Oil Prices and the Trade Balance of Sub-Saharan African Countries: The Roles of Oil Price Volatility, Real Exchange Rates, and Financial Integration.

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Intellectual Property Statement

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Abstract

This thesis empirically examines the effects of oil prices on the trade balances of oil importing and exporting Sub-Saharan African countries. These countries depend heavily on international trade for foreign exchange and economic growth, and fluctuations in oil prices have direct implications for their terms of trade. This thesis contributes to the oil price-trade balance literature by focusing on three aspects of this relationship that are unexplored. First, this thesis introduces the issue of nonlinear oil price effects to the trade balance literature. Using a Threshold Vector Autoregressive Model, it estimates asymmetric and threshold effects of oil prices on the trade balance, focusing on oil price volatility as the source of nonlinearity. Nonlinearities are shown to be stronger in the effects of oil price volatility shocks than oil price level shocks: volatility shocks have larger effects on the trade balance when they occur in an already volatile environment, and decreases in oil price volatility have larger effects than increases. Second, this thesis pioneers the empirical investigation of the role of real exchange rates in determining the effects of oil prices on the trade balance. Using a Cross Section Dependence robust panel data method, this thesis shows that real exchange rate depreciations reduce the effects of oil prices on the trade balances of SSA countries, while real appreciations reinforce these effects. Third, this thesis is the first study to empirically investigate how higher international financial risk sharing affects the response of the trade balance to oil prices. To do this, it employs a Panel Smooth Transition Regression model. The results show that oil importing SSA countries that are well integrated in global financial markets, with higher access to foreign funds, fare better when the oil price is high: they are able to avoid large fluctuations in their nonoil trade balances by smoothing nonoil consumption.

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List of Abbreviations

ADF	Augmented Dickey-Fuller
CBN	Central Bank of Nigeria
CCE	Common Correlated Effects
CCEMG	Common Correlated Effects Mean Group
CSD	Cross Section Dependence
CEMAC	Central African Economic and Monetary Community
CPI	Consumer Price Index
DOTS	Direction of Trade Statistics
DSGE	Dynamic Stochastic General Equilibrium
ECA	Excess Crude Account
ECOWAS	Economic Community of West African States
EIA	Energy Information Agency
EU	European Union
FDI	Foreign Direct Investment
GARCH	Generalised Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
GIRF	Generalised Impulse Response Function
GMM	Generalised Method of Moments
HLM	Harberger-Laursen-Metzler
IFS	International Financial Statistics
IIP	Index of Industrial Production
IMF	International Monetary Fund
IRF	Impulse Response Functions
KPSS	Kwiatkowski, Phillips, Schmidt and Shin
MG	Mean Group
ML	Marshall-Lerner
MTVAR	Multivariate Threshold Vector Autoregressive Model
NAFTA	North American Free Trade Agreement

NBS	National Bureau of Statistics (Nigeria)
NER	Nominal Exchange Rate
NOTB	Non-Oil Trade Balance
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
OPM	Oil Price - Macroeconomy
OTB	Oil Trade Balance
PSTR	Panel Smooth Transition Regression
PTR	Panel Threshold
REER	Real Effective Exchange Rate
RER	Real Exchange Rate
ROP	Real Oil Price
SD	Standard Deviation
SSA	Sub-Saharan Africa
SWF	Sovereign Wealth Fund
TB	Trade Balance
TVAR	Threshold Vector Autoregressive Model
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
US	United States
VAR	Vector Autoregressive Model
WAEMU	West African Economic and Monetary Union
WDI	World Development Indicators
WEO	World Economic Outlook
ZA	Zivot -Andrews

Chapter 1: Introduction

The effects of oil price shocks on the macro economy are of interest to many researchers and policy makers. This interest was primarily spurred by the observed correlation between oil price increases and US macroeconomic performance since the 1970s, when the US became dependent on imported oil. In his seminal paper, Hamilton (1983) showed that 7 out of 8 US recessions were preceded three to four quarters earlier by an oil price shock[1]. Given the importance of oil as an input into production and as a consumption good, a large number of researchers have examined the link between oil prices and economic performance for both oil importing and oil exporting countries (Hamilton, 1983, Hamilton, 2008, Hamilton, 2011, Mork et al., 1994, Lee et al., 1995, Elder and Serletis, 2010, Farzanegan and Markwardt, 2009, Lorde et al., 2009, Mehrara and Sarem, 2009). This thesis examines the effects of oil prices on the trade balances of oil importing and oil exporting Sub-Saharan African (SSA) countries, with particular focus on the roles of oil price volatility, real exchange rates, and international financial risk sharing in shaping these effects.

Oil price shocks can affect economic performance through a number of channels[2]. An oil price increase may result in lower output levels because it represents an increase in the cost of production (Barsky and Kilian, 2004). To the extent that oil and capital equipment are complements, the reduction in oil use will also render some capital redundant, leading to further declines in output. Oil price increases also disrupt consumption decisions by reducing consumer purchases of energy intensive durable goods, with repercussions on the rest of the economy (Hamilton, 2008). If oil price shocks are associated with high oil price volatility- which is usually the case- then uncertainty regarding the future path of oil prices could make economic agents delay irreversible consumption and investment expenditures as they wait for new information, lowering macroeconomic performance in the process (Bernanke, 1983). Oil price increases may also increase domestic inflation, which often results in tight monetary policy responses that eventually exacerbate the effects on the economy (Cunado and De Gracia, 2005, Cologni and Manera, 2008, De Gregorio, 2012, Bodenstein et al., 2012, Bernanke et al., 1997). Oil prices have also been shown to affect stock market prices for both oil importing and exporting countries, with implications for business profits and

[1] An oil price ‘shock’ in the context of this thesis is used to refer to unexpected increases or decreases in the level of the oil price.

[2] Barsky and Kilian (2004) and Hamilton (2008) provide a review

investment decisions (Wang et al., 2013, Cunado and Perez de Gracia, 2014, Gil-Alana and Yaya, 2014, Sadorsky, 2014, Elder and Serletis, 2010).

In contrast to most studies that have focused on the effects of oil prices on the domestic economy, this thesis adopts more of an international perspective and examines how oil prices affect the goods trade balance. There is a surprisingly small body of literature on the oil price-trade balance relationship, with the most notable studies being those by Backus and Crucini (2000), Kilian et al. (2009) and Bodenstein et al. (2011)[3]. This is despite the importance of trade as a key driver of economic growth for most economies, and oil as the most internationally traded commodity. Fluctuations in oil prices, through the terms of trade, can have major implications for the trade balance. Examining this issue is important because oil price induced trade deficits are potentially harmful to economic growth. These deficits do not reflect, for example, increased importation of investment and consumption goods that could raise macroeconomic performance. Rather, given a reasonably low price elasticity of demand for oil, these deficits represent a transfer of wealth from oil importers to exporters if the oil price rises; or a reduction in wealth for oil exporters if the oil price decreases. Though these wealth transfer effects, oil price induced trade deficits have implications for both oil and nonoil consumption and investment levels (Bodenstein et al., 2011).

As noted by Kilian et al. (2009), the small number of studies on the oil price-trade balance relationship does not indicate a lack of interest in the issue. Researchers and policy makers tend to regard the relationship as an obvious one, as it is a common assumption in policy discussions that oil price shocks affect the trade balances of countries, depending on whether they are net oil exporters or importers. There is often a concern that oil importing countries need to borrow from abroad to cushion unfavourable terms of trade shocks, leading to accumulation of external debt. At the same time, it is argued that this international risk sharing is not always sufficient to ensure that the impacts of oil price shocks on the domestic economy are completely offset (Kilian et al., 2009, Le and Chang, 2013). Recently, the theoretical model of Bodenstein et al. (2011) showed that the oil price-trade balance relationship is more complex than is usually assumed: it depends crucially on the response of the nonoil trade balance, which is in turn determined by a host of other factors. In light of this, and given the emergence of large global current account imbalances that are commonly, in

[3] Earlier studies spurred by the work of Harberger (1950) and Laursen and Metzler (1950) are reviewed in a later section.

part, attributed to oil prices, researchers have begun to re-examine the link between oil prices and the trade balance.

The small number of studies makes it difficult to draw any kind of generalisations on the effects of oil prices on the trade balance since these studies are mostly country specific. The Dynamic Stochastic General Equilibrium (DSGE) models of Backus and Crucini (2000) and Bodenstein et al. (2011) are the main theoretical studies in this literature[4]. However, the former model is calibrated for a subset of OECD countries, the latter for the US economy only. Kilian et al. (2009) empirically examine the effects of oil prices for a wide range of oil exporters and importers. However, many low income countries, including SSA, are excluded from their analysis. Country specific empirical studies include Le and Chang (2013) and Arouri et al. (2014). Overall, these studies find that oil price increases improve the trade balance for oil exporters and deteriorate it for oil importers. Still, the studies are too few to constitute a consensus on the empirical effect of oil prices on the trade balance.

This thesis contributes to this literature by examining the effects of oil prices on the trade balances of oil importing and oil exporting Sub-Saharan African countries. SSA countries are examined for a number of reasons: both SSA oil importers and exporters depend heavily on trade for economic growth, oil prices have major implications for their terms of trade, they have limited opportunities for international risk sharing, and they have received little attention in the literature. For these countries more than others, and especially for SSA oil importers, adverse terms of trade shocks arising from oil price changes may have a greater effect on overall economic performance. In addition to examining SSA countries, this thesis focuses on three issues that have not been investigated in the empirical literature for any country. First, this thesis investigates whether oil price volatility induces nonlinearities in the effects of oil prices on the trade balance. Second, this thesis examines whether real exchange rate changes influence the response of the trade balance to oil prices. Third, this thesis examines the role of international financial risk sharing in determining the effects of oil prices on the trade balance[5].

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[4] Backus and Crucini (2000) actually focus on the effects of oil prices on the terms of trade, but Bodenstein (2011) build on many aspects of their model to examine the impact of oil prices on the trade balance.

[5] As with Kilian et al. (2009) and Le and Chang (2013), this thesis focuses on the effects of oil prices on the trade balance without considering the income component of the current account

The focus of this thesis on the role of oil price volatility in determining the effects of oil prices on the trade balance is motivated by the findings of the wider oil price-macro economy (OPM) literature. When the oil price collapse of the mid-1980s failed to produce an economic boom in oil importing economies, many researchers started to explore the possibility that oil price increases are more important than decreases (Hamilton, 2003, Lorde et al., 2009, Elder and Serletis, 2010, Elder and Serletis, 2011, Lee et al., 1995, Huang et al., 2005, Jiménez-Rodríguez and Sánchez, 2005). The volatility of oil prices was shown to be one source of this asymmetry as higher volatility, assumed to have a negative effect, exacerbates the negative effects of oil price increases while reducing the positive effects of decreases for oil importers (Ferderer, 1997, Elder and Serletis, 2011). The effects of oil price volatility on economic growth has also been found to depend on its level (Huang et al., 2005). This nonlinearity in the effects of the oil price and its volatility has been completely ignored by studies on the trade balance. It can be argued that because the oil market is volatile, trade volumes may only be affected by increased volatility when it exceeds a tolerable threshold. In addition, the relatively low price elasticity of demand for oil means the decisions of economic agents regarding the intensity of oil use may not be altered by small changes in oil prices (Kilian and Vigfusson, 2011b). Whether the trade balance would respond more to oil price increases than to decreases is also unknown. This issue is important given the academic debate about the empirical validity of studies that have found asymmetric effects of oil prices on output (Hamilton, 2011, Kilian and Vigfusson, 2011b, Kilian and Vigfusson, 2011a, Herrera et al., 2015). No study has examined any type of nonlinearity in the effects of oil prices on the trade balance.

Addressing this gap in the literature, this thesis examines the nonlinear effects of oil prices on the trade balance, with particular focus on oil price volatility as the determinant of nonlinearity. These effects are investigated for the largest SSA oil exporting country, Nigeria. A Threshold Vector Autoregressive Model (TVAR) model is used to determine whether the effects of oil price level and volatility shocks depend on an oil price volatility threshold, and whether there are asymmetries in these effects. The responses of both oil and nonoil trade balances are considered. The results show

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position which will be affected by oil price changes, such as royalty payments and remitted profits by oil companies. This is because, as noted by Kilian et al. (2009), any effect of oil prices on the income balance will be difficult to interpret unless the composition of the asset and liability positions of the countries are known.

that high oil price volatility makes the effects of oil price level shocks on the trade balance more dramatic. Unlike the findings of studies on economic growth however, volatility does not induce significant asymmetries in the effects of oil price level shocks on the trade balance. It is found that oil price volatility shocks have larger effects on the trade balance when volatility is above its threshold value, and the initial impact of an increase in volatility is negative only when volatility is already high. There are also asymmetries of volatility shocks, as decreases in volatility have larger effects than increases. These findings show that trade volumes are more affected by reduced oil price volatility than they are by increased volatility. Indeed, it is found that lower oil price volatility stimulates trade in both oil and nonoil goods.

The second contribution of this thesis is the examination of the role of real exchange rates in determining the effect of oil prices on the trade balance. This is motivated by the theoretical model in Bodenstein et al. (2011). They show that the effects of oil price increases on the trade balance are associated with the transfer of wealth from oil importers to exporters. Under the model assumptions, the oil component of the trade balance will always deteriorate for oil importers and improve for oil exporters. Reduced wealth and a real depreciation of the exchange rate, however, lead to a nonoil balance improvement for oil importers. In the same way, higher wealth and a real appreciation deteriorate the nonoil balance for oil exporters. In both cases, the nonoil balance response partly offsets the response of the oil balance, such that the overall trade response is reduced. If the model prediction holds, then exchange rate management can be used to limit exposure to oil shocks. No study has tested this empirically, despite the established links between oil prices and exchange rates; and between exchange rates and the trade balance[6].

This thesis addresses this gap in the literature by examining how bilateral real exchange rates determine the effects of oil prices on the overall trade balances of 8 major Sub-Saharan African economies -3 oil exporters, 5 oil importers- and 11 of their main trading partners. Here, a Cross Section Dependence (CSD) robust estimator, the Pesaran (2006) Common Correlated Effects Mean Group (CCEMG) estimator, is employed. Slope heterogeneity is allowed for each SSA country across different trading partners. It is found that, on average, oil prices have insignificant effects on the trade balance of SSA countries. However, the disaggregate bilateral estimates reveal considerable

[6] There are many studies on the oil price-exchange rate nexus, and on the effects of depreciations of the trade balance. These are reviewed in a later section.

heterogeneity, with positive and negative effects for both oil importers and exporters. These bilateral effects are however mostly positive, even for oil importers. The results indicate a strong nonoil trade adjustment for SSA countries. It is argued that the results reflect, in part, the correlation between nonoil commodity prices –the main exports of SSA oil importers - and oil prices. For oil exporters, insignificant average oil price effects may reflect a dampened oil trade surplus since these countries import refined petroleum products, owing to the poor state of their refineries. For both groups of countries, a strong nonoil trade adjustment is particularly likely because their low levels of integration in global financial markets mean their consumption smoothing opportunities are limited, necessitating a large nonoil trade adjustment (Bodenstein et al., 2011). Importantly, it is found that for bilateral trade balances where the oil price effect is positive, subsequent real exchange rate changes are unlikely to further influence trade quantities, such that appreciations have positive effects and depreciations have negative effects on the trade balance. Conversely, where an oil price increase deteriorates the trade balance, subsequent depreciations succeed in improving the trade balance, and appreciations deteriorate it. Consistent with these results, it is also found that bilateral exchange rate depreciations tend to reduce both the positive and negative effects of oil prices on the trade balance, while appreciations reinforce these effects.

The third contribution of this thesis is the examination of the role of international financial integration in determining the response of the trade balance to oil prices. This is motivated by the previous results which point to a strong nonoil balance response to oil prices for SSA countries. The model in Bodenstein et al. (2011) shows that a potential reason for this, and one that fits the situation of SSA countries, is a low level of international risk sharing. Oil importers that are well integrated in international financial markets can access foreign capital to smooth nonoil consumption when the oil price is high. This limits the need to finance the oil trade deficit by reducing nonoil imports, such that only a small nonoil surplus is required, implying a high overall trade balance response. In the same way, well integrated oil exporters are likely to save oil revenue windfalls abroad rather than spend them on goods imports, again limiting the nonoil trade response. Therefore, the low levels of financial integration of SSA countries imply that they are relatively unable to smooth consumption in response to oil shocks; they have to sustain large fluctuations in their nonoil balances. No study has empirically examined the role of financial integration in mediating the effect of oil prices for any country.

This thesis examines the importance of financial integration in the transmission of oil shocks, and determines the levels of integration required for SSA countries to access its consumption smoothing benefits. To do so, it utilizes the Panel Smooth Transition Regression (PSTR) model of Gonzalez et.al. (2005) using data on 37 SSA countries – 8 oil exporters and 29 oil importers. Here, the effects of oil prices are allowed to differ across countries and time periods, depending on the threshold level of integration. It is found that the nonoil balances of SSA oil importers with levels of integration below the estimated thresholds are more affected by oil prices. Above the threshold, the response of the nonoil balance is much smaller. These findings support the view that higher financial integration aids in consumption smoothing when the oil price is high. For oil exporters, the response of the nonoil trade balance is also found to depend on a financial integration threshold, but this nonlinearity is not robust to alternative model specifications. The weak results for oil exporters potentially reflect their small sample size, which complicates analysis especially in the threshold setting.

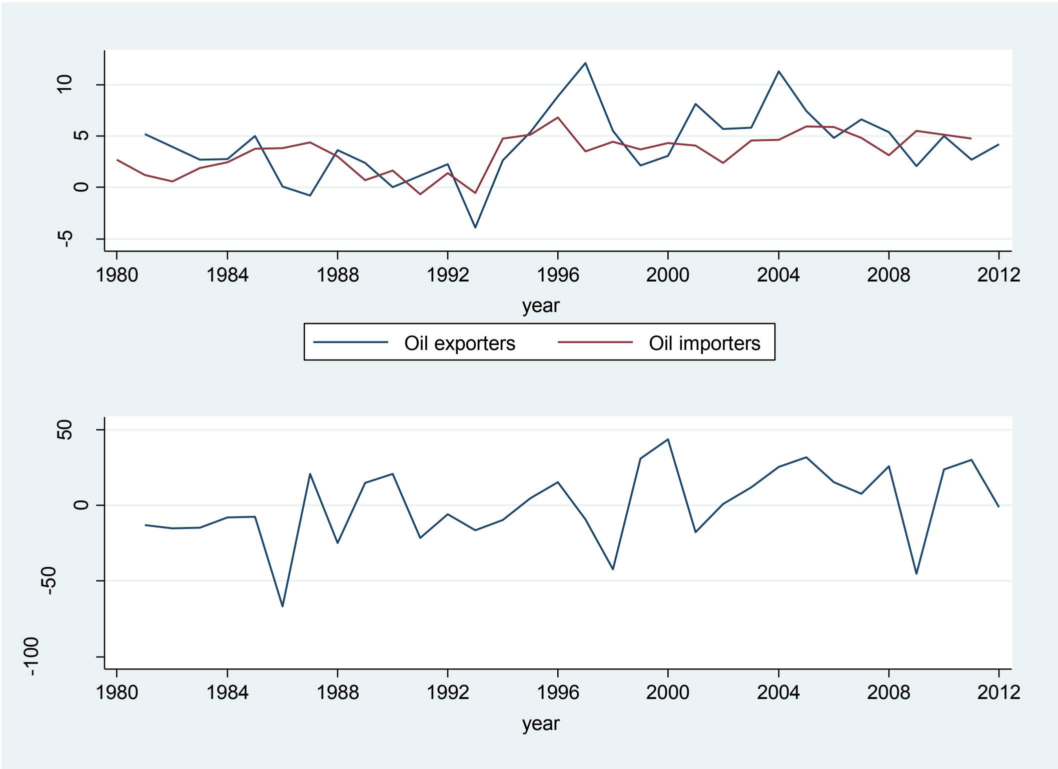
Through these three novel empirical studies, this thesis contributes to our knowledge of the effects of oil prices on the trade balance for SSA countries. It also brings forth important aspects of this relationship that are unexplored, opening up avenues for future research. For example, the roles of oil price volatility, real exchanges rates, and international risk sharing can have important implications for the trade balances of other countries. This is worth investigating especially given the recent volatility in oil prices. Additionally, the results of this thesis provide valuable insights for SSA policy makers. For instance, the findings show that for Nigeria and potentially other oil exporting developing countries, policy makers need not concern themselves with increases in volatility when volatility is initially at low levels, and that decreases in volatility are more important for stimulating trade in both oil and nonoil goods. Second, the results suggest that exchange rate devaluation can be used as a policy tool to cushion negative effects of oil prices on the trade balance. In addition, the results show that greater financial openness would help SSA oil importers smooth nonoil consumption in the event of terms of trade and income shocks associated with oil price increases.

The remainder of this thesis is organised as follows: Chapter 2 presents an overview of the economy of Sub-Saharan Africa, with particular emphasis on the issues relevant for this thesis. Chapter 3 presents an empirical study on the threshold effects of oil price level and volatility shocks on Nigeria's trade balance. Chapter 4 examines the role of real exchange rate adjustments in determining the effects of oil price shocks on the bilateral trade balances 8 SSA countries. In Chapter 5, the role of international financial integration in mediating the effects of oil price increases on the trade balance of 37 SSA countries is examined. Chapter 6 presents a general conclusion of the thesis and provides policy recommendations.

Chapter 2: Overview of the Sub-Saharan African Economy

Sub-Saharan Africa is one of the least developed and least globally integrated regions of the world. The region also has the highest number of formally identified economies that are incapable of catering for the basic needs of their people (Naudé, 2010). This is despite considerable improvements in the region's economic growth over the years. The upper panel of Figure 2.1 shows that compared to the 1980s and early 1990s, SSA countries have generally enjoyed around 4% annual growth on average during the last two decades. The figure shows that the GDP growth of SSA oil exporters has been more volatile than for oil importers, and it coincides with oil price movements, as shown in the lower panel of Figure 2.1. Increases in oil exporters' GDP growth rates are preceded about a year earlier by an increase in the oil price growth. The same is true for reductions in GDP growth.

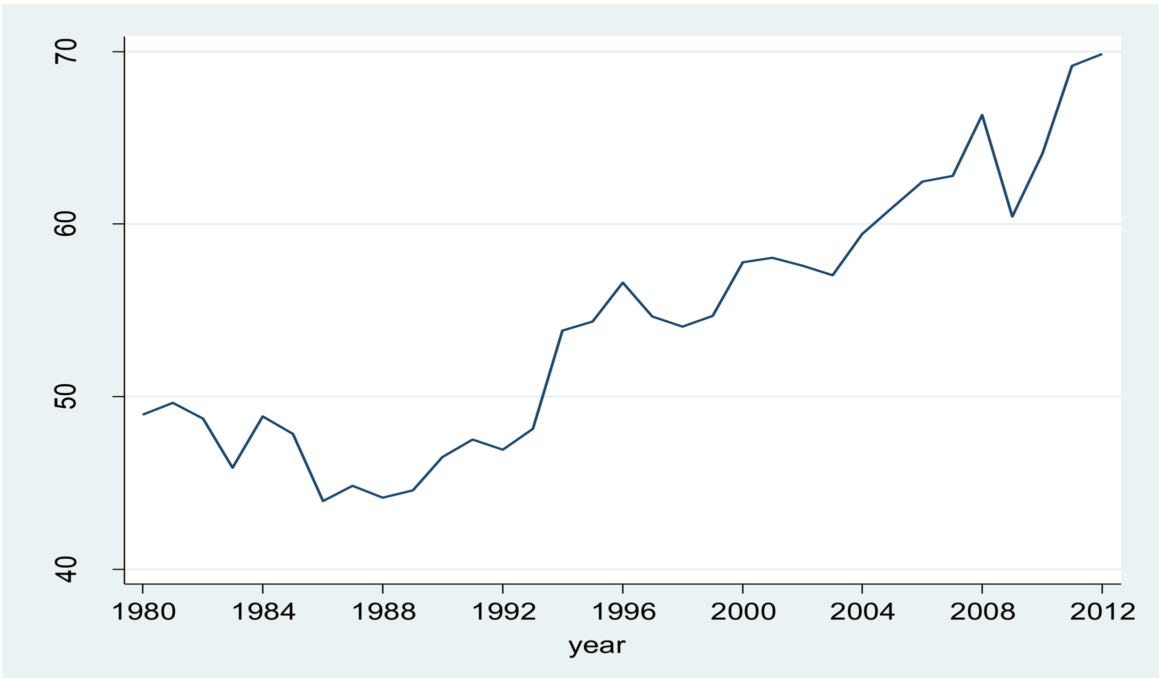
Figure 2.1: Average GDP growth rate of SSA countries and oil price growth rate, 1980-2012



Sources: Author's calculations using data from the World Bank's World Development Indicators (WDI) and International Monetary Fund's International Financial Statistics (IFS).
Notes: The GDP growth rates are calculated as the first difference of log real GDP (constant 2005 US dollars) multiplied by 100.The growth in the real oil price is the log first difference of the real oil price.

Over the years, SSA countries have increased their openness to trade. Figure 2.2 shows that trade as a percentage of GDP reached an average of 70% in 2012. This increasing openness along with terms of trade movements were found be associated with more than half the economic growth experienced by SSA countries over 1980-2010 period (IMF, 2015). The importance of SSA to the world economy stems from its role as a major supplier of raw materials for industrialized countries and as an important market for the finished products of developed and emerging markets. The main export commodities of SSA are crude oil, iron ore, coal, cotton, coffee, cocoa, copper and platinum (IMF 2015). These exports are almost exclusively the sources of government revenue and foreign exchange. The structure of Africa's exports is undiversified, with mineral products accounting for 67% of exports, and food exports accounting for close to 6% (Draper and Biacuana, 2009). South Africa is the only significant exporter of manufacturing exports, accounting for over 50% of manufacturing exports from the region. SSA countries are also ill-diversified with respect to their trading partners. By the late 2000s, EU-27 accounted for 34% of SSA's exports, followed by NAFTA and Asia, with each accounting for over 23%.

Figure 2.2: Average trade as a percentage of GDP for SSA countries: 1980-2012



Source: Author's calculations using data from International Monetary Funds' Direction of Trade Statistics (DOTS)

Notes: Trade as a percentage of GDP is calculated as the sum of total exports and imports as a percentage of GDP

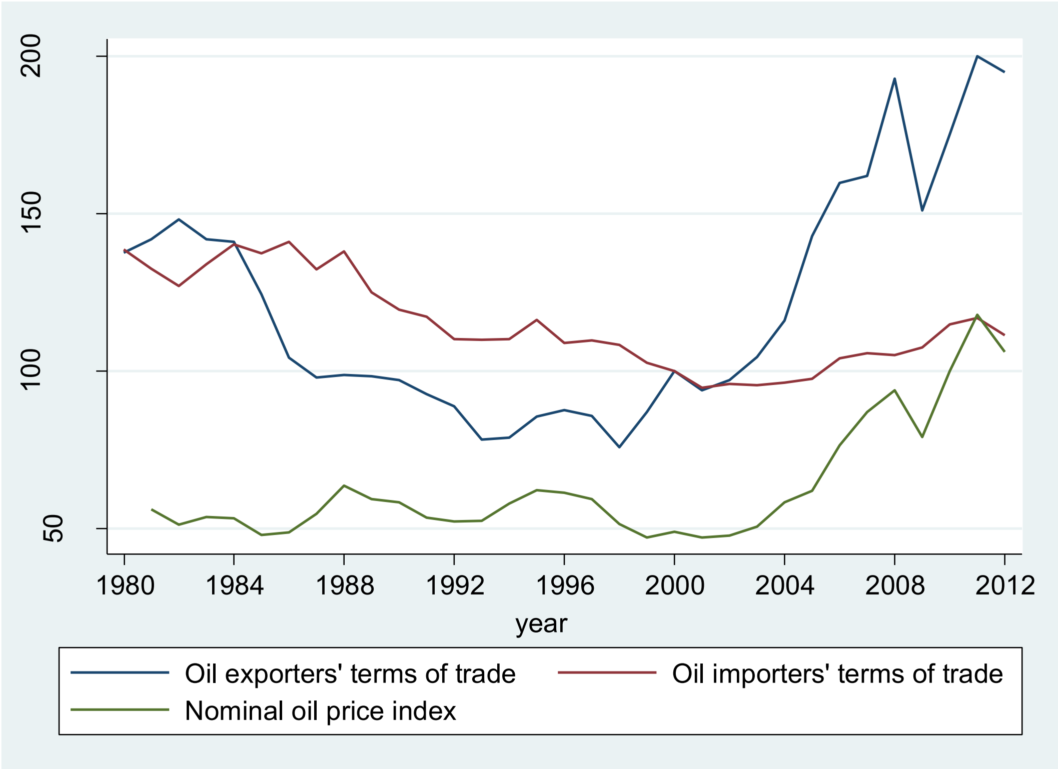
SSA's high dependence on primary commodity exports, limited development of their manufacturing and service sectors; and large agricultural sectors make the region particularly susceptible to trade shocks (Kose and Riezman, 2001, Muhanji and Ojah, 2011). Within a dynamic stochastic small open economy model calibrated to represent a typical African economy, Kose and Riezman (2001) showed that trade shocks account for almost half of the variation in aggregate output for African countries. The impact on the various components of aggregate output is even higher: trade shocks account for 80% and 86% of fluctuations in aggregate consumption and investment respectively. Furthermore, trade shocks were found to account for at least a third of the variation in employment and non-traded goods output; and are even more important than world interest rates in determining foreign asset holdings. Deaton and Miller (1995) find that negative trade shocks, and commodity price shocks in particular, complicate macroeconomic management for SSA countries and lead to fiscal and current account deficits. Muhanji and Ojah (2011) show that commodity price shocks lead to accumulation of external debt for SSA countries. Trade has also been shown to be the main channel through which these countries are affected by global economic shocks (Allen and Giovannetti, 2011, Berman and Martin, 2012). Therefore, for these countries more than others, large trade deficits would have negative implications for economic growth.

