when determining the number of cointegrating vectors, both for Taylor type monetary policy rules and also interest-rate pass through in chapter nine, it has also been acknowledged that the trace and maximum eigenvalue statistics may not always return the correct number of cointegrating vectors. Once again this is largely due to the fact that the data may be sensitive to sample size.

Hence it might be suggested that as far as a further work in this field is concerned, an emphasis might be placed on the theoretical and statistical properties of unit root tests employed. In addition, lag length criteria, methods for determining the number of friends in variables and also cointegration tests. On a more general note, the thesis might also be used to disseminate knowledge on the role of monetary policy. More specifically, the effectiveness of monetary policy has been questioned in this thesis and it has also been shown that monetary policy rules are not necessarily the best descriptions of monetary policy, having said this, a further article might then be to consider the role of monetary policy in the economy as a whole. For example, it was discussed in chapters three and five that monetary policy may also be adopted in conjunction with fiscal policy. Therefore a wider research outcome of this thesis might be to consider the role and nature of monetary policy as conducted by central banks in the current financial climate.

10.4 OVERALL CONCLUSION

This study has presented an analysis of the transmission mechanism of monetary policy in the UK. Historically speaking, the UK has experimented with a number of distinct regimes over the last thirty to forty years, with various degrees of success. A new consensus in monetary policy has emerged over this period, one which has implications for the nature and role of monetary policy in an endogenous framework. In addition, inflation targeting underpins many conventional monetary policy reaction functions and this has been used as a basis for performing econometric analysis of policy rules. The underlying time series properties of such rules require further investigation since these determine descriptions about central bank behaviour. Furthermore, the extent of interest rate pass through in the UK is limited and this leaves open a further question over why this is the case.

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