An important source of trade shocks is fluctuations in the price of crude oil. Figure 2.3 shows how the terms of trade of SSA countries vary with oil price shocks. The terms of trade of oil exporters move in tandem with oil prices, and the reverse is the case for oil importers. This is also true for the trade balance, as shown in Figure 2.4. Here, it is also evident that oil importers have sustained much larger trade deficits than oil exporters over the years. This suggests that the oil price plays a major role in determining the terms of trade and trade balances of SSA countries. Figure 2.5 shows the annual volatility of oil prices. It can be seen that oil price volatility is highest during periods of particularly high or low oil prices. The spikes in volatility correspond to the oil glut in the mid-1980s, the 1990/1991 oil shock due to reduced supplies following Iraq's invasion of Kuwait, the oil price fluctuations in the late 1990s associated the East Asian crisis, reduced oil production from Venezuela and Iraq in 2003, the mid-2008 oil price 'bubble' and the subsequent collapse following the onset of the global financial crisis[7]. Thus, in addition to the challenges posed by oil price level movements, SSA countries also have to deal with the potential effects of higher uncertainty. To the extent that oil price uncertainty reduces economic activity by delaying investment and consumption

[7] Hamilton 2011 provides a historical review of oil price shocks

decisions (Bernanke, 1980, Bloom, 2009), its negative effect could exacerbate the effects of unfavourable oil price changes while limiting the gains from favourable oil price movements (Ferderer, 1997).

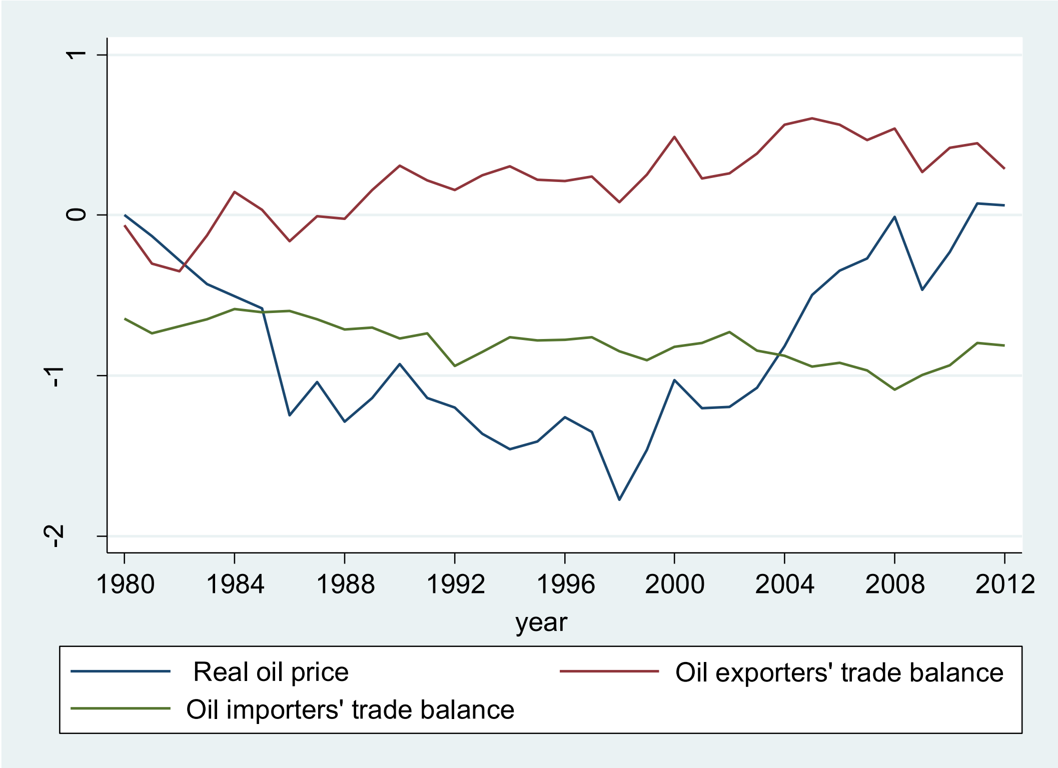
Figure 2.3: Oil prices and average terms of trade of SSA oil importers and exporters, 1980-2012.



Sources: Author's calculations using data from the World Bank's World Development Indicators (WDI) and International Monetary Fund's International Financial Statistics (IFS).

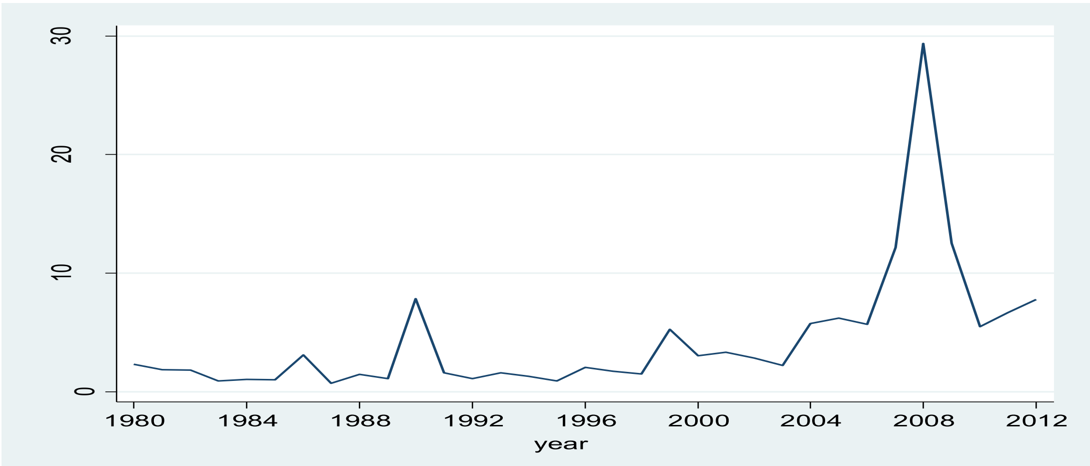
Notes: The oil price is the nominal US dollar 3 spot price index (the average of Dubai, UK Brent and Texas spot oil prices, as reported by the IMF IFS) and the terms of trade is the export price index divided by the import price index.

Figure 2.4: Oil prices and the average trade balance of SSA oil importers and exporters: 1980-2012



Sources: Author's calculations using data from International Monetary Funds' International Financial Statistics (IFS) and Direction of Trade Statistics (DOTS) Notes: The oil price is the log real 3 spot US dollar oil price, and the trade balance is calculated as the natural logarithm of the ratio of total exports to total imports.

Figure 2.5: Oil price volatility, 1980-2012

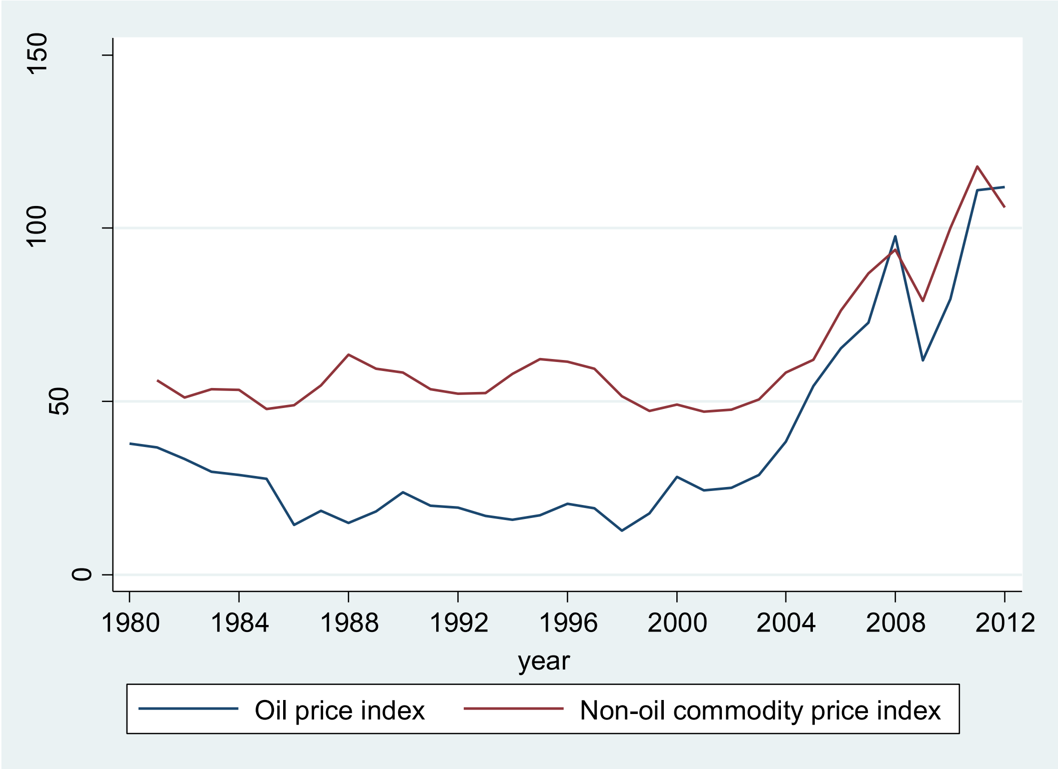


Source: Author's calculations using data from International Monetary Funds' International Financial Statistics (IFS)
Notes: the oil price is the nominal 3 spot US dollar oil price. The annual oil price volatility is measured as the standard deviation of the four (average) quarterly oil prices within each year.

SSA countries have some features that complicate their level of exposure to oil price shocks. First, due to the poor state of their oil refineries, SSA oil exporters import a large proportion of their refined petroleum needs. This means that even as their oil export earnings increase with oil prices, their oil import bill also rises. Thus, any improvement in their oil trade balance would be less than if they imported no oil at all. Second, the prices of SSA oil importers' primary commodity exports tend to be positively correlated with the oil price, as shown in Figure 2.6. This implies that with an oil price increase, their nonoil trade balance may improve not only through a real exchange rate depreciation (as in Bodenstein et al. (2011)), but also because the prices of their commodity exports are relatively higher. This will be the case especially if the oil price increase is driven by a booming world economy, such that there is an increase in the demand for primary commodities[8]. Third, SSA is one of the least integrated regions in global financial markets (World Bank 2012). Figure 2.7 compares the level of financial integration of SSA countries to other developing countries in Asia, Middle East and North Africa. Here, integration is measured as the sum of total foreign assets and foreign liabilities as a percentage of GDP. SSA and developing Asia have maintained average integration levels of less than 200% of GDP until the late 2000s when SSA integration increased. This is much lower than the integration level of Middle East and North African countries, averaging over 300% of GDP over the past two decades. Their relatively low integration level means SSA countries are less able to smooth consumption through international risk sharing in the face oil price shocks, and might sustain larger nonoil trade fluctuations than countries with access to foreign funds (as in Bodenstein et al., 2011).

[8] Kilian (2009) show that historically, oil price shocks have mainly been the result of precautionary oil demand shocks or global "aggregate demand shocks" that raise the demand of all raw materials needed by a booming world economy, as opposed to the supply side shocks that have been advanced in the earlier literature e.g. Hamilton (1983)

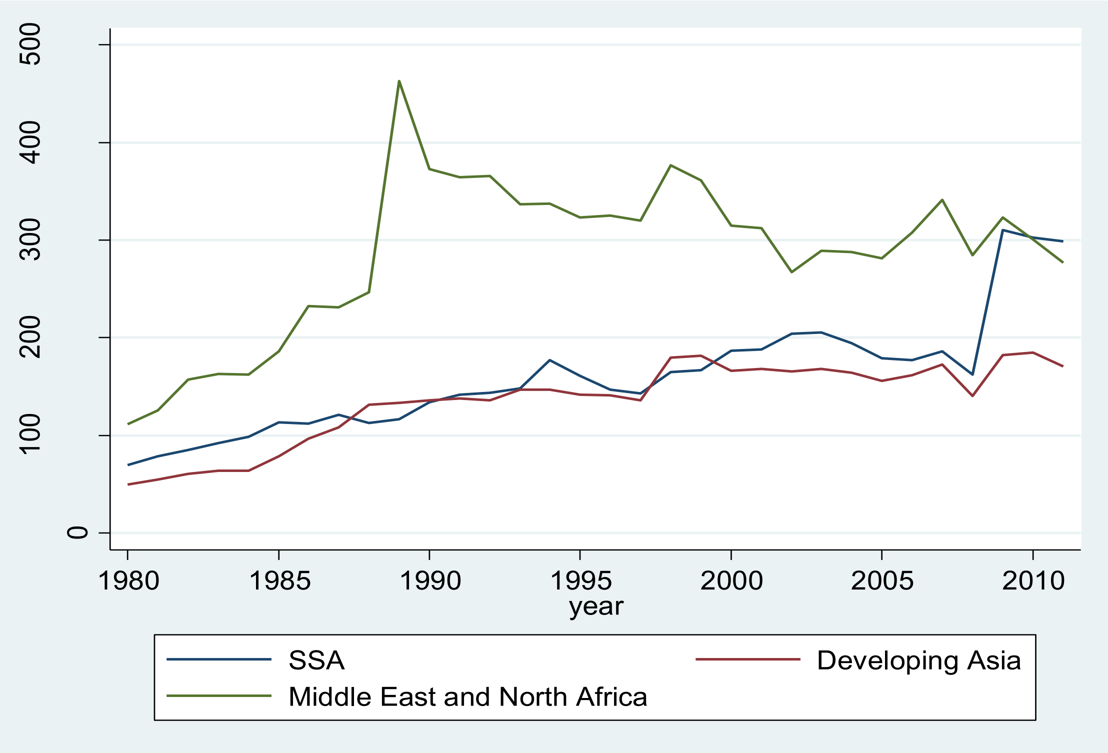
Figure 2.6: Oil and non-oil commodity price indices. 1980-2012



Sources: International Monetary Fund's International Financial Statistics (IMF IFS) and World Bank's Global Economic Monitor (GEM) Commodities Database.

Notes: The oil price index is the 3 spot US dollar oil price index, while the nonoil price index is sourced from the World Bank's database. Non-oil price index consists of prices of Food, Beverages, Agricultural raw materials and Industrial Metals and Precious metals.

Figure 2.7: Average Financial Integration of developing countries by region, 1980-2011



Source: Authors calculations using data from the extended and updated version of the dataset created by Lane and Milesi-Ferretti (2007)
Notes: Financial integration is calculated as the sum of total foreign assets and liabilities as a percentage of nominal GDP, all in US dollars. Developing Asia consists of Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Fiji, India, Indonesia, Lao P.D.R., Malaysia, Maldives, Nepal, Papua New Guinea, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sri Lanka, Thailand and Tonga. Middle East and North Africa consists of Algeria, Bahrain, Djibouti, Egypt, Iran, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, and Yemen. SSA consists of all SSA countries for which data is available.

There are currently 47 countries in Sub-Saharan Africa, and 13 of them have produced and exported crude oil at some point. These are Angola, Benin, Cameroon, Chad, Congo, Cote d'Ivoire, Democratic Republic of Congo, Equatorial Guinea, Gabon, Ghana, Nigeria, Sudan, and South Sudan. At present, Benin, Cameroon and Cote d'Ivoire are no longer consistent net exporters of oil. The rest are net oil importers. These are Botswana, Burkina Faso, Burundi, Cabo Verde, Central African Republic, Comoros, Eritrea, Ethiopia, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Namibia, Niger, Rwanda, São Tomé and Príncipe, Senegal, Seychelles, Sierra Leone, South Africa, Somalia, Swaziland, Tanzania, The Gambia, Togo, Uganda, Zambia and Zimbabwe.

In sum, given the importance of trade for the economic growth of Sub Saharan African countries, the importance of oil prices for their terms of trade, and factors that potentially complicate their oil price- trade balance relationship, it is important to examine the dynamics of this relationship for SSA countries.

Chapter 3: Nonlinear effects of oil price shocks on Nigeria's trade balance: Evidence from a Threshold Vector Autoregressive Model

3.1. Introduction:

Oil prices have experienced significant surges and downturns over the years. The volatility of oil prices implies uncertain terms of trade for SSA countries and volatile oil revenues for SSA oil exporters. Volatility represents a source of risk and uncertainty regarding the future path of oil prices, leading economic agents to delay irreversible investment and consumption decisions as they wait for useful information on future oil prices (Bernanke, 1980, Bloom, 2009). Oil price volatility can also influence the effects of oil prices on the economy in a nonlinear way. For an oil importing country, the negative impacts of oil price volatility have been shown to exacerbate negative effects of oil price increases and limit the gains from oil price decreases (Ferderer, 1997). Many studies have examined the nonlinear impacts of oil prices on various macroeconomic variables for oil importers and exporters, but not in relation to the trade balance. This chapter fills this gap by examining the nonlinear effects of oil price level and volatility shocks on the trade balance of the largest SSA oil exporter, Nigeria.

The bulk of the oil price- macro economy (OPM) literature focuses on the effects of oil prices and their volatilities on output and investment (Hamilton, 1983, Hamilton, 2008, Hamilton, 2011, Mork et al., 1994, Lee et al., 1995, Elder and Serletis, 2010, Farzanegan and Markwardt, 2009, Lorde et al., 2009, Mehrara and Sarem, 2009). This literature has shown that the effects of oil price level shocks are asymmetric, with positive oil price shocks having a higher impact than negative shocks for oil importing economies (Hamilton, 2003, Lorde et al., 2009, Elder and Serletis, 2010, Elder and Serletis, 2011, Lee et al., 1995). The attention turned towards asymmetry following the weaker relationships between US GDP data and oil price increases after 1985, as the oil price collapse in 1986 failed to produce an economic boom. This asymmetry has been shown to result from the effects of oil price volatility, (Ferderer, 1997, Elder and Serletis, 2010, Elder and Serletis, 2011). The effects of volatility itself may be nonlinear because large scale or long term investments may not be affected by small changes in oil prices which will generate low levels of volatility (Kilian and Vigfusson, 2011b, Huang et al., 2005). Van Robays (2012) show that oil price fluctuations have higher impacts on economic activity in uncertain times, and Jobling and Jamasb (2015) show that countries can tolerate oil price increases up to a certain point, after which they begin to adjust consumption levels.

The OPM literature has recently started to move towards examining the effects of oil prices on the trade balance (Backus and Crucini, 2000, Kilian et al., 2009, Bodenstein et al., 2011, Le and Chang, 2013). This recent focus on the trade balance stems not only from its importance for macroeconomic performance, but also because the past two decades have seen high global current account imbalances which are considered to be, at least in part, the result of oil price movements (Kilian et al., 2009, Rebucci and Spatafora, 2006). Studies on the oil price-trade balance relationship generally find that oil price increases improve the trade balance for oil exporters and deteriorate it for oil importers. However, they do not address the issue of nonlinearities in the effect of the oil price on the trade balance. Bodenstein et al. (2011) provide a theoretical framework where the effects of oil prices on the trade balance work through wealth transfer from oil importers to exporters, and a consequent nonoil trade adjustment. However, the authors acknowledge that the linear framework adopted in their model is at odds with advancements in the broader OPM literature, where the role of asymmetries has been stressed. This chapter addresses this gap in the literature by examining the nonlinear, asymmetric and threshold effects of oil price level and volatility shocks on the trade balance.

There are reasons to believe the effects of the oil price and its volatility on the trade balance are plausibly nonlinear. First, the relatively low price elasticity of demand for oil means that small changes in the level of the oil price might not affect the quantity of traded oil and nonoil goods. Indeed, Kilian and Vigfusson (2011b) point out that large scale or long term investment demand is unlikely to be affected by small changes in oil prices which will generate low levels of volatility. Second, in line with Lee et al. (1995), increases in the level of the oil price may have higher impacts in an environment of stable prices than where prices have been known to be volatile. Third, as noted by Van Robays (2012), periods of high volatility may be associated with higher use of hedging instruments and futures markets, such that increases in oil price volatility may have a lower effect on oil demand when volatility is already high. On the other hand, given a historically volatile oil market and different degrees of risk aversion of traders, an increase in oil price volatility may only affect trading decisions when volatility is sufficiently high. Also, some channels through which trade is affected by oil price fluctuations, such as transportation costs, may only be affected when volatility exceeds a tolerable threshold. These are valid questions to investigate for the trade balance where the literature is young. If these nonlinearities do exist, and are strong, then conclusions and inferences made from linear models would be misleading.

To examine these nonlinear effects, this chapter focuses on one oil exporting country, Nigeria. Nigeria is not only the largest oil exporting country in Sub-Saharan Africa, it is also the largest economy on the continent. According to the US Energy Information Administration (EIA), Nigeria was the world's 4th largest exporter of Liquefied Natural Gas in 2012, and the 6th largest exporter of crude oil in 2013 (IEA, 2013). Its imports generally consist of energy intensive durable goods, food items, as well as refined petroleum products. Nigeria has been studied very little with regards to its trade balance despite the importance of oil to its economy. It is thus an ideal candidate for examining the oil price-trade balance relationship while addressing potential nonlinearities suggested by the broader OPM literature[9].

This chapter utilises the Threshold Vector Autoregressive (TVAR) model of Balke (2000). The TVAR model is attractive for this study because it allows the estimation of asymmetries between positive and negative shocks, as well as non-proportional effects of large and small shocks within the threshold model. This comprehensive analysis of nonlinearities is desirable since no form of nonlinearity has been examined for the trade balance. In this chapter, a threshold value of oil price volatility is endogenously estimated, on the basis of which the sample is divided into an "upper regime" and a "lower regime", corresponding to high and low values of volatility respectively. A separate TVAR is then estimated for the oil and non-oil components of the trade balance as well as the overall trade balance. This decomposition allows an examination of the theoretical mechanisms through which the oil price affects the trade balance, in line with the model in Bodenstein et al. (2011). The robustness of the results to an alternative threshold measure of oil price volatility is also checked.

Results from non-linear generalized impulse response functions show that oil price level shocks have more dramatic effects on all the trade balance components when volatility is above its threshold value. The presence of asymmetry between increases and

[9] The choice of country also has to do with data limitations. To implement the TVAR model, a long time series of data (of at least quarterly frequency) is needed for each country. In addition, for meaningful analysis, data on the oil and nonoil components of the trade balance is needed. Such disaggregated quarterly data for SSA countries is unavailable. It is argued that given Nigeria's oil market status and the relative availability of its data, it would be sufficient for this thesis to consider the nonlinear effects of oil prices using only Nigerian data.

decreases in oil prices is found to depend on the measure of volatility used as the threshold variable. Decreases in volatility are found to be more important than increases irrespective of whether volatility is above or below its threshold value, reflecting asymmetric impacts of volatility shocks. The effects of both increases and decreases in volatility are higher when volatility is above its threshold value, reflecting threshold effects. The patterns of the effects show that an increase in volatility hurts the trade balance on impact only if the increase occurs when volatility is already high. Decreases in volatility are found to encourage both oil and nonoil imports within a year of the shock. Overall, high oil price volatility is found to propagate the effects of volatility shocks on the trade balance while making the effects of oil price level shocks more dramatic; and reduced oil price volatility is found to stimulate trade in both oil and nonoil goods.

This chapter finds evidence that at least for Nigeria, the effects of oil price volatility on the trade balance are non-linear, depending on the already existing level of volatility. The effects of volatility itself are asymmetric. However, volatility does not consistently induce asymmetries in the effects of oil price level shocks. Although the focus is only on one oil exporting country, the results potentially have important implications for future research. This is because if such nonlinearities are found to hold true for other countries, then future theoretical and empirical work should take them into consideration. There is also an implication for policies designed to insulate the economy against oil price fluctuations, as the underlying volatility environment is found to be an important factor.

The remainder of this chapter is organised as follows. Section 3.2 provides a review of related theoretical and empirical literature. Section 3.3 discusses the data and methodology used. Section 3.4 presents the results and Section 3.5 provides a discussion of the results. Conclusions and recommendations are made in Section 3.6.

3.2. Literature Review:

This chapter is related to two strands of literature. One is the literature on nonlinear effects of oil price level and volatility shocks on macroeconomic activity (OPM). The other is the literature on the effects of these shocks on the trade balance where nonlinearities have not been addressed.

3.2.1. Nonlinear effects of oil price level and volatility shocks on macroeconomic activity:

Most studies in the OPM literature focus on the effects of oil price shocks on output for oil importing countries (Hamilton, 1983, Hamilton, 2008, Hamilton, 2011, Mork et al., 1994, Lee et al., 1995, Elder and Serletis, 2010). Fewer studies have examined the effects on oil exporters (Huang et al., 2005, Farzanegan and Markwardt, 2009, Lorde et al., 2009, Mehrara and Sarem, 2009). Many of these authors have suggested that the relationship between oil price movements and economic growth is asymmetric (Lee et al., 1995, Mork et al., 1994, Hamilton, 2008, Hamilton, 2011, Balke et al., 2002, Sadorsky, 1999). Ferderer (1997) showed that oil price volatility is an important source of this asymmetry. The argument is that large increases or decreases in oil prices are associated with higher volatility which is itself presumed to have negative impacts on the economy. Ferderer (1997) argues that for an oil importing economy, volatility generated by rising oil prices would eventually worsen the negative effects of oil price increases on output, while that arising from falling oil prices would dampen the positive effects of oil price decreases. As such, increases in oil prices would have higher impacts than decreases. Support for asymmetric oil price effects resulting from volatility has been found by Elder and Serletis (2010) and Elder and Serletis (2011). In the context of Nigeria, asymmetries in the effects of oil prices have been found by Aliyu (2011) and Iwayemi and Fowowe (2011). The former found that oil price increases are more important than decreases in explaining Nigeria's output growth, while the latter found the reverse to be the case. In contrast to most studies that consider the role of asymmetries, Kilian and Vigfusson (2011a) find that the effects of oil price increases and decreases on economic growth are symmetric. They argue that this may be the result of widely used oil price measures that are inappropriate for the VAR framework within which most of these asymmetries have been found. However, Hamilton (2011) argues that the results from Kilian and Vigfusson (2011a) suffer from an unstable model specification. There is thus an unresolved academic debate about asymmetries in the effects of oil prices on the economy (see for example Kilian and Vigfusson (2011b), Hamilton (2011),Kilian and Vigfusson (2014)). The issue is ultimately an empirical one to which this study contributes evidence.

Apart from asymmetric effects resulting from volatility, the analysis in Lee et al. (1995) suggests that the effects of oil prices on the economy might depend on a volatility threshold. They argue that oil price shocks will have a higher impact in an environment of hitherto stable prices, while a shock of a similar size will have a lesser impact where prices have been known to be erratic. In other words, shocks that occur when volatility is low are more important than those that occur when volatility is high. Kilian and Vigfusson (2011b) point out that large scale or long term investments may not be affected by small changes in oil prices which will generate low levels of volatility, also suggesting that oil price shocks will have higher impacts when volatility exceeds a tolerable threshold. Van Robays (2012) shows that a highly uncertain macroeconomic environment is associated with a stronger response of oil prices to oil demand and supply shocks, leading to higher oil price volatility. Using the TVAR model utilized in this chapter, he shows that economic activity is more affected by oil price fluctuations above a macroeconomic volatility threshold.

The effects of oil price volatility have also received attention in the literature. Within partial equilibrium models, Bernanke (1980) and Bloom (2009) show that uncertainty about oil prices will delay irreversible investment and consumption decisions as economic agents wait for new information that could determine the potential returns to investment. This delay in investment will reduce the growth in oil demand and output. On the other hand, Plante and Traum (2012) examine the effects of oil price volatility on macroeconomic aggregates within a real business cycle model. They find that oil price uncertainty is associated with reduced durables consumption, higher precautionary savings, higher investment and real GDP[10]. Başkaya et al. (2013) also show within a real business cycle model that an increase in oil price volatility induces precautionary savings which then increase physical investment and output. Since physical investment is less costly than investment in international bonds for countries with limited access to international bond markets, economic agents would use the higher savings for the former, despite its increased riskiness. In line with Bernanke (1980) and Bloom (2009), Ferderer (1997), Jo (2014), and Bredin et al. (2011) empirically find negative effects of oil price volatility on output and investment. Kellogg (2010) and Elder and Serletis

[10] Irreversibility of investment decisions does not alter this outcome.

(2010) also find that oil price volatility reduces investment in the mining industry because of the more direct implications it has on the sector's return to investment. This is in line with Litzenberger and Rabinowitz (1995) who argue that during uncertain times, oil producers might prefer to reduce extraction in the face of oil demand and supply shocks because higher uncertainty raises the value of oil below the ground relative to that above the ground, increasing the response of the oil price. Together, these findings suggest that oil production and oil demand are negatively affected by increases in volatility, implying a deterioration of oil exporters' oil trade balance. On the other hand, Alquist and Kilian (2010) show that higher oil price volatility, if it induces uncertainty for oil importers about future oil supply, is associated with increased precautionary demand for oil by oil importers. If this is the case, then oil price volatility may improve the oil trade balance of oil exporters. If oil exporters also export other primary commodities that are used as inputs in production, as is the case for Nigeria, then their nonoil balance may deteriorate if increased oil price volatility leads to a reduction in demand for their nonoil exports by inducing lower investment in their oil importing trading partners, in line with Bernanke (1980). Alternatively, it might improve if oil volatility leads to a reduction in demand for durables consumption and hence imports, as found in Elder and Serletis (2010). While these studies on the effects of oil price volatility on output and investment have general implications for its potential impact on the trade balance, the implications do not encompass nonlinearities.

Studies that use a threshold model to examine the effects of volatility on the economy include Sadorsky (1999), Huang et al. (2005), Adeniyi et al. (2011), and Van Robays (2012). Sadorsky (1999) uses a zero threshold and finds that increases in volatility have higher effects on stock market activity than decreases. Using a multivariate threshold vector auto regression (MTVAR) model similar to the TVAR, Huang et al. (2005) find that macroeconomic aggregates react more to oil price volatility when it is above its threshold value for Canada, US and Japan. Adeniyi et al. (2011) follow the same threshold method in a similar study for Nigeria. They find no significant threshold effects in the response of Nigeria's GDP growth to oil price volatility. Their results must however be viewed with caution, as they do not test for a nonlinear structure in their data, and they impose an arbitrary threshold value for volatility. The analysis from the TVAR model in Van Robays (2012) shows that oil price volatility is higher in uncertain times, suggesting that its impact on economic activity would also be higher when volatility is high. Taken together, the findings of these studies suggest that the effect of oil price volatility is higher when volatility is initially above its threshold level.

Overall, none of the studies on the nonlinear effects of oil prices on the economy, or on the linear and nonlinear effects of volatility on the economy, consider the trade balance. This chapter addresses this gap in the literature.

3.2.2. The effects of oil price level and volatility shocks on the trade balance:

The literature on the oil price-trade balance relationship is relatively young and nonlinearities have not yet been studied in this context. The theoretical literature generally shows that the effect of oil price level shocks on the overall trade balance is positive for oil exporting countries and negative for oil importers. However, the positive effects for oil exporters can be offset by their increased wealth and hence increased expenditure on imports, as well as through an exchange rate appreciation. These offsetting effects are manifested through the negative response of the non-oil trade balance which cushions the positive response of the oil trade balance (Bodenstein et al., 2011).

Backus and Crucini (2000) provide a theoretical model in which they augment a stochastic two country growth model with a third country that produces oil. Calibrating the model for the US and EU countries, they show that oil price changes account for much of the variation in the terms of trade between countries. Bodenstein et al. (2011) build on the work of Backus and Crucini (2000) and analyse the effects of oil price changes on a country's trade balance using a Dynamic Stochastic General Equilibrium (DSGE) model. The model consists of two countries- an oil exporter and an oil importer. Oil is used as an input in the production process and as a consumption good. It is shown that oil price changes affect the nonoil trade balance through the transfer of wealth from oil importing countries to oil exporting countries. The combined responses of the oil and non-oil trade balances then determine the response of the overall goods trade balance. Under incomplete international financial markets and low price elasticity of demand for oil, oil price increases lead to a deterioration of the oil trade balance of an oil importing country. This leads to increased wealth transfer to the oil exporter and a reduction in wealth for the importer. This wealth transfer effect leads to a decline in consumption and a depreciation of the real exchange rate of the oil importer, helping to improve the nonoil trade balance. The nonoil trade balance therefore always adjusts to partly offset changes in the oil trade balance. By construction, the effects on the oil exporter's trade balance are the opposite of that of the oil importer, such that oil price increases lead to a surplus of the oil trade balance. This, working through higher wealth and exchange rate appreciation, leads to a deterioration of the nonoil trade balance. Under incomplete financial markets, the response of the oil trade balance dominates such that the overall trade balance improves.

In a similar argument, Rebucci and Spatafora (2006) posit that any trade surpluses an oil exporter may gain from increased oil prices will be partly offset by increased growth and real exchange rate appreciation. Huynh (2016), in a DSGE model similar to Bodenstein et al. (2011), stresses the importance of energy intensive durable goods in determining the response of the non-energy trade balance. He shows that the demand for durables is negatively affected by oil price increases. For a country like Nigeria whose imports consist significantly of durable goods, this implies that an oil price increase might initially improve the nonoil balance through discouraging importation, and the expected deterioration would occur after the positive wealth effects of the oil price increase sets in.

Abeysinghe (2001) showed that negative growth for oil importers resulting for an oil price increase is transmitted to oil exporters through the trade channel. Korhonen and Ledyaeva (2010) build on the work of Abeysinghe (2001) and show that an unexpected oil price increase will have a positive initial effect on oil exporters and a negative effect on importers. However, since it represents a negative supply shock to importers and lowers their income, their aggregate demand will eventually fall. This will in turn reduce some of the positive effects of the oil price increase for oil exporters because they now face lower demand from their trading partners. On the other hand, oil importers may also enjoy some positive effects of oil price increases on their exports through increased demand from the now wealthier oil exporters. This implies similar conclusions to that of Bodenstein et al. (2011), where the effects on the trade balance in any one direction is partly offset by wealth transfer effects. This implies that, in response to oil price increases, Nigeria's overall trade balance should improve initially as the oil trade balance improves, but it should subsequently deteriorate as higher wealth, increased growth and an appreciated exchange rate lead to nonoil trade balance deterioration.

Empirically, Kilian et al. (2009) studied the relationship between oil prices and external balances for a broad sample of oil importing and exporting countries using data from

1970-2005 and a linear VAR model. Consistent with Bodenstein et al. (2011), they find that oil exporting countries experience an oil trade surplus in response to oil price increases. They find the response of the non-oil trade balance to be negative but not large enough to offset the oil trade surplus, such that the overall trade balance improves. Le and Chang (2013) study the impacts of oil prices on the trade balances of Malaysia (an oil exporter) Singapore (an oil refinery) and Japan (an oil importer). The results from impulse response functions of a VAR show that for Malaysia (an oil exporter), improvements in its oil, non-oil and overall trade balances are associated with unexpected oil price increases. For oil importing Singapore and Japan, the effects are negative. Using monthly data from 1980-2011 and VAR techniques, Arouri et al. (2014) find that India's trade balance is negatively affected by positive oil price shocks. These studies are the only ones that empirically examine the effects of oil prices on the goods trade balance. Other studies have however examined its effects on exports, trade volumes, and current account balances. For instance, Ahmed and O'Donoghue (2010) and Muhammad (2012)) also find that oil price increases are associated with a reduction in exports of Pakistan through inducing an increase in production costs. These negative impacts are expected since Pakistan is an oil importer. Chuku et al. (2011) study the effects of oil price shocks on the Nigerian current account balance. Using quarterly data from 1970 to 2008, he estimates a linear structural VAR model. He finds that unexpected oil price increases lead to an improvement in the current account surplus and a subsequent decline. His variance decomposition analysis show that oil price shocks account for over 15% of the variation in the current account balance. Iwayemi and Fowowe (2011) also find Nigeria's trade balance to be positively affected by oil price increases. Abu-Bader and Abu-Qarn (2010) find that structural breaks in the trade ratios of 57 countries over the period 1957-1993 coincided with oil price shocks, suggesting that these may account for the observed breaks. Bridgman (2008) also show that changes in trade volumes globally can be accounted for by changes in oil prices which affect the cost of transporting tradable goods.

Theoretical literature on the effects of oil price volatility on the trade balance is scarce. The argument is derived from the broader OPM literature - volatility represents a source of uncertainty and risk to both exporters and importers. Chen and Hsu (2012) argue that since uncertainties about the future paths of oil prices would induce risk averse consumers and producers to postpone irreversible consumption and investment expenditures, trade volumes will also reduce. However, the effects should depend on the response of the oil and non-oil components of the trade balance which these authors do not consider. Another strand of literature focuses on the implications of oil price fluctuations for the transportation of traded goods, given the high dependence on oil as fuel. Here also, high oil price volatility is found to discourage trade (Hummels, 2007, Curtis, 2009, Rubin and Tal, 2008) .

Empirically, no study has examined the effects of oil price volatility on the trade balance, but two studies have examined its impact on trade volumes. Chen and Hsu (2012) examine the effects of oil price volatility on bilateral trade volumes using panel data on 84 countries from 1984-2008. They measure the trade volume as the sum of imports and exports of a country. They find that generally, oil price volatility reduces trade volumes. The effect is however found to depend on the source of the shock as well as the role of the country as a net oil importer or exporter in the world market. They find a positive but statistically insignificant effect for oil exporters and a negative, statistically significant effect for oil importers. Shiu-Sheng and Kai-Wei (2013) also study the effect of oil price volatility on bilateral export volumes using a gravity model of international trade and annual data on 117 countries from 1984-2009. They find that volatility has a significant and negative effect on export volumes irrespective of the position of the trading partners as oil importers or exporters in the world market; and that this effect is worsened by increased distance between two countries, pointing to the role of transport costs.

The two studies above focus on trade volumes in order to deduce the effects of volatility on international linkages and globalisation, while this chapter contributes to the empirical literature by focusing on the trade balance. In addition, none of the studies on the effects of oil prices on the trade balance, or the effects of oil price volatility on trade volumes, considers the potential role of asymmetries and threshold effects that have been established in the OPM literature. These are the gaps in the literature that this chapter attempts to fill.

3.3. Data and Methodology:

3.3.1. The Theoretical Model

In this thesis, the theoretical trade balance model adopted is the imperfect substitutes model of Bickerdike-Robinson-Metzler, which is comprehensively discussed in Goldstein and Khan (1985). The key assumption of this model is that domestic goods and foreign goods are not perfect substitutes. Since oil has no close substitutes, this model is better suited to this thesis than the perfect substitutes model. The consumer is assumed to maximise utility subject to a budget constraint. As such, the demand for exports and imports depend on the level of foreign and domestic incomes, as well the relative prices of the trade goods. It is further assumed that the consumer has no money illusion. The Marshallian demand equations for imports M and exports X are given as:

$$M = M(r, Y^d); \quad X = X(r, Y^f) \ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

$$r = e * {P^f}/{P^d} \ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

Where r is the real exchange rate defined as the nominal exchange rate e multiplied by the ratio of the foreign good price (the import price) P^f and the domestic good price (the export price) P^d. Y^d is the domestic income level and Y^f is the foreign income level. The trade balance TB can then be derived as the difference between exports and import values in domestic currency thus:

$$TB = X(r, Y^f) - rM(r, Y^d) \ldots\ldots\ldots\ldots (3.3)$$

$$TB \equiv TB(r, Y^d, Y^f) \ldots\ldots\ldots\ldots\ldots\ldots (3.4)$$

Empirically, the real trade values and real foreign and domestic incomes are used. The main caveats of this model relate to the measurement of the real trade data- how trade data are deflated, and the quality of the import and export price proxies (Goldstein and Khan, 1985). As will be discussed, this thesis avoids this problem by measuring the trade balance not as the difference but as the ratio of exports to imports, so that it does not matter whether the trade data are in nominal or real terms.

3.3.2. Methodology:

To determine if the response of the trade balance to changes in the oil price and its volatility depends on a volatility threshold, this study utilizes the Threshold Vector Autoregressive model (TVAR) of Balke (2000). The TVAR is a simple way to capture possible nonlinearities in the response of economic variables to shocks (Balke, 2000). Unlike alternative threshold models such as Markov Switching models, the TVAR allows the threshold variable to be observed. It also allows the investigation of asymmetric and non-proportional effects within the threshold models, because effects of the shocks are allowed to depend on the size and sign of the shocks as well as the past history of the shocks. The impulse responses are nonlinear and it is possible to distinguish between the response of the trade balance to positive and negative shocks to any endogenous variable during periods of high oil price volatility (upper regime) and low oil price volatility (lower regime). Volatility is itself endogenous in the models estimated, such that shocks to other variables in the system can also result in regime switching. The TVAR estimated for each component of the trade balance is;

$$Y_t = A^1 Y_t + B^1(L) Y_{t-1} + (A^2 Y_t + B^2(L) Y_{t-1} I(C_{t-d} > \gamma)) + U_t \text{......... (3.5)}$$

Where Y_t is a vector of 5 endogenous variables: a measure of world and domestic income; the real oil price; its volatility; the real effective exchange rate; and the relevant component of the trade balance (oil, nonoil or overall trade balance). U_t is a vector of structural disturbances. $B^1$and B^2 are lag polynomial matrices while $A^1$and A^2 are structural contemporaneous relationships in the two regimes respectively. Both contemporaneous and lagged relationships are allowed to change across regimes. $I(C_{t-d} > \gamma)$ is an indicator function which depends on the threshold variable C_{t-d}, the threshold value γ, an on delay d. The indicator function equals 1 when $C_{t-d} > \gamma$ and 0 otherwise. The threshold variable C_{t-d} is the two period moving average of the volatility measure in order to allow for some persistence in the volatility regimes. Regime switching is endogenous since C_{t-d} is a function of oil price volatility which itself is one of the endogenous variables in Y_t . As such, shocks to any of the variables in the VAR which affect oil price volatility may cause a regime switch. At least one lag of the threshold variable is needed (the delay parameter d) and it is set to 1. Setting $d = 1$ is the practice among most studies using this approach (Balke, 2000, Batini et al., 2012, Afonso et al., 2011). Since the interest is in the response of the trade balance when a regime switch has just occurred, rather than when it occurred long ago, a 1 quarter lag is feasible (Batini et al., 2012). A lag length of two quarters is used in the TVAR. This is the lag length determined by the Akaike Information Criteria (AIC).

It is assumed that there is a recursive structure with the causal ordering as follows: income differential (the difference between world and Nigeria's output), real oil price, real oil price volatility, real effective exchange rate, and finally the relevant component of the trade balance. It is assumed that the income differential measure, since it contains the world output, is the most exogenous and would affect all the other variables within the same quarter but would only be affected after a lag by shocks to the other variables. We thus assume that even shocks to the oil price will only affect world output after a lag. We order the oil price next because a shock to it will immediately affect the level of oil price volatility. It is also more exogenous than the REER since it is assumed not only to cause a nominal appreciation of the Nigerian currency, the Naira, but also to affect inflation levels, thereby affecting the REER. Finally, the oil, nonoil and overall trade balances are assumed to be the most endogenous since they would respond within the same quarter to changes in income (both domestic and world income), changes in the oil price and hence its volatility, as well as the REER through the latter's implications for relative prices. It is less plausible to assume that changes in the trade balance would affect any of the variables without allowing for a lag. For instance, overall domestic output may only be affected by this period's trade balance in the next period. Nigeria's role as a major oil exporter does not accord it a large role in determining oil prices through its oil exports since oil prices are mainly determined by global economic and/or political conditions, making it unlikely that the oil price or its volatility is contemporaneously endogenous to Nigeria's trade balance[11]

3.3.2.1. Testing for the TVAR and Estimating the Threshold Values:

In order to estimate the TVAR, the nonlinear structure is tested by imposing the null hypothesis of a linear VAR (no threshold behaviour) against the alternative hypothesis of threshold behaviour. If the threshold value γ was known, then testing the null hypothesis of no threshold would simply entail testing that $A^2 = B^2 = 0$, and a heteroskedasticity-robust Wald statistic would be valid (Hansen, 1996). However, the threshold value is unknown and inference is nonstandard since this value is not identified under the null. To test for a threshold, the method of Hansen (1996) is adopted. Here, the specified TVAR model is estimated by least squares for all possible threshold values. For each value, the hypothesis of equality between the linear and nonlinear models is then tested and the estimated threshold value chosen is the one that maximises the log determinant of the structural residuals. As in Balke (2000), threshold

[11] It can be argued that the oil price and its volatility can contemporaneously affect the income measure since the latter contains Nigeria's income. We check the robustness of the results to the alternative ordering where these oil variables are ordered first, and the results remain unchanged. They are available upon request.

values were set so that at least 15% of the observations plus the number of parameters remain in each regime.

3.3.2.2. Nonlinear Impulse Response Functions:

Based on the estimated threshold values, it is possible to examine the response of the trade balance and its oil and nonoil components to shocks across regimes by using nonlinear impulse response functions. Unlike the linear VAR, the moving average representation of the TVAR is not linear in the shocks both across shocks and over time. As shown by Koop et al. (1996), impulse response functions in nonlinear models are dependent on the history of the variables as well as the size and sign of the shocks. The nonlinear Generalised Impulse Response Functions (GIRF) of Koop et al. (1996) are utilised using the bootstrap simulations suggested by Balke (2000)[12]. The GIRF is computed as the change in the conditional expectation of a variable Y at horizon k as a result of knowing the value of a particular exogenous shock at time t, u_t. The impulse response function can be written as

$$E[Y_{t+k}|\Omega_{t-1}, u_t] - E[Y_{t+k}|\Omega_{t-1}] \qquad (3.6)$$

Ω_{t-1} is the initial condition, or the particular history of the variables in the period preceding the shock. This determines whether the system is initially in a high or low volatility regime. To compute the GIRFs, the sign and size of the shocks are specified as +/-2 standard deviation shocks to represent large positive and negative shocks[13]. No restriction of symmetry is placed on the shocks within each regime, and it is possible to see if positive and negative shocks have different impacts. As the initial conditions, each actual observation in the sample during which the economy is in a high volatility regime or low volatility regime is used, so it is assumed that the system is initially in the upper or lower regime. The horizon is set at 12 quarters. Following Balke (2000), the conditional expectations are simulated by drawing random vectors of shocks u_{t+j}, $j = 1\ to\ k$, and then first simulating a path for the variable conditional only on the initial condition Ω_{t-1}. As a next step, another path of the variable of interest is simulated, now conditional on the initial condition as well as a given realization of the shock u_t. The

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[12] The TVAR literature refers to these impulse response functions as "generalised" because they are shock and history dependent, and regime switching can occur during the duration of the shock, as in Koop et al. (1996). However, they are still subject to the composition problem given the structural because the Cholesky decomposition is used.

[13] The effects of small shocks (+/- 1SD) have also been investigated and they follow the direction of large shocks with smaller magnitudes. Since there are no significant non-proportionalities, only the results for large shocks are reported; those for small shocks are shown in appendix A.

difference between the two provides one estimate of the generalised impulse response at horizon k(Calza and Sousa, 2006). The simulations are repeated 500 times for each initial condition. The average of the simulated impulse responses is then the estimated impulse response at horizon k.

3.3.3. Data:

This study uses quarterly data from 1986Q1 to 2013Q4. The trade balance is decomposed into its oil and non-oil components. This is preferable to using only the overall trade balance because it allows the examination of the mechanisms through which the oil price affects the overall trade balance, as postulated by the model Bodenstein et al. (2011). The data on oil and non-oil exports and imports as well as oil prices are obtained from the Nigerian National Bureau of Statistics (NBS) and the Central bank of Nigeria (CBN). The Bonny Light crude oil price is used as it is Nigeria's reference crude oil price. Quarterly data on Nigeria's oil and non-oil imports have only been compiled since 2008. This data is therefore interpolated based on annual oil and non-oil imports reported by the NBS using Kalman smoothing for log-linear models, with iterated linearizations. Nigeria's Real Effective Exchange Rate (REER), Index of Industrial Production (IIP), Consumer Price Index (CPI), and Advanced countries'[14] (IIP) are obtained from the International Monetary Fund's International Financial Statistics (IFS). The IIP is used due to the unavailability of world GDP data at quarterly frequency. Advanced countries' IIP is then used as a proxy for world IIP as the latter is unavailable for the full sample period at quarterly frequency. The difference between advanced countries' IIP and Nigeria's IIP is used as the measure of income, such that an increase represents higher world income relative to Nigeria's income. The CPI is used to deflate the oil price series. All variables except the volatility measures are expressed in logarithmic first differences.

The real oil price at the t_{th} quarter (rop_t) is measured as the quarterly growth in the real oil price, thus;

$$rop_t = \ln(\frac{op_t}{op_{t-1}}) \qquad (3.7)$$

[14] The 'advanced country' group of the IMF IFS consists of Australia, Austria , Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, San Marino, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan Province of China, United Kingdom, and the United States.

Where op_t is the real oil price in quarter t. Throughout this chapter, the growth in the real oil price will be referred to as the real oil price "level" to distinguish it from the real oil price "volatility". As in Elder and Serletis (2010), Le and Chang (2013) and Shiu-Sheng and Kai-Wei (2013), the oil price shocks in this study are not decomposed as oil supply shocks, oil demand shocks and global aggregate demand shocks, as proposed by Kilian (2009). Thus, an oil price shock in this context is best thought of as an average oil shock. Indeed, Bodenstein et al. (2011) show that oil price shocks arising from both oil demand and oil supply shocks have similar qualitative effects on the trade balance. Oil price volatility is measured as the quarterly standard deviation of monthly real oil price growth thus:[15]

$$SD_t = \sqrt{\frac{\sum_{m=1}^{3}(rop_m - \overline{rop})^2}{3-1}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.8)$$

Where rop_m is the monthly real oil price growth and $\overline{rop}$ is the quarterly mean of rop_m. Thus, for each quarter, the calculated volatility is the standard deviation of the real oil prices of the three months within the quarter.

Other measures of volatility commonly used in the literature are the conditional variance and conditional standard deviation from a Generalised Autoregressive Conditional Heteroscedasticity (GARCH) model. In this chapter, it is checked whether the results are robust to using the conditional standard deviation from a GARCH (1, 1) model for monthly real oil price growth thus:

$$rop_m = \mu_m + \sqrt{\sigma_m^2}\,\varepsilon_m\,; \quad \varepsilon_m \sim N(0,1) \ldots\ldots\ldots\ldots\ldots\ldots (3.9)$$

Where μ_m and $\sqrt{\sigma_m^2}$ are the monthly mean and standard deviation of real oil price growth, rop_m. ε_m is the error term. The GARCH model for the conditional variance, σ_m^2 is:

$$\sigma_m^2 = \omega + \alpha\sigma_{m-1}^2\varepsilon_{m-1}^2 + \beta\sigma_{m-1}^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.10)$$

The monthly conditional standard deviation, σ_m, is thus:

$$\sigma_m = \sqrt{\sigma_m^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.11)$$

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[15] This standard deviation measure of volatility is also adopted by Chen and Hsu (2012) and Shiu-Sheng and Kai-Wei (2013), among others.

The quarterly conditional standard deviation is then computed as the 3-month average of σ_m:

$$GARCH_t = \frac{\sum_{m=1}^{3} \sigma_m}{3} \text{.............................} \quad (3.12)$$

The volatility in each period using the GARCH measure is dependent on the oil price growth and volatility in the previous period, such that is captures the persistence in volatility over time. In contrast, the SD measure in each period depends only on the oil prices within that period, with no information on volatility persistence. While this inherent difference between the two measures is reflected in the results, it is still shown that the main findings are robust to using both measures of volatility.

Finally, the overall trade balance (TB), oil trade balance (OTB) and the nonoil trade balance (NOTB) are defined as the log ratio of exports to imports thus:

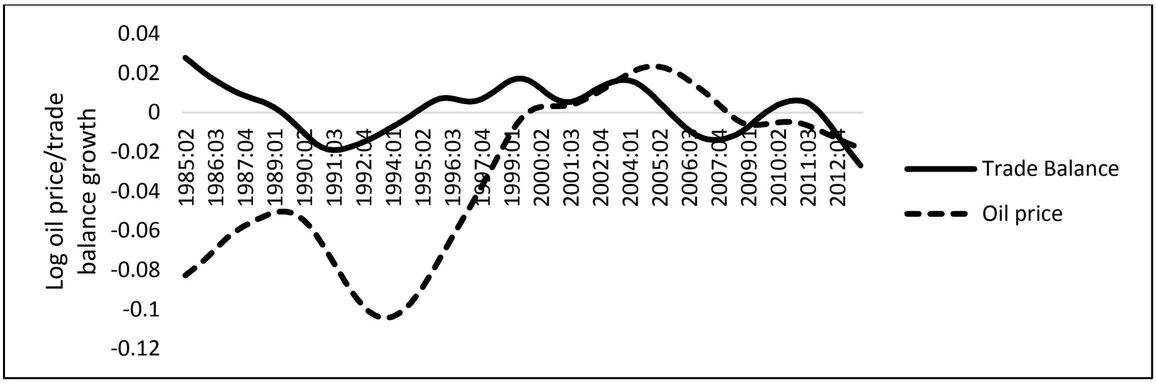
$$TB_t = ln\left(\frac{X_t}{M_t}\right); \; OTB_t = ln\left(\frac{OX_t}{OM_t}\right); \; NOTB_t = ln\left(\frac{NOX_t}{NOM_t}\right) \text{... ... ...} \quad (3.13)$$

Where X, OX and NOX are overall, oil and nonoil exports respectively. Similarly, M, OM and NOM are overall imports, oil imports and nonoil imports respectively. Compared to measuring the trade balance as the difference between exports and imports, this measure has the advantage that it is independent of whether the trade data are in nominal or real terms, the trade balance can be expressed in natural logarithmic form since the ratio is non-negative. The trade balance is in surplus when the ratio is above unity, and in deficit when it is below it. Figure 3.1 shows Nigeria's trade balance and the real oil price. It can be seen that the overall trade balance tends to improve when the oil price is high and deteriorate when the oil price is low, especially since the early 1990s.

As a first step, unit root tests are conducted to examine the time series properties of the data. The Augmented Dickey-Fuller (ADF), Kwiatkowski, Phillips, Schmidt and Shin ((1992) (KPSS) test, and the Zivot and Andrews (2002) (ZA) test are used, the latter valid in the presence of structural breaks. Results of the tests are shown in Table 3.1. The ADF test shows that only the income measure is nonstationary. The ZA test shows that the income measure and the overall trade balance are nonstationary. The KPSS test however shows that all series are nonstationary except for the measures of volatility.

For consistency, all the variables except the volatility measures are in logarithmic first differences.[16] Table 3.2 shows the descriptive statistics of the variables.

Figure 3.1: The Oil Price and Nigeria's Overall Trade Balance



Source: Author's calculations using data from Central Bank of Nigeria (CBN).
Notes: The Figure plots the quarterly log growth of the Bonny Light real crude oil price and Nigeria's overall trade balance. Both series have been filtered using the Hodrick and Prescott (1997) filter.

[16] Note that the volatility measures are constructed from the monthly real oil price growth measures, which are already in logarithmic first differences.

Table 3.1: Unit Root Tests

Variable	Augmented Dickey-Fuller unit root test		Zivot-Andrews unit root test			KPSS unit root test	
	Level	Decision	Level	Decision	Break Year	Level	Decision
IIP Differential	-2.59	I(1)	-3.03	I(1)	2008q4	0.52*	I(1)
Real oil price	-3.80*	I(0)	-10.5**	I(0)	1991q1	3.28**	I(1)
Real Effective Exchange Rate	-5.29**	I(0)	-6.39**	I(0)	1999q1	0.71*	I(1)
Oil price volatility (Standard deviation)	-9.54**	I(0)	-6.61**	I(0)	1998q2	0.22	I(0)
Overall trade balance	-4.97**	I(0)	-4.74	I(I)	1999q2	0.68*	I(1)
Non-oil trade balance	-11.9**	I(0)	4.85*	I(0)	2009q4	1.80**	I(1)
Oil trade balance	-7.62**	I(0)	33.21**	I(0)	1992Q3	0.82**	I(1)
Oil price volatility (GARCH measure)	9.92**	I(0)	6.08**	I(0)	1998q3	0.11	I(0)

Notes: The null hypothesis for the ADF and ZA tests is the presence of a unit root, while the null for the KPSS is that the series are stationary. (**) denotes significance at 1% level and (*) denotes significance at 5% level. I (1) denotes non-stationary variables; I(0) denotes stationary variables.

Table 3.2: Descriptive Statistics

Variable	No. Obs.	Mean	Standard Error	Minimu m	Maximum
Oil price volatility (SD)	116	0.07	0.04	0.01	0.28
Oil price volatility (GARCH)	116	0.09	0.02	0.06	0.18
Overall trade balance	115	0.00	0.27	-0.79	0.79
Oil trade balance	115	-0.04	0.32	-1.58	0.90
Nonoil trade balance	115	0.01	1.00	-2.12	2.19
REER	115	-0.01	0.17	-1.30	0.40
Real oil price	115	-0.03	0.16	-0.74	0.49
IIP differential	115	0.63	4.03	-38.62	5.11

Notes: All the variables except the two volatility measures are in logarithmic first differences i.e. they represent a growth in a particular variable.

3.4. Results

3.4.1. Testing the nonlinear model

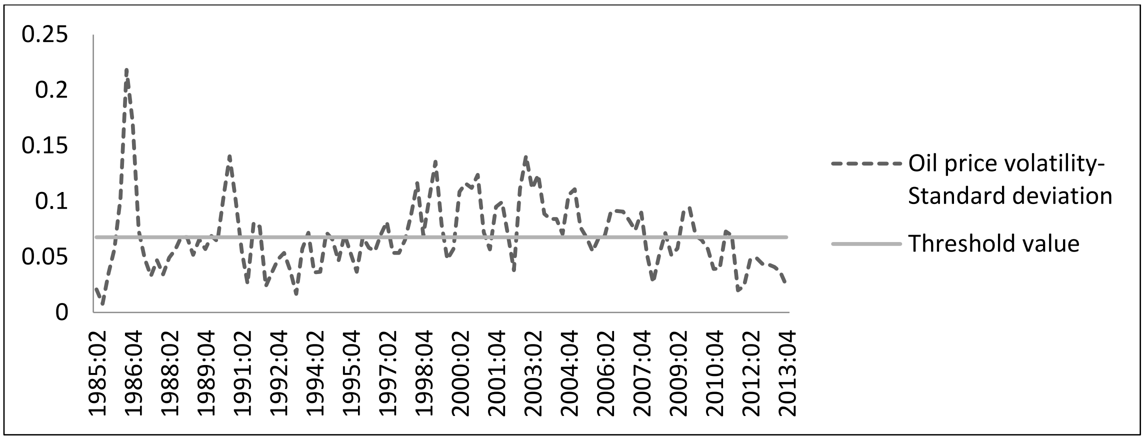
Table 3.3 reports results from the test of a linear VAR model against the alternative of a threshold model using the standard deviation measure of volatility. The null hypothesis of a linear VAR is rejected at 1% level of significance in favour of a threshold VAR for all components of the trade balance. A threshold value of 0.068 is estimated for all the trade balance components. Thus, the relationship between the variables in the TVAR changes when the standard deviation of oil price returns exceeds 6.8%. Figure 3.2 plots the threshold variable against the threshold value. The estimated threshold roughly splits the sample in half, with 55 observations when volatility is above the threshold (upper regime) and 54 observations when it is below it (lower regime). This shows that there are as many periods of high volatility as there are normal/low volatility periods, which is not surprising given that oil prices have been highly volatile over the years.

Table 3.3: Test for Threshold VAR

Trade Balance Component	Threshold value	LR statistic	Degrees of freedom	No. of Obs. In Upper regime	No. of Obs. In Lower regime
Non-oil trade balance	0.068	320.63 (0.000)	70	55	54
Oil trade balance	0.068	317.67 (0.000)	70	55	54
Overall Trade balance	0.068	322.16 (0.000)	70	55	54

Notes: The threshold variable is the two period moving average of the standard deviation of real oil price returns. p-values for each LR statistic are in parenthesis. The variables in the system are log IIP differential growth, log real oil price growth, oil price volatility, log REER growth, and log growth in the relevant component on the trade balance. The delay parameter = 1.

Figure 3.2: Standard Deviation measure of oil price volatility and its threshold value



Notes: The threshold variable is the two period moving average of the standard deviation of real oil price growth

3.4.2. Response of the trade balance to shocks

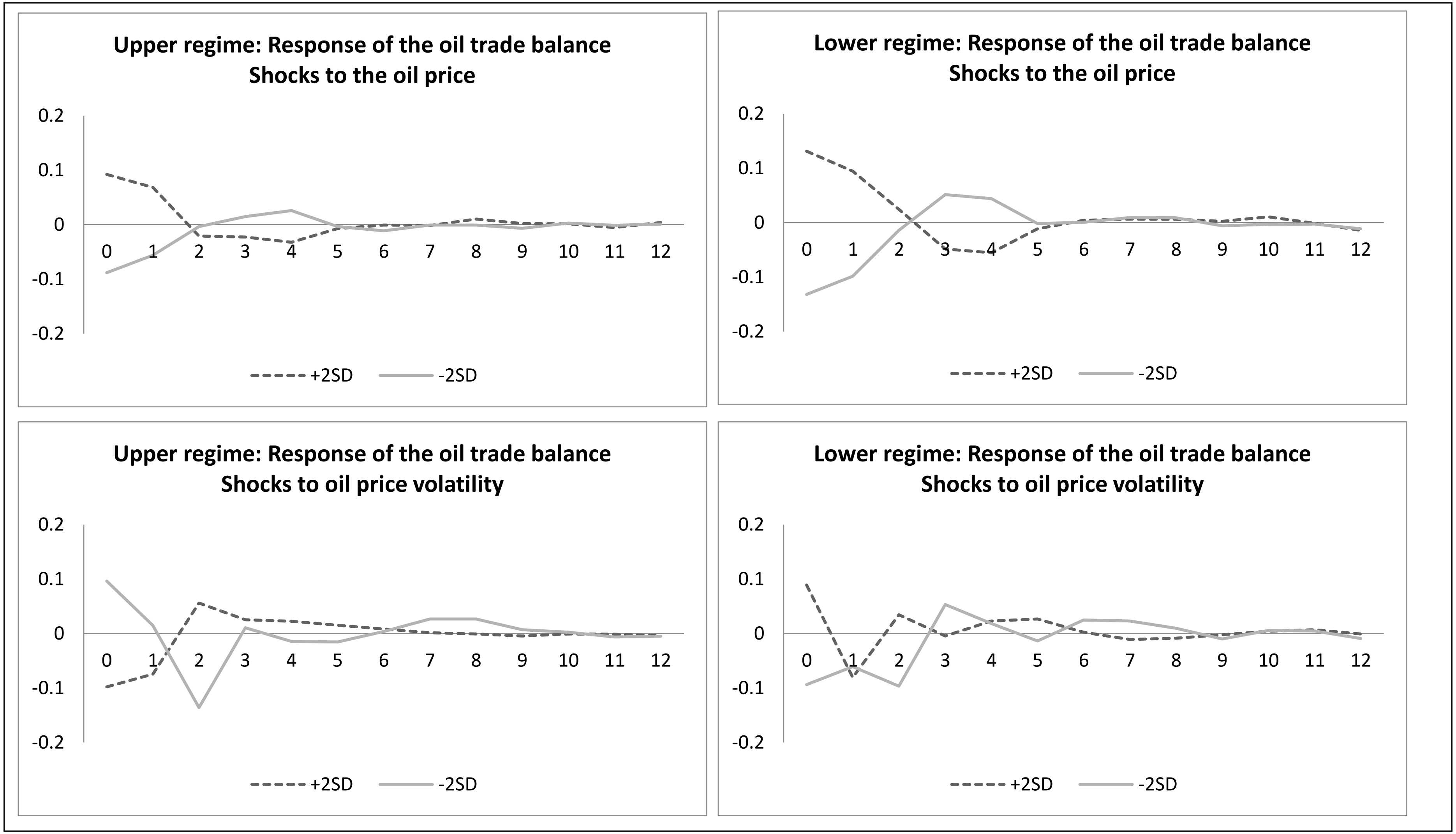
Figures 3.3 – 3.5 show the nonlinear generalized impulse response functions computed over a 12 quarter horizon for the oil, nonoil and overall trade balances. Large positive and negative (+/-2SD) shocks are reported to show the asymmetries in the response of the trade balance within each regime. For brevity, only the response to oil price level and volatility shocks are reported. Responses to other variables in the system are shown in Appendix A. The procedure of the nonlinear Impulse Response Functions does not allow the calculation of proper confidence intervals. Thus, following Balke (2000) and Batini et al. (2012), no discussion of statistical significance is presented as this would be inappropriate for the model.

3.4.2.1. Response of the oil trade balance to shocks:

The response of the oil trade balance to oil price level and volatility shocks is shown in Figure 3.3. In both regimes, positive oil price shocks (unexpected increases in the oil price) initially improve the oil trade balance. This is in line with expectations and reflects increasing earnings from oil exports. The effect diminishes after two quarters, turning slightly negative until the fifth quarter when it diminishes to zero. In both regimes, no asymmetry is observed between positive and negative oil price shocks. However, the impacts of oil price shocks are larger in the lower regime, in line with Lee et al. (1995) who find that oil price shocks have a higher impact in a low volatility environment.

With regards to volatility shocks, in the upper regime, positive volatility shocks deteriorate the oil trade balance initially, but improve it after 2 quarters. This improvement is sustained until the 6th quarter when the effect diminishes to zero. Decreases in volatility initially improve the trade balance sharply, then deteriorate it in the 2nd quarter after the shock. The effect starts to diminish by the 3rd quarter but reaches zero only after 10 quarters. Therefore, in the upper regime the initial impact of an increase in volatility is negative, consistent with Elder and Serletis (2010) who find that investment in the oil sector is negatively affected by volatility. Moreover, if as in Litzenberger and Rabinowitz (1995), high volatility discourages oil extraction by increasing the relative value of oil below the ground, the growth in oil exports might be lower. In the same way, delayed investment abroad would reduce the demand for oil and deteriorate the oil balance, in line with Bernanke (1983). In the lower regime, an increase in volatility improves the oil trade balance on impact, then immediately deteriorates it after one quarter. The oil trade balance response subsequently follows a pattern similar to the upper regime. In contrast to the upper regime, the initial effect of a decrease in volatility is a deterioration of the oil trade balance. By the second quarter, the effect also resembles that in the upper regime. Threshold effects are thus apparent as an increase in volatility hurts the trade balance on impact only if it occurs when the oil market is already volatile. Indeed, it appears that in a low volatility environment, oil exports are actually spurred by increased volatility, perhaps reflecting increased precautionary demand for oil. The findings thus suggest that reduced oil demand due to delays in investment abroad (as advanced by Bernanke (1980)), or lower investment in mining activities and oil extraction (as in Litzenberger and Rabinowitz (1995) and Elder and Serletis (2010)), is more likely to occur if volatility is excessively high. On the other hand, lower levels of volatility are more likely associated with the sort of precautionary demand for oil discussed by, among others, Kilian (2009) and Anzuini et al. (2015). Figure 3.3 also shows that decreases in volatility have larger and more persistent effects in the upper regime. There are asymmetries of volatility shocks, with the initial impacts of positive shocks being more volatile but shorter lived in the lower regime, and negative shocks being larger than positive shocks in the upper regime.

Figure 3.3: Response of the oil trade balance to shocks conditional on regime: Standard deviation measure of volatility.



3.4.2.2. Response of the non-oil trade balance to shocks:

Figure 3.4 shows the response of the nonoil trade balance to oil price level and volatility shocks. In the upper regime, a positive oil price level shock has a volatile effect on the nonoil balance. The nonoil balance first improves but deteriorates after 2 quarters. The effect turns positive again in the third quarter and begins to diminish in the fourth quarter, reaching zero after 8 quarters. As with the oil balance, negative oil price level shocks have symmetric effects to positive shocks. In the lower regime, the effects of oil price shocks are less dramatic and the initial impacts are muted. As in the upper regime, there is an improvement (deterioration) following a positive (negative) oil shock in the 3rd quarter, but this is larger and more persistent in the lower regime. A subsequent deterioration in the nonoil balance also occurs after the 4th quarter, and has a relatively higher magnitude than the upper regime. The effects in the lower regime are more persistent than as they diminish to zero only after 10 quarters. Thus, in both regimes, the effects of oil price increases on the nonoil balance tend to be initially positive, possibly reflecting an immediate reduction in oil intensive durable imports that form a large proportion of Nigeria's imports, in line with Elder and Serletis (2010) and Huynh (2016). The deterioration postulated by Bodenstein et al. (2011) only occurs subsequently but is quite persistent, indicating that positive wealth effects of oil price increases for oil exporters kick in after some time. There are threshold effects as the impacts of oil shocks are more volatile but lower and less persistent in the upper regime, suggesting that high uncertainty makes the effects of oil prices more dramatic but reduces the absolute size of the effects. Again, the latter result is in line with Lee et al. (1995).

For volatility shocks, Figure 3.4 shows that in the upper regime, increases in volatility initially deteriorate the nonoil balance. This effect is however short lived and becomes positive by the 2nd quarter. The response begins to diminish and becomes negligible by the 5th quarter. The effects of decreases in volatility (increases in oil price stability) follow similar patterns to increases but in the opposite direction. However, the effects of decreases in volatility are much larger and more volatile than those of increases. In the lower regime, unlike the upper regime, increases and decreases in volatility have very muted initial impacts on the nonoil balance. Like with the oil trade balance therefore, increased volatility is only harmful on impact if the oil market environment is already volatile. After these initial responses, the effects of both increases and decreases follow similar patterns as the upper regime, but with lower magnitudes. The effects of increases in volatility are particularly muted in the lower regime. Thus, there is evidence of asymmetry in both regimes, as decreases in volatility are more important than increases. There are also threshold effects across regimes because the effects of volatility shocks are larger in the upper regime. The result that higher volatility propagates the effects of oil volatility shocks is consistent Van Robays (2012). On the other hand, the larger effects of decreases in volatility relative to increases suggest that the decisions of economic agents regarding trade volumes are more responsive to increasing oil price stability. This is perhaps because large increases in stability signal favourable global and domestic economic conditions, thereby stimulating trade. On the other hand, increasing oil price volatility will tend to be perceived as temporary, especially since the oil market experiences frequent hikes and downturns.

3.4.2.3. Response of the overall trade balance to shocks:

Figure 3.5 shows the response of the overall trade balance to oil price level and volatility shocks. In the upper regime, positive oil price shocks initially improve the overall trade balance. The trade balance then deteriorates slightly until the 6th quarter when it diminishes to zero. The effects of negative oil price shocks are symmetric to those of positive shocks. In the lower regime, the initial effects of oil price shocks are lower than the upper regime within the first 2 quarters of the shock, reflecting the initial muted response of the nonoil trade balance in this regime. After the 2nd quarter however, the effects are slightly larger and less volatile than the upper regime. Overall, there are no asymmetries between oil price increases and decreases, but higher volatility makes the effects of oil prices more dramatic.

In the upper regime, increases in volatility have an initial negative impact on the overall trade balance, as with the oil and nonoil balances. The trade balance however improves in the 2nd quarter and diminishes to zero by the 3rd quarter. The effects of negative volatility shocks are again larger and more persistent. In the lower regime, increases in volatility initially improve the trade balance while decreases in volatility deteriorate it, consistent with the responses of the oil and nonoil balances. The subsequent effects follow a similar pattern as the upper regime but are relatively lower. Here also, negative volatility shocks have larger and more persistent effects than positive shocks.

Overall, the response of the overall trade balance reflects the combined responses of the oil and nonoil trade balances, as expected. Here, as in the oil and nonoil balances, the largest effect of volatility shocks in both regimes occurs in the second quarter, where the effect of a decrease in volatility is sharply negative. However, the volatile response of the nonoil balance to volatility shocks is smoothed out by the relatively modest response of the oil trade balance, such that the response of the overall trade balance is less dramatic.

Figure 3.4: Response of the nonoil trade balance to shocks conditional on regime: Standard deviation measure of volatility.

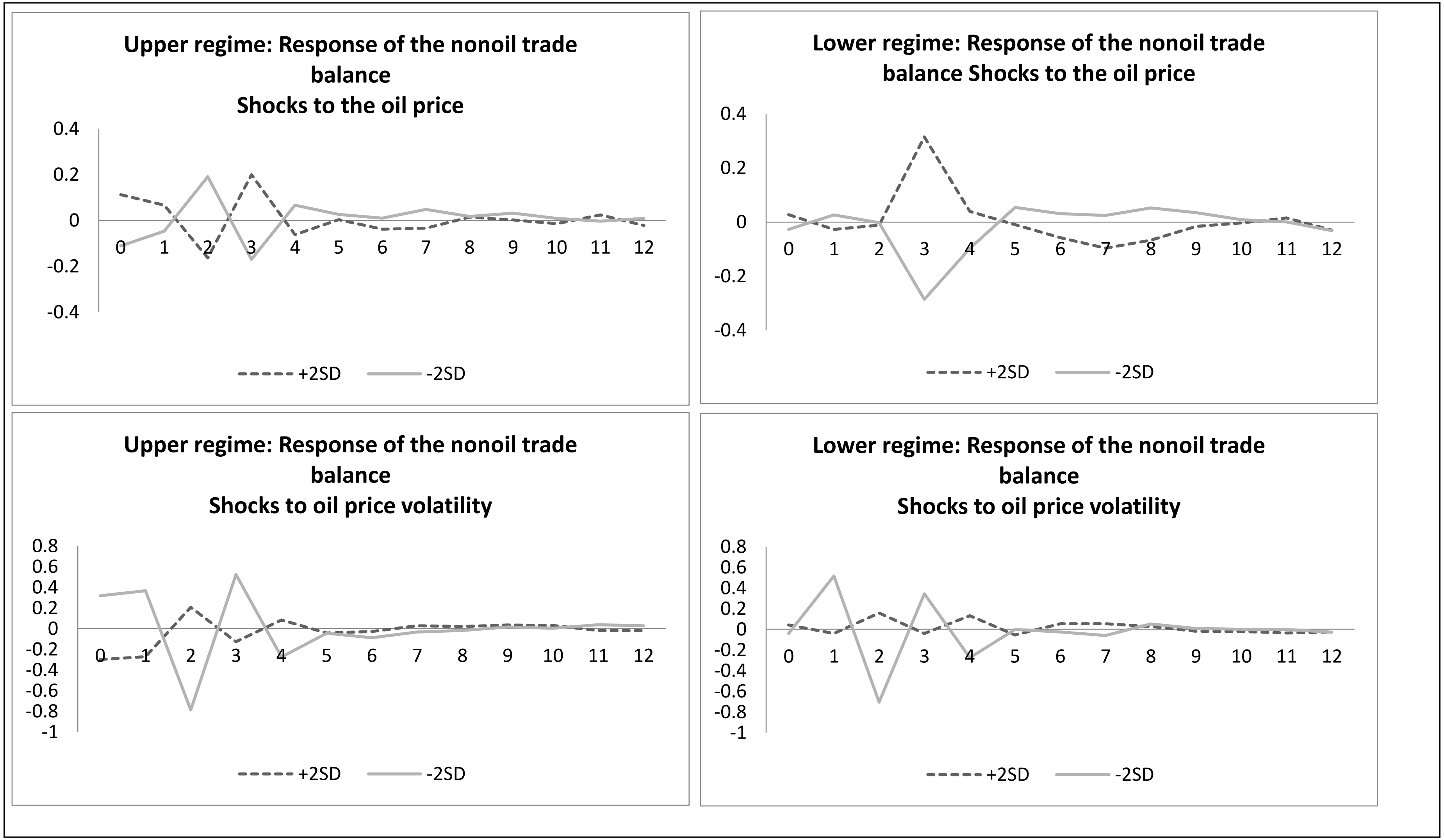
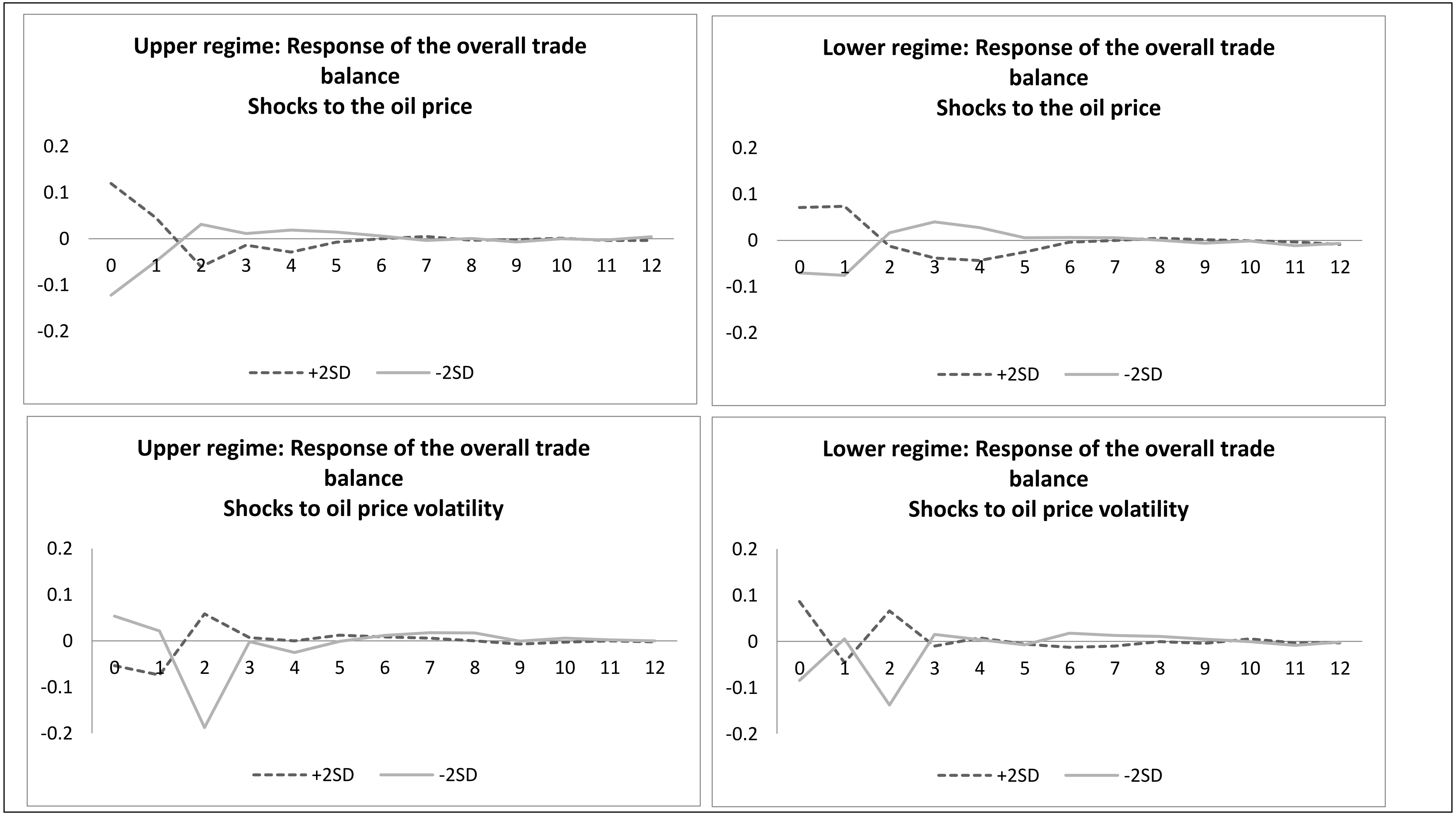


Figure 3.5: Response of the overall trade balance to shocks conditional on regime: Standard deviation measure of volatility.



3.4.3. Robustness to alternative volatility measure:

Figure 3.6 shows a plot of the GARCH volatility variable as defined in equation (3.12) and its estimated threshold value. Here, there is a relatively lower number of observations in the lower regime (70 and 39 observations in the upper and lower regime respectively). This reflects that the GARCH measure captures not only the level of volatility in each period, as with the standard deviation measure, but also the corresponding volatility persistence. This difference is also reflected in the estimated impulse responses which are more volatile and more persistent than those produced by the standard deviation measure. Figures 3.7, 3.8 and 3.9 show the response of the oil, nonoil and overall trade balances using the GARCH measure.

Figure 3.6: GARCH (1, 1) measure of oil price volatility and its threshold value

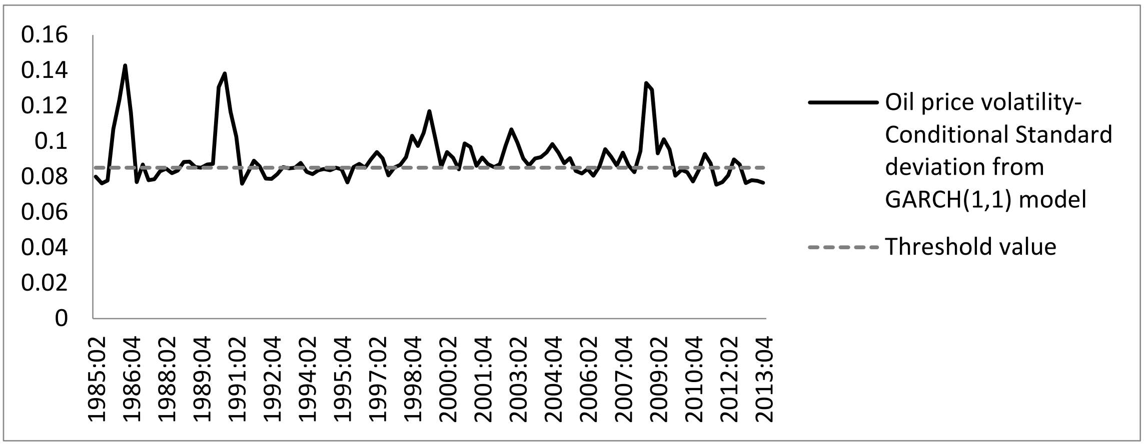


Figure 3.7 shows the response of the oil trade balance. Here increases in oil prices continue to have positive initial impacts in both regimes, as with the SD measure. The effects using the GARCH measure are more persistent, as they do not diminish to zero even after 12 quarters. The effects of oil price decreases are fairly symmetric to those of increases in the upper regime, as with the SD measure. In the lower regime however, there is some degree of asymmetry where negative shocks have similar effects to positive shocks in the same direction between the 5th and 7th quarters. The effects of volatility shocks are also more dramatic than using the SD measure. In the upper regime, increases in volatility have a negative initial impact that lasts only until the 1st quarter, as with the SD measure. Here also, decreases in volatility continue to have larger and more volatile effects within the first 3 quarters. The effects in the lower regime are considerably lower. The initial effects of increases in volatility in this regime continue to be positive using the GARCH measure, but this effect is shorter lived.

Figure 3.8 shows the response of the nonoil trade balance to shocks. In both regimes, effects of level shocks are again more volatile and persistent than they are using the SD measure. Still however, the IRFs show an initial improvement in the nonoil balance following an oil price increase. Unlike the SD measure however, this effect is also large in the lower regime. As with the SD measure, the subsequent deterioration is much larger in the upper regime, and the improvement in the 3rd quarter is larger and more persistent in the lower regime. The effects of oil price shocks continue to be more dramatic in the upper regime than the lower regime. The GARCH measure shows asymmetries not captured by the SD measure, as oil price increases have larger effects than decreases in both regimes. In response to volatility shocks, the threshold effects and asymmetries observed using the SD measure are even more potent here. In both regimes increases in volatility have almost no effects throughout the 12 quarter horizon. The effects of decreases in volatility are much larger in both regimes, and the response of the nonoil balance is considerably higher in the upper regime.

Figure 3.9 shows the response of the overall trade balance to shocks. Using the GARCH measure, the initial impacts of oil price shocks are qualitatively similar as using the SD measure. The effects are much larger and more volatile in the upper regime. There are also clear asymmetries here as the impacts of oil price increases are larger and more volatile than those of decreases, especially in the upper regime. With respect to volatility shocks, threshold effects are more apparent than using the SD measure, with the effects of volatility shocks, especially negative shocks, being larger in the upper regime. In both regimes, the asymmetry observed with the SD measure is maintained, with negative shocks having larger effects than positive shocks.

Therefore, the results regarding the general direction of effects and nonlinearities are in most cases qualitatively similar across both measures. The main differences between the IRFs are in relation to oil price level shocks. The GARCH measure of volatility shows asymmetries that are not present using the SD measure, and the effects tend to be larger in the upper regime as opposed to the lower regime observed with the SD measure. Asymmetric effects of oil price level shocks, and differences in the size of the effects, are thus weak and depend on the measure of volatility. This inconclusive evidence supports the argument of Kilian and Vigfusson (2011b) in that nonlinearities with respect to level shocks are sensitive to variable measurements. Still, the finding that these effects are more dramatic in the upper regime is robust to using both volatility measures. On the other hand, the findings of asymmetries and threshold effects of volatility shocks are very robust.

Figure 3.7: Response of the oil trade balance to shocks conditional on regime: GARCH measure of volatility.

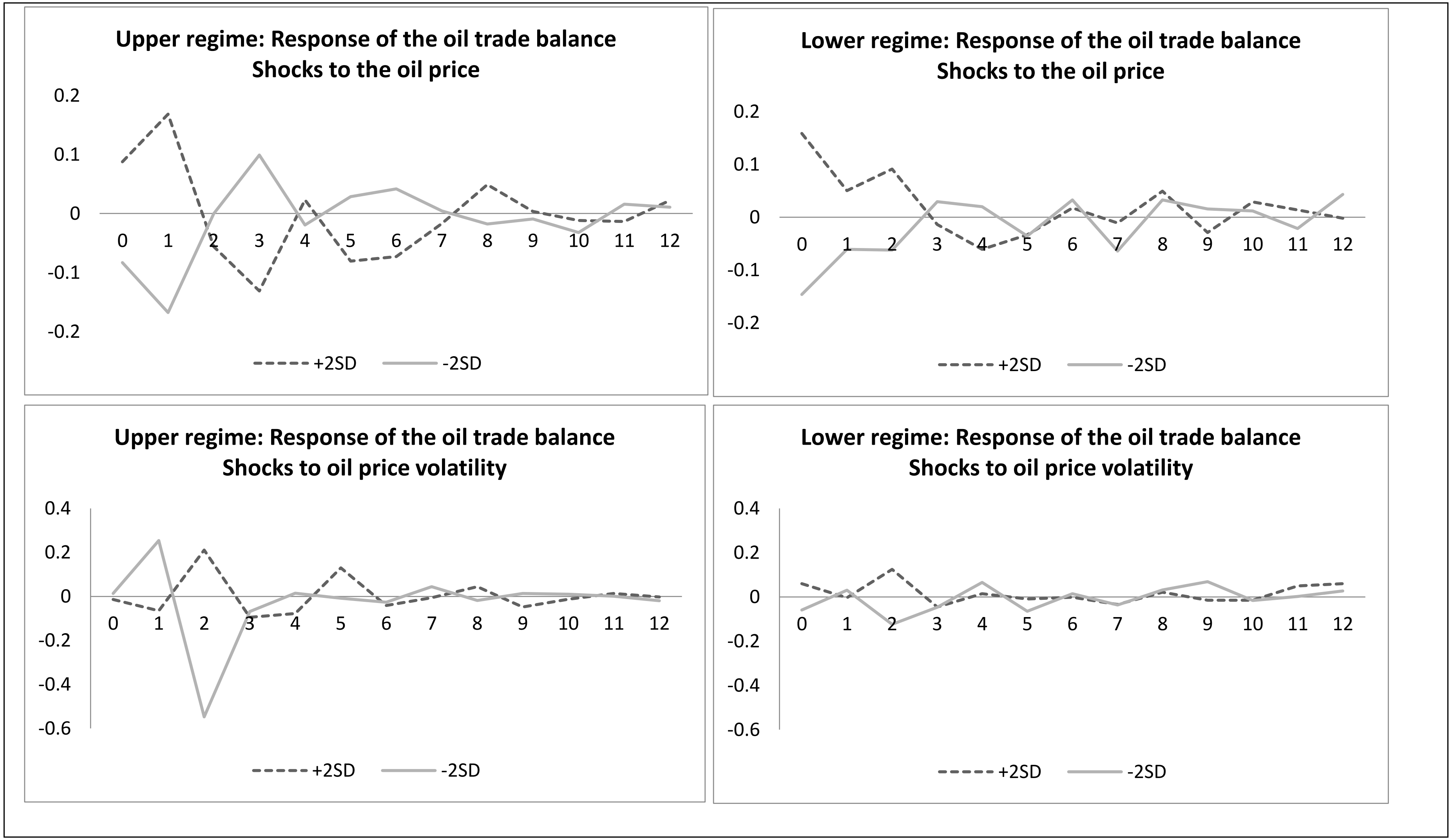


Figure 3.8: Response of the nonoil trade balance to shocks conditional on regime: GARCH measure of volatility.

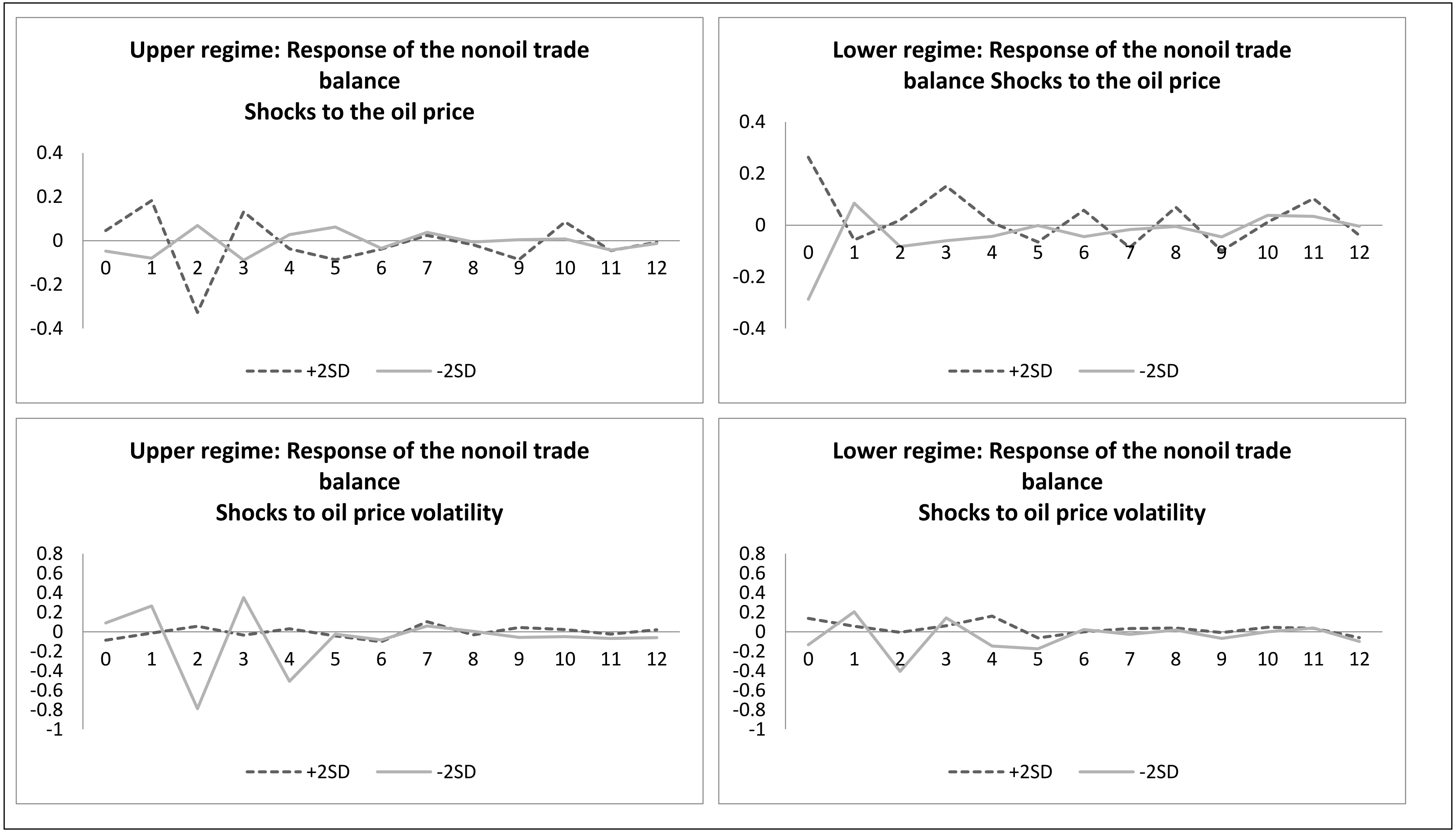
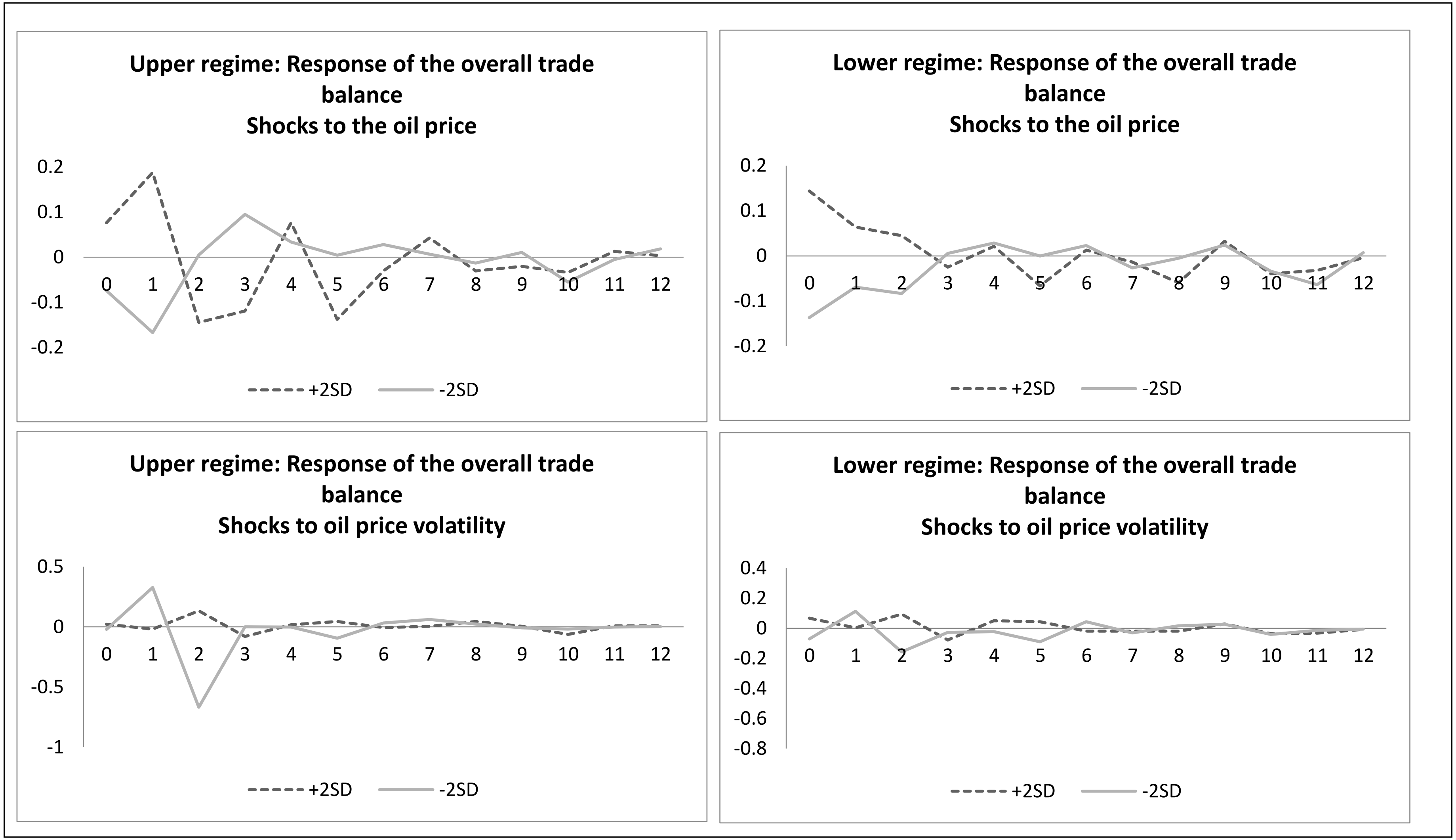


Figure 3.9: Response of the overall trade balance to shocks conditional on regime: GARCH measure of volatility.



3.5. Discussion of results:

Taken together, the results show that the effects of oil price level and volatility shocks on the oil, nonoil and overall trade balance are nonlinear as they depend on an oil price volatility threshold. For oil price level shocks, the response of all trade balance measures are generally more dramatic when volatility exceeds its threshold value. Irrespective of the level of volatility, oil price increases initially improve the oil, nonoil and overall trade balances. This is similar to the findings of Le and Chang (2013) for Malaysia, a developing country oil exporter. The improvement is expected for the oil and overall balances, in line with Bodenstein et al. (2011). For the nonoil balance, it potentially reflects a reduction in oil intensive durable goods imports, such that the expected deterioration occurs after about a year, when positive wealth effects of the price increase become apparent. The subsequent deterioration of the overall balance is consistent with the notion that oil exporters are eventually negatively affected by oil price increases through reduced economic activity (and hence demand) in their oil importing trading partners as well as through their own higher demand for imports (Korhonen and Ledyaeva, 2010, Abeysinghe, 2001, Bodenstein et al., 2011),

With regards to oil volatility shocks, the responses of all trade balance components are higher when volatility is above its threshold value, showing that higher volatility propagates the effects of volatility socks, in line with Van Robays (2012) and Huang et al. (2005). Irrespective of the volatility environment, decreases in volatility have larger effects than increases. This suggests that sudden increases in oil price stability have higher impacts on decisions of economic agents than sudden increases in volatility. A potential explanation for this asymmetry is that increases in stability are perceived to be more permanent than increases in volatility, and also signal a stable global and domestic economy. A consistent finding is that these increases in oil price stability deteriorate all trade balance components within the first year of the shock, indicating an increase in spending on both oil and non-oil imports. Since Nigeria's main non-oil imports consist of energy intensive durable products[17], expenditure on these goods would be positively affected by oil price stability, as would expenditure on the imported refined petroleum needed to fuel these products. The result is an increase in both oil and non-oil imports relative to exports, and a deterioration of all components of the trade balance. This is consistent with Plante and Traum (2012) as well as Başkaya et al. (2013). Although

[17] Main nonoil imports are motor vehicles, large vehicles for transportation of goods, electricity generators and inverters (UN, 2013).

these studies do not consider the effects of volatility decreases, they find that an increase in precautionary savings occurs in response to higher oil price volatility; this is analogous to an increase in consumption spending due to increased oil price stability.

Interestingly, increased volatility only deteriorates the trade balances when volatility is above its threshold, and tends to have a positive effect at lower levels of volatility. Thus, negative impacts such as through reduced investments and hence exports (as in Bernanke (1980) and Bloom (2009)), and increased riskiness of transportation (as in Chen and Hsu (2012)), appear to only set in when volatility has exceeded a certain threshold. When an increase in volatility occurs in a relatively stable environment, it appears to be more likely associated with increased precautionary oil demand.

3.6. Conclusions:

The implications of oil price level and volatility shocks on economic performance are important to academics and policy makers alike. A large body of literature has examined these effects on output. Here, asymmetries have been found, and oil price volatility has been shown to be an important source of these asymmetries. The effects of oil price volatility on the economy have also been shown to be nonlinear. However, these nonlinearities have not been studied in relation to the trade balance, despite the importance of trade as a major channel through which oil prices affect economic growth. It is this gap in the literature that this chapter has addressed.

This chapter utilized the Threshold Vector Autoregressive model (TVAR) of Balke (2000) to provide a comprehensive analysis of nonlinearities in the oil price-trade balance relationship. Quarterly data on Nigerian trade balance and its oil and nonoil components were used. Two oil price volatility measures were used as threshold variables: the standard deviation of the real oil price; and the conditional standard deviation from a GARCH (1, 1) model of the real oil price.

Results from non-linear impulse response functions showed that oil price level shocks have more dramatic effects when oil price volatility is high. Asymmetries between positive and negative oil price shocks were found to depend on the volatility measure, with the GARCH measure displaying asymmetries not captured by the standard deviation measure. For oil price volatility shocks, large threshold and asymmetric effects were found in the response of all components of the trade balance, and using both measures of volatility. Decreases in volatility were found to be more important than increases within regimes, and the magnitudes of the effects were found to be higher in the upper regime. Given the different initial impacts of volatility across regimes, the results show that volatility hurts the trade balance on only when it exceeds a certain threshold. Irrespective of regimes and volatility measure, decreases in volatility sharply deteriorate all trade balance components within a year of the shock, suggesting that sudden increases in oil price stability encourage both oil and nonoil imports. Interestingly, the nonoil trade balance has the largest response to both level and volatility shocks irrespective of regime and volatility measure. This supports the view that the nonoil balance is an important channel through which external balances are affected by oil prices (see Kilian et al. (2009), Bodenstein et al. (2011)).

Overall, high oil price volatility was found to propagate the effects of volatility shocks on the trade balance while making the effects of oil price level shocks more volatile. The analysis in this chapter has focused on only one oil exporting country, and the nonlinearities found may well be present for other oil exporters as well as oil importers. It will thus be desirable for the analysis to be carried out for more countries. Although the limited availability of high frequency data may exclude the possibility of threshold analysis at the global level, the findings have still opened up potential avenues for future research that are worth exploring. There are also implications for the design of theoretical models on the relationship between oil price volatility and trade, as the findings show that the volatility environment plays an important role.

There are policy implications for Nigeria arising from the findings of this chapter. Given that oil accounts for around 70% of government revenue and foreign exchange, oil price volatility is often associated with volatility in fiscal spending and exchange rates. The results show that, as far as the trade balance is concerned, increases in oil price volatility usually have muted impacts, with the largest effects within the first few quarters of the shock. Even these initial impacts are only negative when the oil market environment is already highly volatile. Thus, the use of policies to insulate the economy from high volatility, such as drawing on Nigeria's Excess Crude Account (ECA) or Sovereign Wealth Fund (SWF) to offset potential reductions in oil revenues, would be of more benefit in an already high volatility environment. In fact, the findings of this chapter suggest that decreases in volatility are more important for the trade balance. The results suggest that increased oil price stability deteriorates the overall balance by encouraging higher import expenditure. This overall trade balance deterioration, since it is mainly the result of a nonoil balance deterioration, may signal increased economic activity due to higher oil price stability, such that there is higher demand for both investment and consumption goods.

Chapter 4: Oil Prices and Bilateral Trade Balances of Sub-Saharan African Countries: What are the roles of exchange rates?

4.1. Introduction

The recent oil price collapse and associated adjustment of the exchange rates of various oil exporters has heightened concerns on the effects of oil prices and exchange rates on the macro economy. Through its effects on relative wealth and the terms of trade, an oil price increase is typically associated with real appreciations for oil exporters and depreciations for importers. Theoretically, this relationship has been shown to be important in influencing the response of the trade balance to oil prices (Bodenstein et al., 2011). This chapter empirically examines the role of real exchange rates in determining the effects of oil prices on the bilateral trade balances of oil exporting and oil importing Sub-Saharan African (SSA) countries. While the previous chapter was concerned with the non-linear role of oil price volatility postulated by the wider OPM literature, this chapter engages more with the theoretical oil price-trade balance literature by focusing on the role of real exchange rates in the transmission of oil price movements.

There is a large body of literature on the oil price-exchange rate nexus, which generally finds that oil price increases lead to appreciations for oil exporters and depreciations for importers (Amano and Van Norden, 1998, Chen and Chen, 2007, Korhonen and Juurikkala, 2009, Lizardo and Mollick, 2010, Mohammadi and Jahan-Parvar, 2012, Jahan-Parvar and Mohammadi, 2011, Dauvin, 2014, Reboredo et al., 2014). Theoretically, Bodenstein et al. (2011) show that these oil price induced real appreciations (depreciations) dampen the effects of oil prices on the overall trade balance through deteriorating (improving) the nonoil balance. However, as shown by the vast empirical literature on the effects of exchange rates on the trade balance, in practice, exchange rate changes have ambiguous effects, especially in the short run. (McKenzie and Brooks, 1997, Rose, 1990, 1989, Yol and Baharumshah, 2007, Kodongo and Ojah, 2012, Bahmani-Oskooee and Gelan, 2012, Bahmani-Oskooee and Xu, 2012). For exchange rates adjustments to succeed in correcting external imbalances, first, a nominal devaluation must lead to a real devaluation; and second, the demand for traded goods needs to be sufficiently responsive to the real devaluation, i.e. the Marshall Lerner condition needs to hold. While the first condition is usually met, there is considerable disparity in the empirical findings regarding the second (Reinhart, 1995).

Exchange rates might therefore not affect the oil price-trade balance nexus in the expected way. Empirical studies on the oil price trade-balance relationship do not test whether exchange rate adjustments succeed in limiting the responsiveness of the overall trade balance to oil shocks (Kilian et al., 2009, Le and Chang, 2013, Arouri et al., 2014). This chapter addresses this gap in the literature by being the first empirical study that examines the role of exchange rates in mediating the effects of oil prices on the trade balance.

This chapter also makes an important methodological contribution by addressing the empirical problem of panel Cross Section Dependence (CSD). CSD is pervasive in cross country panel data and, if it exists, renders most conventional panel data estimators inconsistent. All the studies on the effects of oil prices on the trade balance use time series data (Kilian et al., 2009, Le and Chang, 2013, Arouri et al., 2014). Some related studies that examine the effects of oil prices on the current account balance or on trade volumes use cross country panel data but ignore the possibility of CSD (Allegret et al., 2014, Allegret et al., 2015, Chen and Hsu, 2012, Shiu-Sheng and Kai-Wei, 2013). In this chapter, the Pesaran (2006) Common Correlated Effects Mean Group (CCEMG) estimators are used to examine oil price effects with bilateral trade data for 8 major SSA countries and their most important trading partners[18]. The model also allows heterogeneous slopes for each SSA country and the estimation of short and long run impacts. This heterogeneity allows the examination of the bilateral exchange rate behaviour for a range of trading partners which can potentially guide trade preferences. It also facilitates the interpretation of results in light of the model in Bodenstein et al. (2011) which is presented in a bilateral framework. The robustness of the results is checked by comparing the aggregate averages of the bilateral estimates with results from a Fixed Effects (FE) estimator with CSD robust standard errors.

The results reveal that aggregate long and short run effects of oil prices on the trade balance are insignificant. The bilateral effects, in turn, show positive and negative oil price effects for both SSA oil importers and exporters. Overall however, positive effects dominate, even for oil importers. Importantly, it is found that for bilateral trade balances where the oil price effect is positive, exchange rates do not have the expected signs. That is, in these cases exchange rate appreciations seem to improve the trade balance,

[18] The SSA countries considered are Angola, Cameroon, Ethiopia, Ghana, Kenya, Nigeria, Tanzania, and South Africa. The trading partners are Canada, China, France, Germany, India, Italy, Japan, Netherlands, Spain, United Kingdom and United States.

whereas depreciations deteriorate it. Conversely, where an oil price increase deteriorates the bilateral trade balance, subsequent depreciations succeed in improving the trade balance, and appreciations deteriorate it. This indicates that the Marshall Lerner condition is more likely to hold when the oil price has a negative effect. Consistent with these results, the interaction terms between the exchange rate and oil price show that exchange rate depreciations dampen both the positive and negative effects of oil prices on the trade balance, while appreciations reinforce these effects.

The prevalence of insignificant average impacts of oil prices, as well as predominantly positive heterogeneous impacts for oil importers potentially point to large responses of the nonoil trade balances for SSA countries, which serves to offset any effect on the oil trade balance (Bodenstein et. al., 2011). Oil importers' exports may increase with oil prices through a number of channels. There may be higher demand for their exports by the now wealthier oil exporters, exchange rate depreciations may stimulate exports and, if higher oil input prices lead to a sufficiently large increase in export prices, the trade balance may improve. At the same time, the demand for their nonoil imports may fall due to lower real wealth. As shown in Figure 2.6, SSA oil importers also export commodities whose prices often move together with oil prices, such that the negative impact of oil prices on the oil component of their trade balances may be offset, or even dominated, by the positive pressures on their nonoil trade balances. On the other hand, SSA oil exporters are frequently importers of refined petroleum imports, potentially limiting the gains from higher oil prices. In addition, the results may reflect the low levels of international financial integration of these countries (Figure 2.7). As shown by Bodenstein et al. (2011), less financially integrated economies are less able to smooth nonoil consumption when the oil price rises, leading to a large nonoil trade adjustment that may offset or even dominate the response of the oil trade balance. The results regarding exchange rates imply that their influence on the oil-price trade balance nexus is not always as predicted by theory: it depends on the direction of the oil price effect.

The remainder of this chapter is organised as follows: Section 4.2 presents the related theoretical and empirical literature. Section 4.3 describes the data used in the study and the empirical models estimated. Results are presented in Section 4.4 and discussed in Section 4.5. Conclusions and policy recommendations are made in section 4.6.

4.2. Literature Review:

This study relates to three strands of literature: the effects of oil prices on the trade balance; the relationship between the exchange rate and the trade balance; and the oil price-exchange rate nexus[19].

4.2.1. Oil prices and the trade balance:

The theoretical literature generally implies that the effect of oil price shocks on the trade balance is positive for oil exporting countries and negative for oil importers. Early theoretical models that analysed the effects of oil prices on the trade balance consider the effects of an oil price induced terms of trade deterioration, where the trade balance is determined residually as the difference between savings and investment.

The effect of a terms of trade deterioration on the trade balance was first examined by Harberger (1950) and Laursen and Metzler (1950) for an oil importing economy. The Harberger-Laursen-Metzler (HLM) result was that a terms of trade deterioration leads to a reduction in real income in terms of importables. This in turn reduces savings out of income and leads to a deterioration of the trade balance (Sen, 1994). Schmid (1976) find within a two country open economy monetary model that increases in the oil price resulting from negative oil supply shocks lead to a deterioration of the trade balance for oil importers and an improvement for oil exporters, with the key feature of the model being a low elasticity of substitution between domestic factors of production and imported oil. However, Obstfeld (1982) find that a terms of trade deterioration resulting from an oil price increase leads to a trade surplus by increasing savings to smooth future consumption since consumers would want to maintain a certain level of utility. Svensson and Razin (1983) and Svensson (1984) find that the effects of an oil price increase depend on whether the increase is temporary or permanent. If the oil price increase is temporary, there is no need to increase savings to smooth future consumption. Rather, current savings fall to smooth current consumption, and investment is unaffected, resulting in deterioration of the trade balance. If however the oil price increase is expected in the future, then savings rise to smooth future consumption and investment falls, leading to a trade balance improvement. A permanent oil price increase is shown to have ambiguous effects. In a similar model,

[19] There is also the "Dutch disease" literature which focuses on how the presence of a natural resource such as oil affects the trade balance through exchange rates. Since the focus of this chapter is on examining the effects of changes in the price of oil for both oil importers and exporters, rather than oil discovery or the resource curse, this literature is not discussed. Magud and Sabatian (2013) provide a recent review of the Dutch disease literature.

Matsuyama (1987) finds that an oil price increase would reduce savings and deteriorate the trade balance if the consequent reduction in income (wealth effect) outweighs the tendency of investors to substitute away from oil (substitution effect). If the substitution effect dominates however, the trade balance improves because lower oil use reduces investment since oil and the capital stock are employed cooperatively. Sen and Turnovsky (1989) find that an oil price increase leads workers to substitute away from labour towards leisure. This substitution effect dominates the negative wealth effect of the price increase that tends to increase labour supply. This in turn leads to dissaving and deteriorates the trade balance. Sen (1990) and Sen (1991) reach similar conclusions.

In these earlier models, the effects of oil price increases on the trade balance of oil importing countries is generally found to be negative. Results also depend on the persistence of the price increase and the relative strength of the wealth and substitution effects it generates. These early models have the limitation that they generally do not consider oil exporting countries; assume perfect international capital mobility or perfect immobility; and define the trade balance in a way that does not allow its decomposition into oil and nonoil components. As recently shown by Bodenstein et al. (2011), all these factors turn out to be important for understanding the trade balance response to oil prices.

Bodenstein et al. (2011) build on the work of Backus and Crucini (2000) and analyse the effects of oil price changes on a country's trade balance using a Dynamic Stochastic General Equilibrium (DSGE) model in which the oil price is endogenously determined and market incompleteness is assumed. Oil is used as an input in the production process and as a consumption good. The effects of oil price changes are shown to depend on the sources of the change, the price elasticity of demand for oil, and the extent to which international financial markets are incomplete. It is shown that oil price increases directly deteriorate the oil trade balance for oil importers and improve it for exporters. This is because the price elasticity of demand for oil is low, such that the oil import bill rises even as oil importers substitute away from oil. A higher oil import bill constitutes a transfer of wealth from oil importers to oil exporters. For oil importers, the lower wealth deteriorates the terms of trade and depreciates the real exchange rate. This depreciation aids the improvement in the nonoil component of the trade balance by discouraging imports, and by making exports even cheaper for the now wealthier oil exporters. For oil exporters, higher wealth and a real appreciation lead to a deterioration of the nonoil balance. By aiding the adjustment of the nonoil balance in a way that offsets the response of the oil balance, the real exchange rate plays a role in limiting the effects of oil prices on the overall balance for both oil exporters and importers. Empirically, its role will depend on the elasticity of demand for nonoil traded goods, which is in turn influenced by the elasticity of substitution between domestic and foreign goods. Bodenstein et al. (2011) also shows that low international risk sharing increases the need for a nonoil trade adjustment, such that the response of the overall balance is lower. A high price elasticity of demand for oil has the same effect by reducing the magnitude of the oil balance response. Similarly, Rebucci and Spatafora (2006) posit that any trade surpluses an oil exporter may gain from increased oil prices would eventually be offset by increased growth and real exchange rate appreciation. Oil importers' trade deficit will also be offset through real depreciations and reduced wealth.

In sum, the theoretical literature predicts that oil price increases will improve the overall trade balance of oil exporters and deteriorate it for oil importers. The associated terms of trade deterioration (improvement) and the real exchange rate depreciation (appreciation) for oil importers (exporters) is shown to dampen the effects of oil prices on the trade balance. No study has empirically examined whether these exchange rate adjustments do limit the overall effects of oil prices on the trade balance.

Empirically, Kilian et al. (2009) study the relationship between oil prices and external balances for both oil importing and exporting countries using aggregate data from 1970-2005. They find that the overall trade balances of oil exporters are positively affected by oil price increases, while high-income oil importing countries are negatively affected. Le and Chang (2013) study the impact of oil prices on the aggregate trade balances of Malaysia (an oil exporter) Singapore (an oil refinery) and Japan (an oil importer). The results from impulse response functions of a VAR showed that oil prices lead to an improvement in the trade balance of Malaysia, a deterioration for Japan and no effects for Singapore. Using monthly data from 1980-2011 and VAR techniques, Arouri et al. (2014) find that for oil importing India, the trade balance is negatively affected by oil price increases. Chen and Hsu (2012) examine the effects of oil prices on bilateral trade volumes using panel data on 84 countries from 1984-2008. They found that oil supply disruptions have a negative impact on trade because they lower GDP and hence imports of oil importers, as well as export volumes of oil exporters. Oil specific demand shocks on the other hand increase trade volumes by inducing higher exports for oil exporters and higher imports for importers. In a similar study, Shiu-Sheng and Kai-

Wei (2013) examine the effects of oil prices on bilateral export volumes using a gravity model of international trade and annual data on 117 countries from 1984-2009. They find that oil price changes have insignificant effects on trade flows. Korhonen and Ledyaeva (2010) examine the indirect effects of oil price increases on different countries' GDP working through the bilateral trade with their major trading partners. They find that for the oil exporters in their sample (Canada and Russia), the effects of oil price increases were positive. However, there were also indirect negative effects as a result of lower economic activity in their oil importing trading partners. Some oil importers were also found to benefit from oil price increases due to higher demand from their oil-exporting trading partners.

Other related studies have examined the impacts of oil prices on exports, terms of trade and the current account balance. Kuboniwa (2014) examine the effects of oil prices on the terms of trade for oil exporting Russia, Malaysia, and Indonesia. He finds that a 10% increase in the price of oil is associated with 4.4% and 1.8% improvement in the terms of trade for Russia and Malaysia respectively. However, for Indonesia, the effect was found to be negative, deteriorating the terms of trade by 1%. Ahmed and O'Donoghue (2010) and Muhammad (2012)) also find that oil price increases are associated with a reduction in exports of Pakistan (an oil importer) through inducing an increase in production costs. Chuku et al. (2011) study the effects of oil price shocks on the Nigerian current account balance. Using quarterly data from 1970 to 2008, they estimate a structural VAR model. They find that unexpected oil price increases lead to an improvement in the current account balance in the first 6 quarters after the shock, after which it declines. Their variance decomposition analysis reveals that oil price shocks account for 15.77% of the variation in the current account balance. The authors argue that the absence of a "one-for-one" relationship could be the result of an exchange rate appreciation offsetting the oil price effect through the non-oil trade balance, although they do not explicitly model this. Huntington (2015) finds that oil trade surpluses lead to an improvement in the current account balances of oil exporters, but oil trade deficits do not affect those of oil importers.

It is evident that no study has examined the effects of oil prices on the trade balances of SSA countries. The result that oil prices should deteriorate the overall trade balance for oil importers and improve it for exporters is based on some assumptions that may be weak for these countries. First, Bodenstein et al. (2011) show that having access to international funds is important for ensuring consumption smoothing when the oil price rises: the less financially integrated an economy, the more its nonoil balance will adjust and the less its overall balance will be affected by oil prices. In line with this, Kilian et al. (2007) find that the nonoil balances of some oil importers in Latin America respond more to oil price increases than those in Emerging Asia, leading to a relatively muted response of the overall trade balance for Latin America. The authors argue that this may reflect Latin America's relatively limited access to international capital markets which discourages borrowing to smooth consumption in response to oil shocks. As shown in Figure 2.7, even among developing countries, SSA is not well integrated in international financial markets. It has been shown that this low integration level limits consumption smoothing opportunities for SSA countries (Ahmed and Suardi, 2009). Second, as shown in Figure 2.6, SSA oil importers are exporters of primary commodities whose prices often move in line with oil prices, which means that periods of oil price increases are sometimes associated with higher import expenditure *and* higher export receipts. Third, due to the poor state of oil refineries, SSA oil exporters import refined petroleum products, meaning that periods of oil price increases bring both rising oil revenues and import costs. Together, these factors imply a dampened overall trade balance response for these countries. Empirically, Le and Chang (2013) find that oil prices have negligible effects on the trade balance of Singapore because it imports crude oil, refines it, and exports the final product. As the authors argue, for this type of economy, the negative effects on imports may cancel out the positive effects of oil price increases on exports. Similarly, Kuboniwa (2014) finds that the terms of trade for Indonesia, an oil exporter, deteriorates with an oil price increase. He argues that this is because Indonesia began to import oil in 2004 due to dwindling oil reserves. Again, this is much like the case of SSA oil exporters who also import oil[20].

This chapter contributes to the literature by examining the effects of oil prices for SSA countries while explicitly modelling the role of real exchange rate adjustments in influencing these effects. Unlike Chen and Hsu (2012) and Shiu-Sheng and Kai-Wei (2013), this chapter does not assume homogenous impacts of oil prices for all trading partners. Rather, the disaggregated bilateral effects which may differ across trading partners are estimated. This chapter also improves on the few studies that use panel data

[20] Another factor that can lead to a low response of the overall balance is a high price elasticity of demand for oil. In Appendix D, we estimate long and short run price elasticities of demand for oil for our sample countries. We find that these are quite low, close to zero for both oil importers and exporters. It is therefore not likely that a low oil trade balance response to oil prices is responsible for their muted overall trade balance response. This also points to a large nonoil balance component for these countries.

methods in examining the effects of oil prices on the trade by accounting for potential cross section dependence.

4.2.2. Exchange rates and the trade balance:

The main theoretical model which sets out the conditions that determine the impact of an exchange rate change on the trade balance is the widely known Marshall-Lerner condition. It states that if the sum of the price elasticities of demand for imports and exports is greater than unity, then the immediate effect of a depreciation would be positive. In other words, if import and export volumes are highly responsive to price changes, a depreciation would have a positive short-run effect. However, if this condition is not met, the effect of a depreciation may follow a 'J-curve'. Under this view, a depreciation of a country's currency has a positive long-run effect on the trade balance through encouraging exports and discouraging imports, but the effect is negative in the short-run. The initial negative effect occurs if the depreciation quickly increases the money spent on imports, while export and import volumes are slow to adjust to the exchange rate change (Rose and Yellen, 1989). In this case, the cost effect of the depreciation initially outweighs the quantity effects. After some time, the quantities of traded goods adjust to the change in the exchange rate, and the effect of the depreciation becomes positive. [21]

A related issue is the degree of substitutability of domestic and foreign goods over time (Reinhart, 1995). If this is high, then changes in relative prices will lead to a larger change in quantities of goods traded. For African countries, imports generally have no close domestically produced substitutes due to low manufacturing activity, making the price elasticity of import demand typically low. On the other hand, Alessandra et. al. (2010) find that in emerging and developing economies, short run import elasticities are high, usually because higher fixed costs per trade transaction (for instance high bureaucratic costs) encourage importing firms to build up inventories such that, in the event of a depreciation, existing inventories are run down before further purchases are made at the new higher price. On the export side, commodity exporters face a relatively price inelastic export supply curve, at least in the short run, because expanding the production of natural resources is subject to capacity and technological constraints, menu costs etc. In addition, their primary commodity exports usually have a global US

[21] However, Magee (1973) showed that the short run effect of an exchange rate change on the trade balance is at best ambiguous. In his analysis, the J-curve is only one out of a number of possible outcomes namely: the I,L,M,N,V,W curves and their inversions, at the minimum.

dollar oil price, such that a depreciation of any one country's exchange rate is unlikely to influence the foreign currency export price. This implies a low elasticity of foreign demand to relative price changes (Hakura and Billmeier, 2008).

From the empirical perspective, few studies using both aggregate and bilateral data have found evidence in support of a J-curve for developing countries[22]. Kodongo and Ojah (2013) examine the relationship between the real exchange rate, the aggregate trade balance and capital flows of major African countries. They used annual data from 1993-2009 to estimate a panel VAR. Using the US dollar as a proxy for world foreign currency, they find causality running from changes in the real exchange rates of African countries to the trade balances of these countries, with a one year lag. A 1% depreciation was found to improve trade balance by 0.029%-0.032% units.

Bahmani-Oskooee and Gelan (2012) test the presence of a J-curve in African countries. They use quarterly aggregate data from 1972Q1 to 2008Q4 for 9 African countries, and model the trade balance as a function of domestic and foreign incomes as well as real exchange rates. Using an error correction model, they find no support for the J-curve effect in any country in their sample, and the long-run effects of a depreciation were favourable only in Nigeria, South Africa, and Egypt. For other countries, both long-run and short run coefficients were predominantly insignificant, indicating the absence of a relationship between real exchange rates and trade balances. The authors argue that this may reflect the low degree of responsiveness of trade volumes to exchange rates.

Rose (1990) also examines the impact of changes in the real exchange rate on the aggregate trade balance of 30 developing countries including African countries. The paper finds no significant effects of exchange rate changes on the trade balance. In a similar study, Rawlins and Praveen (1993) find that a devaluation leads to an improvement of the aggregate trade balance for a sample of 19 African countries. Amzath et al. (2010) conduct a similar study for Côte d'Ivoire. They estimate the effects of real exchange rate changes on the country's aggregate trade balance using error correction models and testing for granger causality. They find that the real exchange rate granger-causes the trade balance in Côte d'Ivoire. They find evidence of a J-curve, as a real depreciation was found to worsen the trade balance initially and improve it after one lag.

[22] McKenzie (1999) and Bahmani Oskooee and Hegerty (2007) provide an extensive review of this literature.

Allen (2006) examines the effects of exchange rate changes on the trade balance for a sample of 46 emerging market economies including oil and nonoil commodity exporters over the 1980-2005 period. He finds a positive relationship between exchange rate depreciations and the trade balance. However, he finds that the initial trade position of countries plays an important role in determining the impact of exchange rates: the higher a country's initial trade surplus, the less is the sensitivity of its trade balance to exchange rate changes. Thus, the higher the surplus, the less likely is a depreciation to further improve the trade balance and the less likely is an appreciation to deteriorate it. On the other hand, the larger the initial deficit, the more likely is a depreciation to improve the deficit and an appreciation to reduce it. He thus finds that a deteriorating trade balance is more likely to be governed by the ML condition.

Bleaney and Tian (2014) examine the effects of exchange rates on the trade balance of 87 countries from 1994-2010 using a fixed effects model. They find that depreciations improve the trade balance. For developing countries, most of the trade balance adjustment is found to come from the import side. Their analysis excludes oil exporters.

A study that examines the effects of exchange rates depending on the status of a country as an oil exporter or oil importer is that of Hakura and Billmeier (2008). Using annual data from 1990-2006 on a combination of 27 oil exporting and oil importing emerging Asian economies, they find that the elasticities of export and import volumes to exchange rates are lower for their oil exporting sub-sample. They argue that this is because oil exporters are price takers, such that a change in any one country's currency is unlikely to affect the price of oil and its demand. Oil exporters can however increase supply when there is a depreciation, but this is subject to capacity constraints and OPEC restrictions where applicable. Given that their elasticity of demand for imports is also typically low (due to unavailability of locally produced substitutes), the net effect on the trade balance is muted for oil exporters. For oil importers, it is found that a depreciation is typically associated with a trade balance improvement.

The studies above may be subject to an aggregation bias. Marquez (1990) finds that bilateral price elasticities of demand for imports and exports are generally in line with those implied by aggregate models, but aggregation conceals heterogeneous information which is potentially useful for policy design. Studies utilising bilateral data include Yol and Baharumshah (2007). They study the effects of exchange rate changes on bilateral trade balances of 10 SSA countries vis-à-vis the US. They find that a depreciation has positive effects on the trade balance of 6 countries, negative for one (Tanzania) and no effect on three. Unlike the present study, they do not examine the effects on the bilateral trade balances with other major trading partners apart from the US.

Dash (2013) investigate the existence of a J-curve for India's bilateral trade balance with four of its major trading partners. They find evidence of J-curve in India's trade balance with Japan and Germany, but not with the United Kingdom and United States. In a similar study, Wilson (2001) examine the effects of exchange rate changes on bilateral trade balance of three Asian economies vis-à-vis the US and Japan. They find no significant effect of exchange rate depreciations on the trade balances, and no evidence of a J-curve for any country in their sample.

Onafowora (2003) examines the effects of a depreciation on bilateral trade balances of Malaysia, Indonesia and Thailand vis-à-vis the US and Japan. Using quarterly data and VECM techniques, they find that the Marshall-Lerner condition holds in the long run, while short run impulse response functions show varying degrees of J- curve effects. In another study, Bahmani-Oskooee and Harvey (2010) study the effects of an exchange rate depreciation on Malaysia's bilateral trade balances with 14 of its trading partners. Evidence from their co-integration and error correction models provide support in favour of a J-curve.

Overall, no consistent relationship has been found in the effects of real exchange rate changes on the trade balances of SSA and other developing countries. The role of exchange rates in influencing the effects of oil prices depend on whether real exchange rate movements have the expected impact on trade flows i.e. if the price elasticity of demand for traded goods is sufficiently high. It is thus interesting to test whether exchange rate adjustments succeed in influencing the effects of oil prices on the trade balance, and whether their role is that predicted by theory. If it is, exchange rate management can potentially be used as a policy tool to limit exposure to oil prices.

4.2.3. The oil price-exchange rate nexus:

The literature on the relationship between oil prices and exchange rates is vast. Many studies have shown that oil-exporting countries' currencies appreciate against the US dollar when the oil price increases, giving rise to the coined term 'oil currencies' (Dauvin, 2014). On the other hand, the currencies of oil importers are found to depreciate. Theoretically, the real exchange rate can be affected by oil prices through the terms of trade. The terms of trade is affected through a spending effect and a resource shift effect (Korhonen and Juurikkala, 2009).

The spending effect implies that when the price of a dominant export good increases (in this case oil), there is a transfer of wealth from oil importing countries to oil exporting ones. This leads to higher profits and wages in the energy sector, and increases aggregate demand. This higher demand is directed at least in part to the domestic market. Public expenditure may also increase with increased oil revenue (Korhonen and Juurikkala, 2009). As a result, domestic prices increase relative to the prices of importables (which are determined in international markets). The terms of trade thus improve, and the real exchange rate appreciates. In the same way, there is a corresponding terms of trade deterioration for the oil importer, and a consequent real depreciation of its currency.

The resource shift effect implies that when the oil price increases, there is an increase in the demand for labour and capital by the energy sector of oil exporting countries, which will offer higher returns to these factors of production. Resources shift away from other sectors, reducing the supply of goods from these sectors and increasing the prices of their products. There is thus an increase in prices of domestic relative to foreign goods, a terms of trade improvement and a corresponding real exchange rate appreciation. The reverse is the case for an oil importer whose currency would depreciate.

Various empirical studies have confirmed causality running from oil prices to real exchange rates. Korhonen and Juurikkala (2009) examine the oil price-exchange rate nexus for OPEC countries using data from 1975-2005. They find that for all the countries (including Nigeria and Angola), oil price increases lead to a significant appreciation of the real exchange rate, with an elasticity of 0.4-0.5. Jahan-Parvar and Mohammadi (2011) reach similar conclusions for their sample of 14 oil-exporting countries, in which 5 countries' currencies (including Nigeria and Angola) appreciated with oil price increases. In another study, Mohammadi and Jahan-Parvar (2012) examine the relationship between oil prices and exchange rates of 13 oil-exporting countries. They find a stable relationship between the two variables in the long run, but higher oil prices only led to an exchange rate appreciation for 3 countries in the short run. Dauvin (2014) finds that for energy producing countries, a 10% increase in energy prices leads to a 2.8% appreciation of their currencies. Chaudhuri and Daniel (1998), Amano and Van Norden (1998), Chen and Chen (2007), Lizardo and Mollick (2010), Reboredo et al. (2014) among others show a stable relationship between oil prices and exchange rates.

Bodenstein et al. (2011)'s model also shows that the real exchange rates of oil importing countries depreciate against those of oil exporters when the oil price increases. An important implication of the model is that these exchange rate adjustments, through the non-oil trade balance, offset the effects on the oil trade balance and hence the overall trade balance. It is this implication of the model that this chapter attempts to test.

Overall, the empirical literature on the oil price-trade balance relationship does not model the role of exchange rates in influencing this relationship. This is despite the strong links between oil prices and exchange rates, and the ambiguous effects of real exchange rates on the trade balance. Although this chapter does not model exchange rate changes as the outcome of oil price changes, it examines how the effect of oil prices on the trade balance are influenced by observed changes in the real exchange rate. By so doing, this chapter in part addresses the gap in the literature.

4.3. Data and Methodology:

4.3.1. The Model:

The theoretical trade balance model adopted is the imperfect substitutes trade model expressed in bilateral terms as:

$$TB_{t,ij} = TB(Y_i^d, Y_j^f, RER_{t,ij}) \ldots\ldots\ldots\ldots\ldots\ldots (4.1)$$

Where $TB_{t,ij}$ is the bilateral trade balance of SSA country i with trading partner j at time t, $Y^d(Y^f)$ is the domestic (foreign) income proxied by domestic (foreign) GDP, and $RER_{t,ij}$ is the bilateral real exchange rate between SSA country i with trading partner j at time t. $RER_{t,ij}$ is calculated as:

$$RER_{t,ij} = NER_{t,ij} \times \left(\frac{CPI_{t,i}}{CPI_{t,j}}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.2)$$

Where NER is the nominal exchange rate expressed as domestic (SSA) currency per unit of foreign currency and CPI is the Consumer Price Index. An increase in the exchange rate thus means a depreciation.

The model in (4.1) is augmented with the real oil price (ROP) and the interaction term between the real exchange rate and the real oil price (RER*ROP). Note that the empirical model used in this chapter controls for both time invariant and time variant unobserved common factors through fixed effects and common correlated effects. It is therefore unnecessary to include control variables such as distance, common language, common borders, and other time invariant determinants of the underlying import and export equations. The effects of financial and currency crises as well as political unrests common to specific SSA countries are also accounted for by the model. All variables are transformed into their natural logarithmic forms and are in first differences. We allow for delayed responses of the trade balance to the variables by including a lag of one quarter. The contemporaneous real exchange rate is used with lagged oil prices so as to see the effect of exchange rate changes that occur after an oil price change. The empirical model estimated for each SSA country panel is thus;

$$dlnTB_{t,ij} = \alpha + \sigma_i dlnTB_{t-1,ij} + \beta_1 dlnY^d{}_{t-1,i} + \beta_2 dlnY^f{}_{t-1,j} + \beta_3 dlnRER_{t,ij} + \beta_4 dlnROP_{t-1,i} + \beta_5 \left\{RER_{t,ij} * lnROP_{t-1,i}\right\} + \varepsilon_{t,i} \ \ldots\ldots\ldots (4.3)$$

With regards to the expected signs of these variables, increases in domestic real income should increase imports, which will worsen the trade balance. In the same way, an increase in foreign income is expected to improve the trade balance through increasing the demand for exports. The effect of the real exchange rate would depend on whether the Marshall-Lerner condition is fulfilled. In line with Bodenstein et al. (2011), it is expected that the interaction term between the oil price and a real depreciation will be positive if the Marshall Lerner condition is met, and negative otherwise.

4.3.2. The Method:

This chapter uses the Pesaran (2006)'s Common Correlated Effects Mean Group(CCEMG) estimators. The CCEMG estimators are employed to account for cross section dependence. The time-series panel data utilised in this study is subject to properties of non-stationarity, potential parameter heterogeneity across groups, and cross-section dependence. The latter has been a major concern recently in the macro panel data literature. Cross section dependence occurs when the variables or residuals across the panel members (countries) are correlated due to common shocks such as recessions, oil price shocks, spill-over effects, etc. (Pesaran, 2006). These factors are unobserved, common to all countries, and may have heterogeneous impacts on the panel members (Eberhardt, 2011). The most widely used panel data methods such as the Fixed Effects, Random Effects, Mean Group, Pooled Mean Group, and some classes of GMM estimators all assume cross section independence. However, this assumption is usually not valid and leads to imprecise estimates or even identification problems if CSD is ignored (Eberhardt, 2011). CSD is typically accounted for using either spatial estimators that assume knowledge of the unobserved common factors; or common factor models that do not. Since the observed common factors are not known, this study utilises the latter approach by using Pesaran (2006)'s Common Correlated Effects (CCE) estimator.

The Mean Group (MG) estimator of Pesaran and Smith (1995) is ideal for this analysis because it allows the precise estimation of the bilateral effects in which this study is interested[23]. The MG model is a panel Autoregressive Distributed Lag (ARDL) model

[23] An alternative estimator is CSD robust Pesaran (1999) Pooled Mean Group estimator which is more efficient than the MG estimator if a homogeneity assumption holds for the long run coefficients. Hausman tests between the PMG and MG showed that for most countries, the MG

reparametrized into an error correction equation, where both short and long run coefficients are estimated. It is based on the estimation of a time series regression for each panel member by maximum likelihood, and then averaging across groups. Pesaran (2006) showed that cross section dependence would be addressed by the augmentation of the Mean Group estimator with cross sectional averages of the dependent and independent variables, and these represent the common factors. This augmentation is powerful in eliminating the effects of the common factors asymptotically as the number of panel members increases i.e. as N→∞ (Pesaran, 2006). In this chapter, the short run and long run models are augmented with the cross section averages of the dependent and independent variables. Cross section averages of the real oil price, the interaction term, and domestic GDP are not included. This is because the real oil price and domestic GDP measures are common across trading partners for each SSA country, and the interaction term contains the real oil price. Including their averages will lead to a collinearity problem. To set up the CCE estimator, consider the panel data model;

$$y_{it} = \propto_i' d_t + \beta_i' x_{it} + e_{it} \ldots\ldots\ldots\ldots\ldots \text{(4.4)}$$

Where y_{it} is the observation of the dependent variable on the ith country at time t, d_t is the vector of observed common effects including intercepts, x_{it} is a vector of regressors, and e_{it} is a vector of individual specific errors which have the following structure;

$$e_{it} = \gamma_i' f_t + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4.5)}$$

Where f_t is the vector of unobserved common factors and ε_{it} is the vector of errors assumed to be i.i.d of both the observed factors d_t and the regressors x_{it}. However, the unobserved factors f_t which are components of e_{it} are allowed to be correlated with d_t and x_{it}, so that endogeniety is accommodated. Unit roots can also be allowed in d_t or f_t which in turn introduces unit roots in in x_{it} and y_{it}. The number of observed factors and regressors are assumed to be known but the number of unobserved factors are not. Errors are also allowed to be serially correlated and heteroskedastic. Under this framework, Pesaran (2006) shows that the individual slope coefficients of interest β_i as well as their means β can be consistently estimated by augmenting the regression with cross sectional averages of y_{it} and x_{it} given by;

$$\sum_{i=1}^{N} W_i Z_{it} \ldots\ldots\ldots\ldots\ldots\ldots \text{(4.6)}$$

---

model is preferred and for other countries, the test did not converge. The MG is thus used for all the countries since it is consistent even in cases where the PMG may be preferred.

Where Z_{it} consists of y_{it} and x_{it}, and W_i are the weights used in the construction of the averages. These weights do not matter for the asymptotic properties of the estimator, so equal weights are applied in this study. The individual specific estimates of the slope coefficients, $\widehat{b_{\iota MG}}$ in the context of this study, represent bilateral estimates for each SSA country vis-à-vis each trading partner, such that the estimates differ across trading partners for each SSA country. The averages of the individual specific slope coefficients, the $\widehat{b_{MG}}$, which are directly comparable to other standard panel data aggregate methods, are also reported.

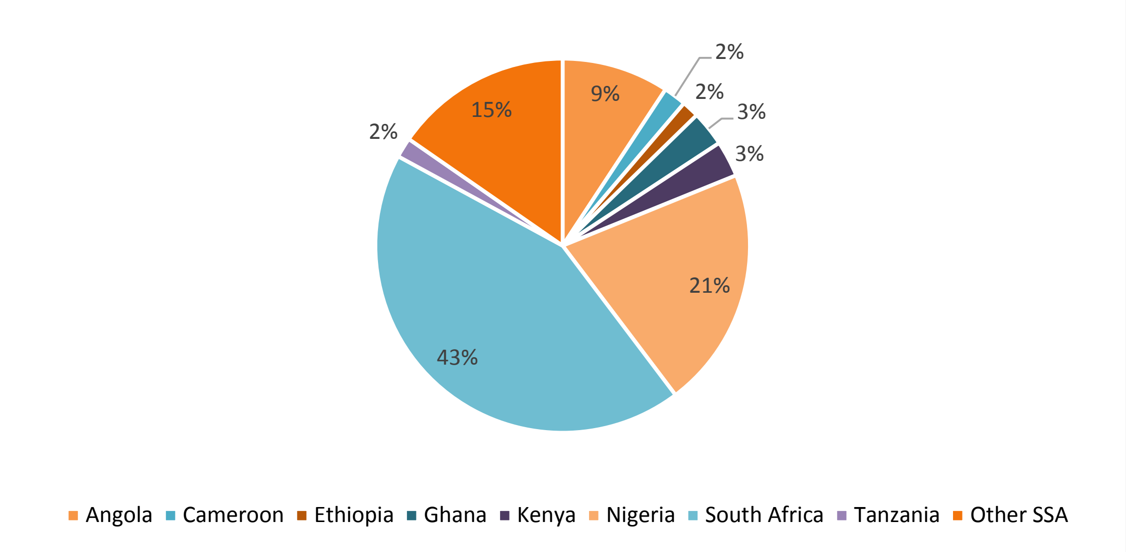
An alternative method to account for cross-sectional dependence is to use the Driscoll and Kraay (1998) CSD robust standard errors in the context of a Fixed-Effects estimation. The standard errors are well calibrated in the presence of CSD, and have desirable small sample properties. Here also, the errors are assumed to be heteroskedastic and serial correlation is accommodated. The standard errors are robust to very general forms of CSD and are based on large T asymptotics (Hoechle, 2007), particularly suited for the present study. We therefore check that our results are robust to using this model. Unlike the CCEMG model however, this model is non-dynamic and assumes homogenous slopes for each SSA country with its trading partners, so it is not possible to obtain the individual specific bilateral estimates i.e. $\widehat{b_\iota}$. The estimates however are comparable to those of the averages from the CCEMG model i.e. the $\widehat{b_{MG}}$.

4.3.3. Data:

This study uses quarterly data from 1990Q1 to 2011Q4[24] for 8 SSA countries and 11 bilateral trading partners. The SSA countries considered are Angola, Cameroon, Ethiopia, Ghana, Kenya, Nigeria, South Africa and Tanzania. As shown in Figure 4.1, these countries account for over 86% of SSA's total trade over the period. Nigeria and South Africa alone account for over 60% of the regions trade.

[24] Data for South Africa is available only from 1998.

Figure 4.1: proportion of total SSA trade represented by sample countries (84.6% of total SSA trade).



Source: Author's Calculations using data from International Monetary Funds' Direction of Trade Statistics. Notes: Trade represents the values of exports plus imports in current US dollars.

The major oil exporters in the sample are Nigeria and Angola, the two largest oil producers in Africa. Cameroon and more recently, Ghana also produce and export crude oil in smaller quantities. However, during the sample period, Ghana was primarily a net oil importer as it began to export oil in 2011. These SSA oil exporters import refined petroleum products. Data from the United Nations Conference on Trade and Development (UNCTAD) shows that over the period, Angola, Cameroon and Nigeria have imported up to 3%, 76%, and 10% the value of oil they have exported, respectively.[25] Also within the same period, oil has accounted for up to 5.5%, 27%, and 14% of their total imports respectively. Despite declining oil production in recent years, Cameroon's oil trade balance with the trading partners considered has been in surplus during most of the sample period, so that it can be considered a net oil exporter relative to the partner countries.

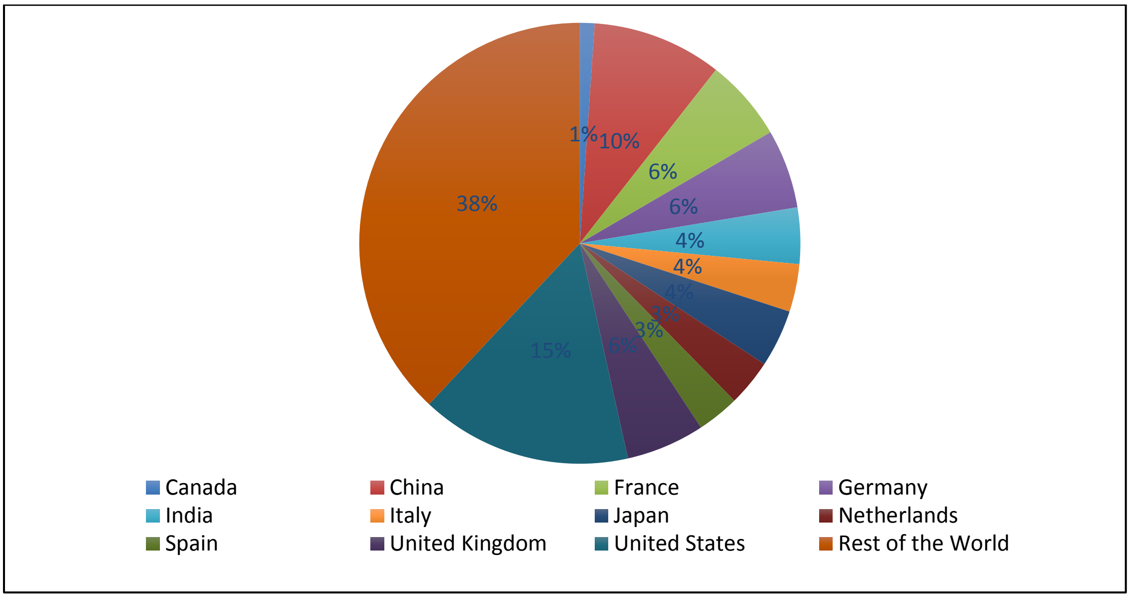
The trading partners chosen are Canada, China, France, India, Italy, Germany, Japan, Netherlands, Spain, United Kingdom and United States[26]. Together, these countries account for over 62% of SSA's trade as shown in Figure 4.2. The oil exporters among the trading partners are Canada, Netherlands and to a lesser extent the UK. Figure 4.3 shows the average percentage of total trade accounted for by the trading partners for

[25] This data is of annual frequency and is available from the UNCTADstats database as well as from the author upon request.

[26] Brazil is an important trading partner for SSA countries but it is excluded from the analysis due to the poor availability of its bilateral trade data.

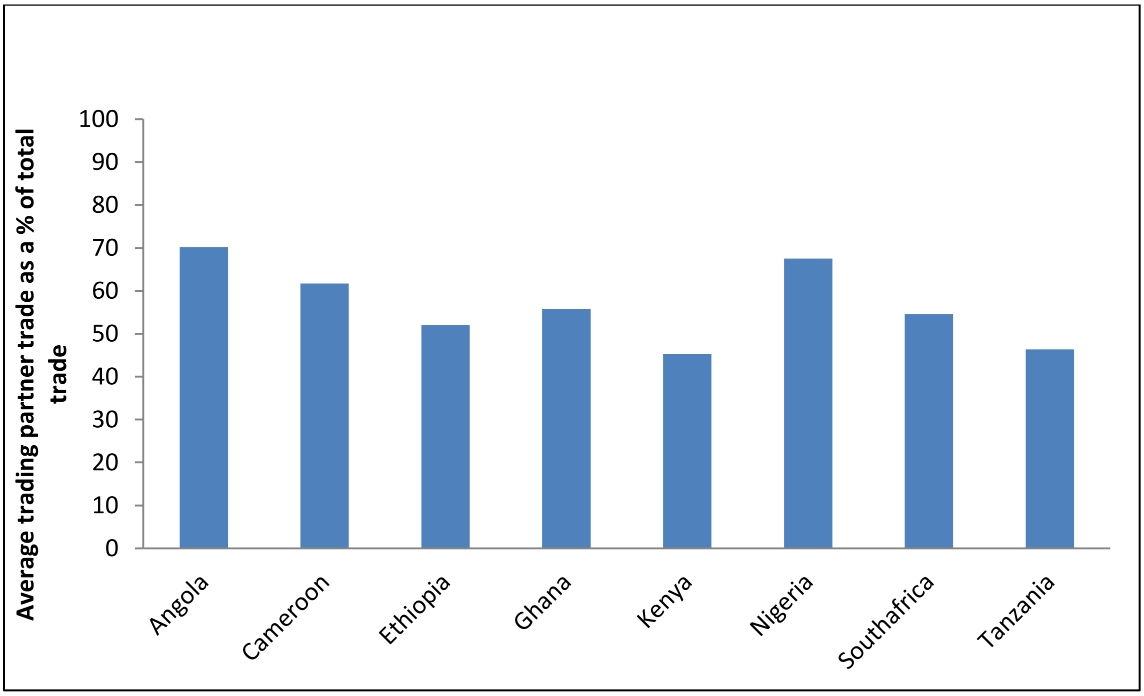
each SSA country in the sample. The highest is 70% for Angola, the lowest 45% for Kenya.

Figure 4.2: Proportion of SSA trade accounted for by chosen trading partners, 1991-2011 (62% of total trade).



Source: Author's Calculations using data from International Monetary Funds' Direction of Trade Statistics. Notes: Trade represents the values of exports plus imports in current US dollars.

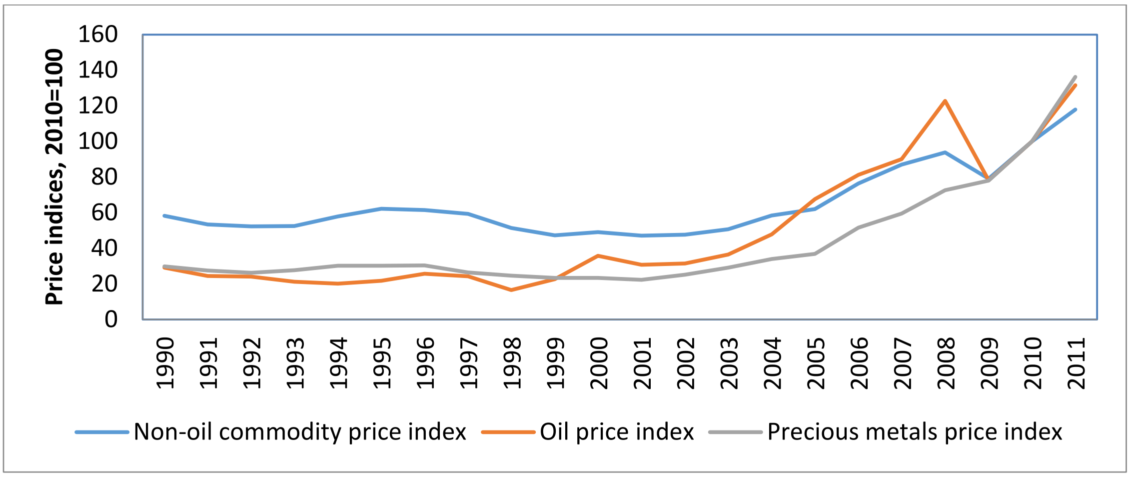
Figure 4.3: Percentage of total trade accounted for by chosen trading partners, period average.



Source: Author's Calculations using data from International Monetary Funds' Direction of Trade Statistics. Notes: Trade represents the values of exports plus imports in current US dollars.

The SSA oil importers considered export gold, beverages, other food items and agricultural commodities (UN, 2013). For instance, Ethiopia's main exports are coffee, oil seeds and gold. Ghana's main exports are gold and cocoa beans, while Kenya exports tea, coffee and cut flowers. South Africa exports platinum, iron and gold while Tanzania exports gold and other precious metals (UN, 2013). Using commodity price data from the International Monetary Fund's International Financial Statistics (IMF IFS) and the World Bank, Figure 4.4 plots the oil, non-oil and precious metals commodity price indices. The positive relationship between these indices is striking. The calculated correlation coefficient between the oil price index and the non-oil and precious metals price indices are 0.93 and 0.89 respectively.

Figure 4.4: Oil and Non-oil Price Indices



Source: Commodity price indices data from the World Bank and International Monetary Fund's International Financial Statistics (IMF IFS).
Notes: Non-oil price index consists of prices of Food, Beverages, Agricultural raw materials and Industrial Metals. The oil price index is derived from a simple average of Texas Intermediate, Brent and Dubai spot prices. The Precious metals index consists of prices of Gold, Silver and Platinum.

African countries have experienced different types of exchange rate arrangements. Following the colonial era, the former British colonies generally adopted flexible exchange rate regimes while the French colonies, 14 of them, formed the CFA Franc zone, and have their currencies pegged to that of France- now the Euro. The CFAF countries consist of the Central African Economic and Monetary Community (CEMAC) and the West African Economic and Monetary Union (WAEMU). The economic community of West African states (ECOWAS) which consists of 15 member countries, 8 of which are CFAF counties, is also moving towards adopting a common currency. Similar initiatives can be found in the southern and eastern parts of the continent (Qureshi and Tsangarides, 2012). Cameroon is the only country in our sample that is a member of the CFAF zone, but the nominal currency peg does not matter since our interest is in the real exchange rate.

The data used in this study are obtained from the International Monetary Fund's International Financial statistics and Direction of Trade Statistics databases (IMF IFS and IMF DOTS). Real oil prices are the domestic real oil prices for SSA countries using their nominal exchange rates and Consumer Price Indices (CPI) thus:

$$ROP_{t,i} = NOP_i \times \left(\frac{NER_{t,US}}{CPI_{t,i}}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4.7)}$$

Where NOP is the 3 spot US dollar oil price, ROP is the real oil price, CPI is the consumer price index, and NER is the nominal US dollar exchange rate.

Foreign and domestic GDP data are obtained as annual series in constant 2005 US dollars from the World Bank's World Development Indicators (WDI) database. The annual series are then interpolated into quarterly series using the method of Boot et al. (1967). This is because quarterly GDP data are not available for most countries[27]. The bilateral overall trade balance is used because of the poor availability of bilateral oil and nonoil trade data. However, the response of the overall trade balance is sufficient to show the influence of the real exchange rate, and also allows us to infer the relative impacts of oil prices on both components of the trade balance. Meaningful interpretation is also facilitated by the bilateral nature of the data which makes it easier to infer whether a country is a net importer or exporter of oil relative to a particular trading partner[28]. The trade balance (TB) is measured as the natural logarithm of the ratio of bilateral exports to bilateral imports thus;

$$TB_{t,ij} = ln\left({exports_{t,ij}}/{imports_{t,ij}}\right) \ldots\ldots\ldots\ldots \text{(4.8)}$$

As discussed in the previous chapter, measuring the trade balance in this way has the advantage that the TB measure is insensitive to the unit of measurement (i.e. whether domestic or foreign currency), and to whether the trade balance is in nominal or real terms (Bahmani-Oskooee, 1991). It also allows the use the logarithm of the trade

[27] An alternative would be to use the Index of Industrial Production (IIP) as a proxy for GDP. While this data is available for most of the partner countries, it is available only for few SSA countries and even then, is characterised by a lot of missing values.

[28] The UNCTADstat database provides oil and nonoil bilateral trade data, but it could not be used for this study because there are too many missing values especially for oil importers. However, where the values are available, it is used as a guide for understanding the general pattern of oil trade between the trading partners.

balance because the latter is non-negative, so the regression coefficients can be interpreted as elasticities. The trade balance is in deficit when TB is less than unity, and in surplus when it is above it.

Appendix B shows the bilateral trade balance for each SSA country with the trading partners considered. It can be seen that Angola's trade balance is generally in deficit with all trading partners except the US. Trade surpluses have occurred towards the end of the sample period, for instance with China, India, Italy and Netherlands. The large deficits with Canada and Netherlands throughout the sample period indicate that Angola imports more from these oil exporters than it exports. Cameroon's trade balance has been in deficit with most countries over the sample period despite its oil exporter status, highlighting the presence of a large nonoil balance component. Ethiopia's trade balance has also been in deficit with all trading partners throughout the sample period with the exception of Canada, where there is a surplus for a few quarters, despite Canada's oil exporter status. Although Ghana's trade balance has also been in deficit with most trading partners, it has fared relatively better than the other SSA countries. Its deficits are larger with Canada and China. In contrast with the other countries, Kenya has maintained a surplus with Canada and Spain, and, to a lesser extent, Netherlands, especially at the beginning of the sample period. The relative surpluses with oil exporting Canada and Netherlands indicate that Kenya might be the recipient of recycled oil revenues. Kenya's trade balances with the other trading partners have been in deficit throughout the sample period. In general, Nigeria has had surpluses with Canada, Spain and the US. Its largest deficits are with China, Japan, India and to a lesser extent, the UK. Thus, Nigeria is the only oil exporter in the sample that has a relative surplus in its trade with Canada, another oil exporter. South Africa's trade balance tends to be in a surplus towards the end of the sample period, possibly reflecting increased trade integration following the lifting of its sanctions. South Africa has maintained surpluses with Spain (save a deficit in 2009) and Netherlands, despite the latter's oil exporter status. Notable surpluses have occurred for South Africa in 2010 for the UK, India, Italy, Netherlands and China. Finally, it can be seen that Tanzania's trade balance tends to be in deficit except for a few periods of surpluses for Canada, France and Spain. These descriptive graphs show that the oil exporters tend to have trade deficits with fellow oil exporting trading partners. Even more surprising is that where oil importing SSA countries have a surplus, it is usually with Canada and

Netherlands, two oil exporting countries. Descriptive statistics of other variables, by SSA country, are shown in Appendix C.

4.4. Results:

4.4.1. Tests for Cross Section Dependence

Table 4.1 shows the results from tests for error cross section dependence for each SSA country. A mean group estimator is applied for each country, and the residuals are tested for CSD using the Pesaran (2004) CSD test. It is shown that null hypothesis of cross section independence is rejected at 1% level of significance for all countries, making it necessary to account for CSD.

Table 4.1: Test for Cross-Sectional Dependence (CSD)

Country	CSD Statistic	P-value	Average Correlation coefficient
Angola	13.98***	0.000	0.20
Cameroon	5.95***	0.009	0.08
Ethiopia	18.8***	0.000	0.29
Ghana	11.63***	0.001	0.17
Kenya	42.78***	0.000	0.63
Nigeria	30.79***	0.000	0.45
South Africa	6.89***	0.000	0.13
Tanzania	34.36***	0.000	0.50

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$The null hypothesis is cross-section independence.

4.4.2. Long run heterogeneous impacts of oil prices and exchange rates on the trade balance

Tables 4.2-4.9 show the long-run individual-specific bilateral estimates for each SSA country i.e. the $\widehat{b_{i,}}$. The following discussion shows the impact of real oil prices, the real exchange rate and their interaction on the trade balance of oil exporters and importers respectively. The average short and long run CCEMG estimates, as well as the CSD robust Fixed Effects estimates, are presented in a later section.

4.4.2.1. Oil exporters (Angola, Cameroon and Nigeria)

Table 4.2 shows the bilateral trade balance equation for Angola. As expected, an oil price increase improves Angola’s trade balance with Canada, India, Netherlands and the US by 25.5%, 6.1%, 7.9% and 1.4% respectively. The effect is however negative for China and the UK, deteriorating the trade balance by 6% and 3.6% respectively. The effect of the exchange rate is negative for Canada and Netherlands, meaning that a real depreciation (appreciation) deteriorates (improves) the trade balance by 22.5% and

4.8% respectively. This indicates that the Marshall-Lerner condition is not met, and price elasticities of traded goods are not sufficiently high. The effect of the exchange rate is positive for the UK, where a real depreciation (appreciation) improves (deteriorates) the trade balance by 4.4%. Consistent with these results, the coefficients on the interaction terms show that a higher real depreciation (appreciation) dampens (increases) the positive effects of oil prices on Angola’s trade balance with Canada, India and Netherlands by 3.9%, 15.5% 1.2% respectively. In the same way, a higher real depreciation (appreciation) dampens (increases) the negative effects of oil prices on the trade balance with China and the UK by 2.6% and 1% respectively. The oil price and exchange rate have no significant effect for other trading partners.

Table 4.3 shows that for Cameroon a real oil price increase improves the trade balance with Canada by 13.4% and Italy by 0.8%, but deteriorates it for Spain by 1% and the US by 6%. The effect of the exchange rate is negative for Canada, which means a real depreciation (appreciation) deteriorates (improves) the trade balance by 19.6%. On the other hand, the effect is positive for Germany and India, improving the trade balance by 1% and 6.5% respectively. The coefficients on the interaction terms show that a higher real depreciation (appreciation) dampens (increases) the positive effects of oil prices on Cameroon’s trade balance with Canada by 1.4% and the US by 0.8%. Thus, as was the case with Angola, negative oil price effects are associated with the fulfilment of the ML condition, while positive oil price effects are not. The oil price and exchange rates are insignificant for other trading partners.

Table 4.4 presents the bilateral estimates for Nigeria. An oil price increase improves Nigeria’s trade balance with the US by 5.6%, but deteriorates it with Japan by 2.8%. On the other hand, a real depreciation deteriorates the US trade balance by 6.4% and improves the trade balance with Japan by 6.5%. Consequently, a real depreciation (appreciation) dampens (increases) the negative oil price effect for Japan by 5.1% and the positive oil price effects for the US by 1.1%. This shows that, similar to Angola and Cameroon, exchange rate depreciations tend to dampen oil price movements in both directions, whereas exchange rate appreciations exacerbate them. The oil price has no significant effect on the trade balance with other trading partners.

Table 4.2. Long run heterogeneous Common Correlated Effects Mean Group estimation of bilateral trade balance equation for Angola, 1990-2011

	Canada	China	France	Germany	India	Italy	Japan	Netherlands	Spain	UK	US
Domestic	20.7***	-2.15	-2.956**	4.481*	15.52***	-2.592	-3.347	5.089**	-4.653**	.3401	-.0459
GDP	(4.03)	(-0.56)	(-2.38)	(1.83)	(2.71)	(-1.01)	(-0.69)	(2.02)	(-2.17)	(0.20)	(-0.11)
Foreign	-63.94***	4.422	16.41*	-20.11	.7479	-29.95	-5.631	7.939	2.322	-3.008	-.43
GDP	(-4.45)	(1.38)	(1.90)	(-1.54)	(0.09)	(-1.13)	(-0.11)	(1.02)	(0.23)	(-0.95)	(-0.50)
RER	-22.51**	7.395	.2244	.8795	-5.483	1.111	-1.084	-4.832*	.7049	4.42*	-1.236
	(-2.00)	(1.64)	(0.30)	(0.35)	(-0.83)	(1.47)	(-0.29)	(-1.94)	(1.21)	(1.88)	(-1.39)
Real oil	25.46***	-6.094*	-.8011	1.687	5.989**	-.4115	-.4581	7.87***	-.2076	-3.556*	1.359*
price	(2.72)	(-1.65)	(-0.84)	(0.62)	(1.97)	(-0.25)	(-0.13)	(2.82)	(-0.20)	(-1.82)	(1.74)
RER*ROP	-3.901**	2.598*	.2995	-.8256	-15.48***	1.142*	2.296	-1.196**	.4504	.9196**	-.2563
	(-1.97)	(1.75)	(1.17)	(-1.45)	(-3.03)	(1.95)	(0.64)	(-1.98)	(1.33)	(2.38)	(-1.43)
N	786										

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.3. Long run heterogeneous Common Correlated Effects Mean Group estimation of bilateral trade balance equation for Cameroon, 1990-2011

	Canada	China	France	Germany	India	Italy	Japan	Netherlands	Spain	UK	US
Domestic	-1.456	-5.532	-2.279	-1.067	-.0628	-3.634**	-10.78***	-2.189	-7.296***	-8.616*	-.6894
GDP	(-0.13)	(-1.54)	(-1.64)	(-0.86)	(-0.02)	(-2.54)	(-2.73)	(-1.57)	(-4.43)	(-1.83)	(-0.20)
Foreign	-.4278	.3324	.1087	-.5311	.4138	3.791	43.71**	1.914	10.15***	15.71***	6.557
GDP	(-0.03)	(0.28)	(0.03)	(-0.14)	(0.20)	(0.89)	(2.54)	(0.79)	(4.81)	(2.72)	(1.48)
RER	-19.64**	.432	.0077	1.104*	6.463***	-.0113	-.1504	-.7859*	.08	2.747	2.689
	(-2.11)	(0.22)	(0.03)	(1.78)	(3.25)	(-0.14)	(-0.06)	(-1.72)	(0.53)	(0.74)	(0.82)
Real oil	13.37**	.9996	-.0672	-1.037	-.2259	.8378**	-2.014	.4149	-1.126*	-3.665	-5.9**
price	(2.31)	(0.56)	(-0.13)	(-1.45)	(-0.21)	(2.03)	(-0.73)	(0.77)	(-1.94)	(-1.60)	(-2.07)
RER*ROP	-1.387**	.127	.0555	.1704*	-.2574	-.0381	.4606	.032	.0981	.4414	.821*
	(-2.03)	(0.28)	(0.68)	(1.82)	(-0.64)	(-0.64)	(0.33)	(0.42)	(1.01)	(1.33)	(1.87)
N	905										

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.4. Long run heterogeneous Common Correlated Effects Mean Group estimation of bilateral trade balance equation for Nigeria, 1990-2011

	Canada	China	France	Germany	India	Italy	Japan	Netherlands	Spain	UK	US
Domestic	-3.193	-.6072	-2.145*	1.014	-11.55**	-.6609	-2.041	-1.646**	.9371	4.438***	-1.142
GDP	(-1.34)	(-0.14)	(-1.66)	(1.11)	(-1.97)	(-0.95)	(-1.15)	(-2.13)	(0.88)	(3.33)	(-1.45)
Foreign	1.758	2.146	-1.06	-6.416*	8.994**	10.45***	67.22***	-.8527	-3.16	-10.46***	2.037*
GDP	(0.37)	(0.96)	(-0.13)	(-1.77)	(2.21)	(2.72)	(5.56)	(-0.47)	(-1.00)	(-5.63)	(1.88)
RER	1.564	5.769	1.122	-.6696	-2.07	-.131	6.481***	-.9142	.1301	-.7373	-6.431***
	(0.38)	(1.16)	(1.01)	(-0.56)	(-0.46)	(-0.88)	(2.94)	(-1.06)	(0.55)	(-0.37)	(-3.26)
Real oil	-1.207	-3.405	-1.132	.6284	1.766	.106	-2.839***	1.117	.2075	-.6883	5.55***
price	(-0.34)	(-0.99)	(-0.91)	(0.55)	(0.65)	(0.40)	(-2.62)	(1.32)	(0.58)	(-0.41)	(3.36)
RER*ROP	.44	1.207	.4272	.1679	.0387	-.0853	5.084**	.0545	.1195	.2686	-1.114***
	(0.66)	(0.89)	(1.32)	(0.72)	(0.02)	(-0.77)	(2.46)	(0.30)	(0.91)	(0.94)	(-3.10)
N	942										

t statistics in parentheses, $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.4.2.2. Oil importers (Ethiopia, Ghana, Kenya, South Africa and Tanzania)

Table 4.5 shows that an oil price increase improves Ethiopia's trade balance with France by 1.1% and India by 6.8%. In both cases, a real depreciation (appreciation) deteriorates (improves) the trade balances by 0.9% and 5.3% respectively. A real depreciation also deteriorates the trade balance with Italy by 0.2% but improves it for China by 5.8%. In contrast with previous results, the coefficient on the interaction term shows that a higher real depreciation (appreciation) increases (dampens) the positive effect of an oil price increase on Ethiopia's trade balance with India by 3.5%. The exchange rate does not influence the oil price effect for France. The oil price has no significant impact on the trade balance with other trading partners. The results show that despite Ethiopia's oil importer status, the oil price effect, where significant, is positive. This suggests that, in line with Bodenstein et. al. (2011), Ethiopia's nonoil balance is highly responsive to oil prices, and its improvement dominates any deterioration in its oil trade balance.

For Ghana, Table 4.6 shows that an oil price increase deteriorates the trade balance with Italy by 0.8%, but improves it for Spain by 1.3% and the UK by 0.8%. A real depreciation has no effect for Italy and Spain, but deteriorates the trade balance with the UK by 2.8% and improves it with the US by 3.1%. The interaction term is only significant for the UK, where a real depreciation (appreciation) dampens (increases) the positive effects of oil prices by 3.4%, in line with previous results. As with Ethiopia, Ghana tends to be positively affected by oil prices, again pointing to large nonoil trade adjustments. The oil price and exchange rates have no significant impacts for other trading partners.

Table 4.7 presents the results for Kenya. An oil price increase deteriorates Kenya's trade balance with Netherlands by 0.9%, but improves it with China by 3.4% and the US by 3.3%. A real depreciation improves the trade balance with Netherlands by 0.85%, has no effect for China, and deteriorates the trade balance with the US by 4.2%. It also improves the trade balance with Japan by 1.1% and deteriorates it with Italy by 0.3%. Consistent with previous results, a higher real depreciation (appreciation) is found to dampen (increase) the effects of oil prices for China by 1.4%, and for Netherlands by 0.2%. The effects for other trading partners are not significant.

Table 4.8 shows that an oil price increase improves South Africa' trade balance with France by 1.4%. Here, a real depreciation deteriorates the trade balance by 0.7%, but does not influence the oil price effect. The positive oil price effects again point to a large nonoil trade adjustment. The oil price has no impact for the other trading partners. A real depreciation (appreciation) improves (deteriorates) the trade balance with Germany by 0.6% and Spain by 0.7%, while deteriorating (improving) it for the UK by 0.5%.

For Tanzania, Table 4.9 shows that oil prices have no effect on the bilateral trade balance with any of its trading partners, and exchange rate changes do not influence this result.

In sum, the results show that oil price increases have heterogeneous effects on the bilateral trade balances of SSA countries. Where this effect is positive, it appears that the Marshall Lerner condition is unlikely to hold, such that real exchange rate depreciations reduce the positive oil price effect, while appreciations reinforce it. On the other hand, when the oil price effect is negative, the Marshall Lerner condition is fulfilled- depreciations reduce the negative oil price effect while appreciations reinforce it.

Table 4.5. Long run heterogeneous Common Correlated Effects Mean Group estimation of bilateral trade balance equation for Ethiopia, 1990-2011

	Canada	China	France	Germany	India	Italy	Japan	Netherlands	Spain	UK	US
Domestic GDP	-3.78	-7.782	-.7009	4.343*	3.944	1.237**	6.4	9.932	3.933	.0581	1.792
	(-0.74)	(-1.36)	(-0.94)	(1.86)	(0.78)	(2.00)	(1.55)	(0.91)	(0.71)	(0.07)	(1.08)
Foreign GDP	12.45	12.69***	.6229	-12.1	-2.989	4.166	35.97	-8.535	-4.797	2.249	.9774
	(1.01)	(2.82)	(0.13)	(-0.87)	(-0.52)	(0.88)	(1.11)	(-0.20)	(-0.29)	(0.97)	(0.22)
RER	3.483	5.759**	-.8688*	-.4027	-5.332*	-.2095*	.3228	4.929	-.8204	-1.009	-2.044
	(0.51)	(2.23)	(-1.84)	(-0.15)	(-1.92)	(-1.71)	(0.12)	(0.44)	(-0.67)	(-0.67)	(-0.60)
Real oil price	-5.708	.318	1.116**	-.5953	6.752***	-.3853	-5.188	-6.284	1.681	-.6693	.2075
	(-1.11)	(0.22)	(2.21)	(-0.28)	(2.73)	(-0.70)	(-1.32)	(-0.81)	(0.55)	(-0.68)	(0.07)
RER*ROP	2.589	-2.38	-.3108	-.2004	3.455**	-.1655	1.177	1.019	-.6174	.1703	-.8444
	(0.99)	(-0.69)	(-1.30)	(-0.22)	(2.46)	(-1.44)	(0.78)	(0.31)	(-0.60)	(0.46)	(-0.62)
N	885										

t statistics in parentheses, $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.6. Long run heterogeneous Common Correlated Effects Mean Group estimation of bilateral trade balance equation for Ghana, 1990-2011

	Canada	China	France	Germany	India	Italy	Japan	Netherlands	Spain	UK	US
Domestic GDP	-1.771	-4.417	2.854	-.3435	.8661	.3987	2.419*	-2.341*	-4.28*	-2.69***	1.754
	(-0.48)	(-0.3)	(1.46)	(-0.33)	(0.10)	(0.41)	(1.92)	(-1.92)	(-1.74)	(-2.67)	(1.05)
Foreign GDP	4.216	5.446	-9.034	-7.86*	-2.376	.131	-6.666	6.273**	1.238	4.837***	-3.772
	(0.71)	(0.66)	(-1.4)	(-1.92)	(-0.4)	(0.03)	(-1)	(2.37)	(0.26)	(2.71)	(-1.44)
RER	2.424	6.504	-.2059	.0517	.9682	.0333	-.3146	.1127	-.0756	-2.825**	3.072**
	(0.89)	(1.49)	(-0.4)	(0.08)	(0.53)	(0.28)	(-0.4)	(0.19)	(-0.29)	(-2.02)	(2.29)
Real oil price	.227	-.064	-.0015	.1398	.5937	-.790**	.3786	.405	1.262**	.7728*	-.2976
	(0.08)	(-0.01)	(-0.00)	(0.38)	(0.36)	(-1.98)	(0.38)	(1.30)	(1.97)	(1.81)	(-0.42)
RER*ROP	1.432	.9082	-.3429	-.7375	-.0241	-.0217	.217	.6575	-.1288	-3.403***	2.333
	(0.32)	(0.40)	(-0.61)	(-1.05)	(-0.07)	(-0.19)	(1.02)	(1.17)	(-0.52)	(-2.97)	(0.97)
N	937										

t statistics in parentheses, $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.7. Long run heterogeneous Common Correlated Effects Mean Group estimation of bilateral trade balance equation for Kenya, 1990-2011

	Canada	China	France	Germany	India	Italy	Japan	Netherlands	Spain	UK	US
Domestic	-5.053**	-6.069	-.9608	1.712	-8.372**	4.045**	.1588	-2.107	-5.042***	2.476	-.7242
GDP	(-2.55)	(-1.06)	(-0.72)	(1.09)	(-2.10)	(2.32)	(0.11)	(-1.46)	(-3.25)	(1.59)	(-0.23)
Foreign GDP	-2.444	2.173	-.6992	-7.248**	4.332**	-.7158	3.793	1.842	.376	-.5731	.2817
	(-1.34)	(1.45)	(-0.25)	(-2.52)	(2.37)	(-0.19)	(0.91)	(1.23)	(0.17)	(-0.58)	(0.14)
RER	-.8175	-2.779	.3134	.5676	.3211	-.3146*	1.063**	.8584*	.2386	1.424	-4.209*
	(-0.59)	(-1.56)	(1.07)	(1.14)	(0.31)	(-1.91)	(2.00)	(1.89)	(1.34)	(1.56)	(-1.74)
Real oil price	-.1695	3.37***	-.5345	-.3226	.3165	.2781	.1542	-.9333*	-.4159	-.6829	3.293*
	(-0.14)	(2.72)	(-1.02)	(-0.55)	(0.58)	(0.56)	(0.41)	(-1.65)	(-0.92)	(-0.99)	(1.82)
RER*ROP	.3035	-1.362**	.1538	-.0301	-.7723	-.3265**	.6195	.2195*	.3807***	.1537	-.6844
	(1.17)	(-2.20)	(1.15)	(-0.23)	(-0.87)	(-2.18)	(1.18)	(1.72)	(2.85)	(1.14)	(-1.57)
N	935										

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.8. Long run heterogeneous Common Correlated Effects Mean Group estimation of bilateral trade balance equation for South Africa, 1998-2011

	Canada	China	France	Germany	India	Italy	Japan	Netherlands	Spain	UK	US
Domestic	-3.241	-12.78***	.5815	-.6621	-10.78**	-.8892*	.3494	-.7856	-5.306*	-3.908***	-1.732
GDP	(-0.30)	(-2.67)	(0.25)	(-0.99)	(-2.33)	(-1.85)	(0.23)	(-0.36)	(-1.76)	(-4.74)	(-1.47)
Foreign GDP	7.018	5.98***	-5.557	3.302	3.903*	.5718	4.479	-3.582	-.0193	6.663***	8.256***
	(0.38)	(3.79)	(-0.78)	(1.52)	(1.78)	(0.28)	(0.58)	(-0.65)	(-0.01)	(4.79)	(3.26)
RER	2.161	1.098	-.6928*	.5718***	.3853	.1689	-.7438	.5382	.6807*	-.5409*	.7477
	(0.68)	(1.36)	(-1.80)	(2.64)	(0.49)	(1.32)	(-0.97)	(1.33)	(1.66)	(-1.67)	(1.37)
Real oil price	-.6945	-.0385	1.369***	-.2973	-.1228	-.191	.1458	-.2794	-.5783	.2682	-.6408
	(-0.33)	(-0.10)	(3.22)	(-1.58)	(-0.14)	(-0.85)	(0.24)	(-0.86)	(-1.02)	(1.03)	(-1.48)
RER*ROP	.1285	.4265	-.3603	.1135	-.3964	.1059	.0724	.3397**	.5133	-.0432	.1465
	(0.12)	(0.50)	(-1.64)	(1.37)	(-0.72)	(1.03)	(0.33)	(2.18)	(1.56)	(-0.39)	(0.74)
N	605										

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.9. Long run heterogeneous Common Correlated Effects Mean Group estimation of bilateral trade balance equation for Tanzania, 1990-2011

	Canada	China	France	Germany	India	Italy	Japan	Netherlands	Spain	UK	US
Domestic	4.753	-2.814	-7.183**	.6727	2.155	1.381	-.3895	-3.447***	-5.283	-5.138***	.4468
GDP	(0.59)	(-0.21)	(-2.04)	(0.49)	(0.37)	(1.55)	(-0.43)	(-3.79)	(-1.62)	(-3.82)	(0.47)
Foreign GDP	-14.49	4.472	14.58	-1.92	-3.428	-1.648	8.551	4.557***	11.89*	6.641***	-3.247**
	(-0.88)	(0.68)	(1.10)	(-0.41)	(-0.77)	(-0.48)	(1.57)	(2.77)	(1.83)	(2.77)	(-2.10)
RER	-2.456	6.21	.5116	-.5821	-1.299	-.0265	1.787**	.6083	-.3948	-2.217	-.8574
	(-0.34)	(0.69)	(0.39)	(-0.56)	(-0.97)	(-0.22)	(2.22)	(1.15)	(-1.06)	(-1.60)	(-0.54)
Real oil price	7.221	2.299	-1.296	-.515	-.0549	.5192	-.6181	-.7963	.3314	1.07	1.32
	(1.07)	(0.39)	(-0.49)	(-0.40)	(-0.06)	(1.26)	(-0.95)	(-1.07)	(0.28)	(0.76)	(1.09)
RER*ROP	-1.016	-.4198	.3275	.1149	-.0685	-.0966	-.0025	.1646	-.0018	-.0973	-.2017
	(-1.15)	(-0.34)	(0.68)	(0.58)	(-0.22)	(-0.98)	(-0.01)	(1.35)	(-0.01)	(-0.52)	(-1.13)
N	944										

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.4.3. Long and short run average CCEMG and Fixed Effects estimates

Table 4.10 show the short run average CCEMG estimators for each SSA country. Here, the oil price only affects Tanzania's trade balance, deteriorating it by 0.2%. The error correction terms are, as expected, negative and significant in all cases. The long run average CCEMG estimates in Table 4.11 show that none of the countries is affected by oil prices, on average, in the long run. Table 4.12 shows the Fixed Effects estimates for each SSA country, with Driscoll-Kray CSD robust standard errors. Here also, an oil price increase is only significant for Tanzania, where it deteriorates the trade balance by 0.5%. The results corroborate those of the CCEMG model, with the higher coefficient likely reflecting an upward bias since, unlike the CCEMG, the FE estimator is non-dynamic. The insignificant results from these aggregate models show that they conceal a great deal of heterogeneity among SSA countries, and within each country with regards to the trading partners.

Table 4.10. Short run average Common Correlated Effects Mean Group estimation of bilateral trade balance equations for SSA countries, 1990-2011

	Angola	Cameroon	Ethiopia	Ghana	Kenya	Nigeria	South Africa	Tanzania
Error Correction	-.689***	-.6795***	-.466***	-.631***	-.673***	-.585***	-.774***	-.5503***
	(-15.98)	(-10.28)	(-6.00)	(-14.91)	(-11.52)	(-10.27)	(-13.66)	(-11.18)
Domestic GDP	.6284	-1.953	-1.26	7.482	2.415	-.7662	3.195	20.59**
	(0.14)	(-0.31)	(-1.01)	(1.33)	(0.44)	(-0.47)	(0.34)	(2.41)
Foreign GDP	-13.74	-28.34**	11.43	10.57	1.651	20.19	-2.836	-16
	(-0.31)	(-2.15)	(1.42)	(0.65)	(0.20)	(1.15)	(-0.60)	(-1.49)
Real oil price	-.0876	.1157	.0033	-.0154	-.0167	.1696	-.0917	-.1706*
	(-0.50)	(1.05)	(0.01)	(-0.11)	(-0.14)	(1.60)	(-0.87)	(-1.69)
RER	.8889	-1.279	-.6542	-.4719	.0154	.1092	.0877	.1133
	(0.57)	(-1.59)	(-1.17)	(-0.91)	(0.03)	(0.19)	(0.78)	(0.37)
RER*ROP	.3326	1.313	1.58	-.2164	.9523	1.092	-.3951	-.1184
	(0.54)	(0.23)	(0.60)	(-0.15)	(0.58)	(0.61)	(-0.69)	(-0.07)
Constant	85.05	-45.84	-50.29**	19.6	32.3*	-92.84	13.93	-18.99
	(0.87)	(-1.23)	(-2.09)	(0.93)	(1.79)	(-0.91)	(0.47)	(-0.95)
N	786	905	885	937	935	942	605	944

t statistics in parentheses, , * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.11. Long run average Common Correlated Effects Mean Group estimation of bilateral trade balance equations for SSA countries, 1990-2011

	Angola	Cameroon	Ethiopia	Ghana	Kenya	Nigeria	South Africa	Tanzania
Domestic GDP	2.762	-3.964***	1.761	-.6865	-1.812	-1.509	-3.559***	-1.35
	(1.11)	(-3.67)	(1.20)	(-0.88)	(-1.54)	(-1.28)	(-2.64)	(-1.22)
Foreign GDP	-8.293	7.429*	3.701	-.688	.1016	6.424	2.82**	2.36
	(-1.23)	(1.88)	(0.93)	(-0.41)	(0.11)	(1.01)	(2.09)	(0.94)
RER	-1.855	-.642	.3461	.8859	-.3031	.3739	.3976	.1168
	(-0.79)	(-0.32)	(0.36)	(1.22)	(-0.58)	(0.35)	(1.55)	(0.16)
Real oil price	2.803	.1446	-.7961	.2387	.3957	.0094	-.0963	.8619
	(1.10)	(0.10)	(-0.70)	(1.44)	(0.87)	(0.01)	(-0.56)	(1.21)
RER*ROP	-1.269	.0476	.3537	.0809	-.1223	.6008	.0951	-.118
	(-0.84)	(0.28)	(0.72)	(0.19)	(-0.68)	(1.26)	(1.10)	(-1.10)
N	786	905	885	937	935	942	605	944

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.12. Cross Section Dependence robust Fixed Effects regression of the bilateral trade balance equations of SSA countries, 1990-2011

	Angola	Cameroon	Ethiopia	Ghana	Kenya	Nigeria	South Africa	Tanzania
Domestic GDP	2.717	6.072	-2.232	2.375	-11.3**	1.518	6.093	18.94**
	(0.58)	(1.22)	(-0.61)	(0.28)	(-2.20)	(0.28)	(1.00)	(2.09)
Foreign GDP	-46.1**	-14.83*	10.02	8.422	2.314	-8.370	-0.905	4.733
	(-2.19)	(-1.78)	(0.91)	(0.76)	(0.46)	(-0.96)	(-0.24)	(0.64)
Real oil price	0.152	0.203	-0.305	-0.0493	-0.003	0.330	-0.137	-0.466**
	(0.70)	(1.08)	(-1.18)	(-0.24)	(-0.03)	(1.37)	(-1.57)	(-2.65)
RER	-0.177	0.0899	0.0219	-0.195	0.0202	0.325*	0.0931	0.0665
	(-1.13)	(0.17)	(0.15)	(-1.05)	(0.22)	(1.96)	(1.23)	(0.31)
RER*ROP	-0.369	0.865	2.670	-1.875	0.565	4.787**	0.257	1.439
	(-1.42)	(0.17)	(0.85)	(-0.89)	(0.25)	(2.57)	(0.39)	(0.66)
Constant	-0.216	-0.118	-1.56***	-0.97***	-1.2***	0.134	-0.29***	-1.403***
	(-1.20)	(-1.51)	(-11.72)	(-6.50)	(-20.3)	(0.93)	(-6.03)	(-11.38)
N	802	917	895	940	940	944	616	945

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are Driscoll and Kraay (1998) standard errors that are robust to cross section dependence, autocorrelation and heteroscedasticity

4.5. Discussion of results

The results show that the aggregate trade balances of SSA countries are mostly unaffected by oil price increases both in the short run and long run. However, the examination of individual specific bilateral effects shows heterogeneous responses of their trade balances: oil price increases have both positive and negative impacts for oil importers and exporters.

The predominantly insignificant average impacts of oil prices for these countries, as well as the positive heterogeneous impacts for oil importers suggest that the response of the nonoil balance is large enough to counteract that of the oil trade balance, in line with Bodenstein et. al. (2011), Abeysinghe, (2001), Korhonen and Ledyaeva,(2010), and Rebucci and Spatafora, (2006). As previously mentioned, the low price elasticity of oil demand for the sample countries suggests that our results are mainly driven by the nonoil balance. Large nonoil trade responses are likely, especially for SSA oil importers, because they export commodities whose prices frequently co-move with the oil price. For oil exporters, in addition to potentially higher nonoil imports resulting from higher oil revenues, their importation of refined petroleum products reduces the positive response of their oil trade balances, contributing to the insignificant average effects. The findings corroborate those of other studies that have examined oil exporters with similar characteristics, e.g. Le and Chang (2013) and Kuboniwa (2014).

Another factor that potentially explains a large nonoil trade response for both SSA oil exporters and importers is their low level of international financial integration. Financial integration has been shown to influence the effects of oil price increases on the trade balance by enabling oil importers to use foreign funds for smoothing nonoil consumption, reducing the necessity to run large nonoil surpluses, but amplifying the negative effects on the overall trade balance (Bodenstein et al. (2011). In the same way, oil exporters with little integration will tend to spend more on nonoil imports rather than foreign investment, again amplifying the nonoil trade response. The potential importance of the degree of financial integration in driving the effects of oil prices for SSA countries is investigated in the next chapter.

The results show an interesting pattern in the effects of oil prices and exchange rates on the bilateral trade balances. Where an oil price increase improves the trade balance, subsequent exchange rate depreciations deteriorate it, and an appreciation further improves it. Conversely, where the oil price deteriorates the trade balance, an exchange rate depreciation improves it, while an appreciation deteriorates it[29]. Therefore, a negative effect of the oil price is associated with the fulfilment of the ML condition, while a positive oil price effect is not. In the latter case, it appears that trade elasticities are not high enough, such that the price effect of the exchange rate change dominates the quantity effect.

Why might price elasticities be lower when the oil price effect is positive? Generally, low export price elasticities are expected for SSA countries because the supply of their primary commodity exports is subject to capacity and technological constraints, as well as quota restrictions where applicable (for instance Angola and Nigeria's OPEC quotas). At the same time, since there is usually a single world US dollar price for these commodities, a change in the exchange rate of any one of these countries is unlikely to affect the foreign currency price of their exports, such that foreign demand is likely to remain unchanged (Hakura and Billmeier, 2008). On the other hand, imports should be more elastic, but even this is subject to the availability of locally produced substitutes. The implication of our result is that these elasticities are higher when an oil price increase has deteriorated the trade balance compared to when it has improved the trade balance. It may be that when the trade balance is in deficit or deteriorating, there is more incentive to, for instance, reduce imports due to a depreciation, despite the low availability of domestically produced substitutes. In the same way, there might be less incentive to change traded quantities in response to relative prices when the trade balance is improving or already in surplus. The result is consistent with Allen (2006) who finds that, the higher the initial trade surplus of a country, the lower the likelihood that a depreciation will further improve it (or that an appreciation will reduce the surplus). Similarly, the higher the initial deficit, the higher the likelihood that a depreciation will improve it and an appreciation will further worsen it.

Another potential explanation for the pattern of the oil price and exchange rate effects is simply that, where the oil price improves the trade balance, exports and imports have already adjusted to the level permitted by price and income elasticities, such that a subsequent exchange rate change does not further influence quantities, and the price effect of the exchange rate change dominates. This is especially likely for oil importers,

[29] The only exception is for Ethiopia, where a positive oil price effect is accompanied by a positive exchange rate effect

because a positive oil price effect for them indicates that substantial adjustments have already taken place in their non-oil imports and exports.

Finally, with regards to the interaction term, our results show that, in line with the effect of the exchange rate, an exchange rate depreciation (appreciation) improves (worsens) negative effects of oil prices on the trade balance. On the other hand, a depreciation (appreciation) dampens (reinforces) the positive effects of oil prices on the trade balance. In both cases, depreciations serve as buffers that dampen the oil price effect in any one direction, while appreciations reinforce the effect. Overall therefore, our results show that the influence of the exchange rate on the oil price-trade balance relationship is consistent with the model in Bodenstein et. al. (2011) only when the oil price has a negative effect on the trade balance.

4.6. Conclusions:

This chapter has examined the effects of oil prices on the bilateral trade balances of Sub Saharan African countries, with particular focus on the role of exchange rates in determining these effects. Oil price increases are typically associated with real exchange rate appreciations for oil exporters and depreciations for oil importers. These exchange rate adjustments have been theoretically shown to offset the effects of oil prices on the trade balance (Bodenstein et al. (2011). However, the role of exchange rates has been ignored in the empirical analysis of the oil price-trade balance relationship. This chapter has addressed this gap in the literature by being the only study to examine the influence of real exchange rates on the oil price-trade balance relationship.

This chapter has also made an important methodological contribution by using a Cross Section Dependence (CSD) robust panel data estimator and heterogeneous bilateral trade data. Previous studies that have used panel data methods to examine the effects of oil prices on trade have ignored the possibility of CSD which could bias results. In addition, studies that have used bilateral trade data have not allowed for heterogeneous responses of the bilateral trade balances to oil price increases. This chapter has addressed both methodological gaps in the literature by employing the Pesaran (2006) Common Correlated Effects Mean Group (CCEMG) estimators. These estimators are appropriately applied after testing for CSD in the panels. Both long-run and short-run coefficients are estimated and heterogeneous impacts across trading partners are examined.

It was found that considering the aggregated bilateral trade balance, SSA countries are predominantly unaffected by oil prices both in the long run and short run. However, the disaggregate results show both negative and positive impacts for oil importers and exporters. Most of the effects are positive, even for the oil importers. These results indicate a highly responsive nonoil trade balance, potentially due to the trade characteristics of these countries, and their low level of integration in international financial markets which limits consumption smoothing opportunities. Importantly, it was found that for bilateral trade balances where the oil price effect is positive, subsequent real exchange rate changes are unlikely to further influence traded quantities and the ML condition does not hold. As such, appreciations have positive effects and depreciations have negative effects on the trade balance. Conversely, where the oil price effect on the trade balance is negative, the ML condition holds, and subsequent depreciations succeed in improving the trade balance while appreciations deteriorate it.

It was argued that a negative oil price effect is associated with a higher price elasticity of demand perhaps because there is a higher incentive to change the demand for traded goods, compared with a trade balance that is improving or in surplus. Consistent with these findings, the results also showed that bilateral exchange rate depreciations dampen the positive and negative effects of oil prices on the trade balance, while appreciations reinforce these effects. Thus, theoretical predictions on the influence of the exchange rate on the oil price-trade balance nexus is supported only when an oil price increase deteriorates the trade balance.

The results provide some policy implications for SSA countries. First, the impacts of oil prices tend to be positive for oil importers. Policy makers in these countries may not need to worry too much about higher oil prices as far as their trade balances are concerned. However, it could be that this trade balance improvement signals lower nonoil imports and hence, lower consumption and investment due to lower real wealth, amplified by low access to foreign funds for consumption smoothing. On the other hand, some insignificant effects for oil exporters indicate that they seem to lose out on the potential benefits of oil price increases, perhaps partly due to their refined petroleum imports and limited integration in world capital markets. A policy implication would be to reduce dependence on imported oil in order to fully benefit from oil price increases. Importantly, when the oil price deteriorates the trade balance, a devaluation may serve as a policy tool to reduce trade deficits. On the other hand, where the oil price improves the trade balance, a devaluation will also serve to reduce the surplus, but likely through influencing the values of traded goods without affecting quantities. It thus appears that exchange rate adjustments cannot be relied upon to reduce trade imbalances when the oil price effect is positive because, in most of these cases, the ML condition does not hold.

A useful extension to this study would be an in-depth analysis of the role of exchange rates in shaping the trade balance response while explicitly modelling the oil and non-oil bilateral trade balances. Data limitations have made it difficult for this study to distinguish between the two trade balance components in a bilateral framework, but it would have given a clearer picture of the sources of the effects identified. Since the results are also consistent with a low degree of financial integration of SSA countries in global financial markets, it would be interesting to empirically examine its role in the oil-price trade balance relationship for these countries. It is this issue that the next chapter investigates.

Chapter 5: Oil Prices and Trade Balances of Sub-Saharan African Countries: The Role of International Financial Integration.

5.1. Introduction:

This chapter investigates the role of international financial integration in determining the effects of oil prices on the trade balances of SSA countries. According to the theoretical model in Bodenstein et. al. (2011), when there is an oil price shock, more financially integrated economies should be better able to smooth consumption, enabling them to avoid large fluctuations in their nonoil balances. This means that an oil price shock will have a lower impact on the overall trade balance (Kilian et al., 2009, Bodenstein et al., 2011). In the previous chapter, it was found that the trade balances of some SSA economies are largely unaffected by oil prices, indicating a substantial nonoil trade adjustment for which their limited financial integration is a potential cause. This chapter further investigates this issue.

Bodenstein et al. (2011) show that when the oil price rises, a high level of international risk sharing ensures that oil importers can borrow foreign funds to finance their growing oil trade deficit, reducing the need to do so through limiting nonoil consumption. In the same way, highly integrated oil exporters can invest oil revenue windfalls abroad rather than spend them on goods imports. Higher financial integration should therefore limit the responsiveness of the nonoil trade balance to oil shocks and, with a given oil trade balance response, it should amplify the effects on the overall trade balance. The model in Bodenstein et al. (2011) is however theoretical and calibrated only for the US economy. Empirically, Kilian et al. (2009) examined the effects of oil prices on the trade balances of oil importers and exporters and consider both the oil and nonoil balances. They find that the effects of oil prices on the nonoil balances of many countries is not high enough to completely offset the oil trade response, such that the overall trade balances are more affected. They argue that this is evidence of an intermediate level of financial integration in the global economy. They also show that valuation effects on net foreign asset positions of countries support this conclusion. In an expanded working paper version of their paper[30], they find that some developing countries' nonoil balances are more affected by oil prices than others, and argue that varying degrees of financial integration explain this difference. However, Kilian et al. (2009) do not explicitly consider international financial integration in their empirical

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[30] See Kilian et al. (2007)

estimation. In the same way, none of the empirical studies on the oil price-trade balance relationship consider the role of financial integration (Le and Chang, 2013, Arouri et al., 2014). This chapter is the first to examine empirically the role of international financial integration in influencing the effects of oil prices on the trade balance.

To do this, this chapter investigates the existence of a threshold level of financial integration for SSA countries beyond which its consumption smoothing benefits become apparent. Below the threshold, countries would need to adjust their non-oil consumption and trade balances to offset the effects of oil prices[31]. It employs the Panel Smooth Transition Regression model (PSTR) model of González et al. (2005) for a sample of 37 SSA countries – 29 oil importers and 8 oil exporters. The PSTR model is particularly suitable as it allows for heterogeneous impacts of oil prices on the trade balance depending on the value of financial integration. In the model, the presence of a threshold level of financial integration is tested. Where it exists, a threshold value is endogenously determined and the model is estimated with varying coefficients depending on the threshold value. Annual data on the oil, nonoil and overall trade balances are used to facilitate interpretation in light of the model in Bodenstein et al. (2011).

The results confirm that the effects of oil prices on the nonoil trade balances of SSA countries depend on a financial integration threshold. It is found that the nonoil trade balance of oil importers with levels of financial integration below the estimated threshold is significantly more responsive to oil price increases. However, above the threshold, the effect is insignificant. This result is robust to using various alternative model specifications and is consistent with the model in Bodenstein et al. (2011): highly integrated oil importers are better able to smooth consumption and avoid large nonoil fluctuations in response to oil shocks. For oil exporters, the response of the non-oil trade balance is lower below the threshold value, contrary to expectations. This result however does not hold up once the parameters of the model are changed, and the estimates are generally unstable, perhaps due to the small size of the oil exporters' sample. The overall trade balances of both oil exporters and importers are generally

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[31] The idea that financial integration may affect other macroeconomic variables nonlinearly, depending on a threshold level, has been advanced in the literature by, among others, Kose et. al. (2003) and Kose et al. (2009). Both studies find that countries with levels of financial integration above an estimated threshold have lower levels of consumption volatility relative to output volatility.

found to be unaffected by oil prices. The findings in this chapter thus corroborate that of the previous chapter, as large nonoil trade responses of poorly integrated economies help explain the insignificant overall trade balance effects. The response of the oil trade balance to oil prices is not found to depend on a financial integration threshold. This is consistent with expectations since the oil trade balance should deteriorate (improve) for oil importers (exporters) irrespective of their level of integration. Interestingly, it is found that the effects of other variables in the estimated models also depend on a financial integration threshold. The effects of an increase in financial integration on the trade balance are found to be higher below the threshold. This indicates that less financially integrated economies have the most to gain from increasing integration. An increase in world income relative to domestic income has a higher impact on the trade balance when financial integration is above its threshold, implying that more financially integrated economies respond more to global income levels.

In terms of general implications, the findings for oil importers show that increasing financial openness is necessary if they are to smooth nonoil consumption in times of oil shocks. This is especially important given the current high volatility of oil prices, with some forecast seeing them gradually increasing to about $85 per barrel by 2020, despite current low levels (OPEC, 2015). However, the results also show that higher integration is associated with increased exposure to global income shocks, so a careful risk-benefit analysis may be necessary.

The rest of this chapter is organised as follows. Section 5.2 reviews the relevant theoretical and empirical literature. Section 5.3 discusses the data and methodology used in the analysis. Section 5.4 presents the results and Section 5.5 provides a discussion of the results. Conclusions and recommendations are provided in section 5.6.

5.2. Literature review:

Theoretical models on the effects of oil prices on the trade balance generally find that rising oil prices lead to trade deficits for oil importing countries. As reviewed in the previous chapter, early theoretical models generally define the trade balance as the difference between savings and investment, with the effects of terms of trade changes resulting from oil price shocks being the main focus. They show that the response of the trade balance depends on the persistence of the oil price increase and the relative strength of the wealth and substitution effects it generates. These studies consider only oil importing economies and ignore the potential role of international risk sharing by assuming complete financial markets (Obstfeld, 1982, Svensson and Razin, 1983, Persson and Svensson, 1985, Svensson, 1984, Matsuyama, 1987, Sen, 1990, Sen and Turnovsky, 1989). On the other extreme, Sen (1990) and Sen (1991) assume financial autarky, where countries have no access to foreign capital. Both groups of models generally reach similar conclusions.

Bodenstein et al. (2011) revisit the issue of the transmission of oil shocks to the trade balance while considering the role of international financial risk sharing. They build on the complete international financial market model of Backus and Crucini (2000) who consider the effects of oil prices on terms of trade. Bodenstein et al. (2011) use a two country DSGE model, with each country specialising in the production of final goods which are imperfect substitutes. Both countries have a given oil endowment but only one is the net oil importer, assumed to have a lower oil endowment relative to the intensity of its oil use. The price elasticity of demand for oil is assumed to be low. Financial asset markets are complete at the country level, and these assets are acquired by individuals through purchasing state contingent domestic bonds. Foreign assets are accumulated by purchasing one non-state contingent foreign bond which is subject to an intermediation cost not present for domestic bonds. Within this context, Bodenstein et al. (2011) show that oil price shocks affect the countries' trade balances mainly through the transfer of wealth from oil importers to oil exporters. This leads to a reduction in output, consumption and investment in the net oil importing country. Real oil imports reduce as firms substitute away from oil, but nominal oil imports still increase, pushing the oil trade balance into a deficit. Thus, the non-oil trade balance has to improve to offset the oil trade deficit. This is facilitated by a terms of trade (the real exchange rate in their model) deterioration. Under incomplete international financial markets, the economic agents can access foreign capital subject to the intermediation cost. They thus borrow from abroad to smooth consumption. However, a nonoil surplus is still required since, owing to the intermediation cost, they cannot smooth consumption perfectly, thereby offsetting only some of the oil trade deficit. This in turn results in a small overall trade balance deterioration. Under financial autarky, their model yields similar results except here, since the economy has no access to foreign capital because the intermediation cost is very high, non-oil consumption cannot be smoothed through foreign borrowing. The terms of trade (RER) therefore deteriorate by more, and the non-oil trade balance necessarily improves by the exact amount of the oil trade deficit, such that the overall trade balance is unaffected. The results under complete markets are, however, very different. Here, profits from oil production are effectively shared across countries so that oil importers receive insurance transfers from oil exporters. As such, consumption smoothing does not require any non-oil trade surplus. The terms of trade (RER) deteriorate by less, the non-oil trade balance is unchanged and the overall trade balance bears the full impact of the oil trade deficit. Thus, the model in Bodenstein et al. (2011) implies that, the more an economy is integrated in international financial markets, the more it is able to smooth consumption through borrowing, and the lower the response of the non-oil trade balance to oil prices. This in turn results in a higher response of the overall goods trade balance.

The model in Bodenstein et al. (2011) also points to the potential role of valuation effects, although they do not explicitly model it. As argued by Kilian et al. (2009), more integrated and diversified oil importing economies will reap capital gains from their investments in oil exporting countries, which will also go towards reducing the need to run non-oil surpluses. Indeed, Gourinchas and Rey (2005) show that valuation effects are important channels of international financial adjustments. For the trade channel of adjustment, current trade deficits have to be offset by future trade surpluses if the returns on foreign assets are expected to remain unchanged over time. However, if returns differ across assets and over time, then the expected capital gains and losses reduce the need to run trade deficits and surpluses. This valuation effect works not only through changes in asset value but also through exchange rate depreciations and appreciations. Thus, oil price induced exchange rate depreciations for oil importers can lead to valuation effects by altering the value of foreign asset returns favourably, if the assets are held in foreign currency. This will also aid in reducing the need for a nonoil surplus. They show that historically, these valuation effects have accounted for over 30% of US external adjustments.

In contrast to Bodenstein et al. (2011), Başkaya et al. (2013) showed within a real business cycle model that the degree of a country's integration in foreign asset markets does not matter for the transmission of oil price level shocks to the trade balance, but are important for the transmission of volatility shocks. This is because their model focuses on the role of precautionary savings and the subsequent investment of these savings domestically and abroad. Since oil price level shocks do not induce as much precautionary savings as oil price volatility shocks, their model does not predict an important role for financial integration in the transmission of these shocks. Egger and Falkinger (2015) examine the interactions between international trade and financial markets. They show within a two country general equilibrium model that international financial transactions between two countries are associated with higher trade imbalances. This is because accessing the gains from integration requires goods trade, with the net borrowing country in the initial period being the net goods exporter in the next period. Thus, more financially integrated economies will tend to have higher overall trade imbalances. Despite the different channels of effects, the conclusions are similar to those of Bodenstein et al. (2011).

The models above have been calibrated for oil importing countries, and it is assumed that for oil exporters, the effects would be the exact opposite. Bems and de Carvalho Filho (2011) develop a small open economy model for oil exporters. The model includes an exhaustible resource sector, where the price of the exhaustible resource is the only source of uncertainty. The representative consumer faces a self-insurance problem where he seeks to diversify away from the uncertain exhaustible resource income through accumulation of foreign assets. Calibrating their model based on data for 13 oil exporters, they show that consumption smoothing motive accounts for much of the current account surpluses accumulated by oil exporting countries, and that precautionary motives associated with oil price uncertainty also play an important role. Their findings support the hypothesis that oil exporters do save abroad during revenue windfalls, making funds available to the now poorer oil importers and facilitating risk sharing.

Other related contributions are concerned with the role of international risk sharing in the transmission of oil price induced productivity shocks across countries. They regard oil shocks as productivity shocks for oil importing economies since they represent an increase in the price of a major input, whose demand is relatively inelastic given the limited availability of substitutes. Some studies find international risk sharing to be important (Baxter and Crucini, 1995, Corsetti et al., 2008), while others find that it does not matter (Heathcote and Perri, 2004, Heathcote and Perri, 2002, Cole and Obstfeld, 1991)[32].

Overall, only Bodenstein et al. (2011) provide a theoretical model that explicitly examines the role of international financial integration in determining the effects of oil price shocks on the trade balance and its nonoil component. Their model is only theoretical and its implications for the role of financial integration have not been empirically tested. Bodenstein et al. (2011) also do not consider the possibility of threshold levels of integration that may matter in the transmission of oil shocks. This chapter contributes to the literature by addressing these issues.

Empirically, a small number of studies have examined the impact of oil price shocks on trade but they do not consider the role of international financial integration. Le and Chang (2013) find that positive oil price shocks lead to an improvement in the oil, non-oil and overall trade balances of Malaysia. For Singapore, the effects are negligible and for Japan, positive oil price shocks dampen its oil trade balance and, depending on the associated improvement in its non-oil trade balance, its overall trade balance may be pushed into a deficit. Arouri et al. (2014) find that India's trade balance is negatively affected by oil price shocks. Ahmed and O'Donoghue (2010) and Muhammad (2012) find that oil price increases are associated with a reduction in exports of Pakistan through inducing an increase in production costs. Abu-Bader and Abu-Qarn (2010) find that structural breaks in the trade ratios of 57 countries over the period 1957-1993 coincided with oil price shocks, suggesting that these may account for the observed breaks. Bridgman (2008) show that changes in trade volumes globally can be accounted for by changes in oil prices which affect the cost of transporting tradable goods. Chen and Hsu (2012) examine the effects of oil prices on bilateral trade volumes using panel data on 84 countries from 1984-2008. They find that oil supply disruptions have a negative impact on trade because they lower GDP and hence imports of oil importers, as well as export volumes of oil exporters. Oil specific demand shocks on the other hand increase trade volumes by inducing higher exports for oil exporters and higher imports for importers. In a similar study Shiu-Sheng and Kai-Wei (2013) examine the effects of

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[32] The models that find financial integration to be unimportant assume a high elasticity of traded goods such that the terms of trade provide sufficient insurance against productivity shocks. However, as discussed in Bodenstein et. al. 2011, the demand for oil is relatively inelastic and some international risk sharing is required.

oil prices on bilateral export volumes using a gravity model of international trade and annual data on 117 countries from 1984-2009. They find that oil price increases have insignificant effects on trade volumes. Özlale and Pekkurnaz (2010) find a negative effect of oil price shocks on the Turkish current account balance. Allegret et al. (2015) find that oil price increases usually lead to current account deficits for oil importers.

The only empirical study that points to the importance of international financial integration in the effects of oil prices on the trade balance is Kilian et al. (2009). They examine the effects of oil price shocks on the oil, nonoil and overall trade balances as well as the current account balance and net foreign asset positions for oil exporters and advanced country oil importers. Using VAR models, they find that for oil importers, the oil trade balance deteriorates with an oil price increase, the non-oil trade balance improves to a smaller extent, and the overall trade balance deteriorates. Accordingly, the authors note that, in light of the model in Bodenstein et al. (2011), their findings are consistent with an intermediate degree of financial integration for their sample countries, since they are able to avoid large fluctuations in their nonoil trade balances in response to oil shocks. They also find large valuation effects in that oil importers make some capital gains as a result of the oil price increase; and these help reduce the need to run large non-oil surpluses. In the same way, oil exporters make some capital losses. In an expanded working paper version of their paper where they consider developing country oil importers[33], Kilian et al. find that the nonoil balance of some oil importers in Latin America respond more to oil price increases than those in Emerging Asia, leading to a relatively muted response of the overall trade balance for Latin America. The authors argue that this may reflect their sample Latin American countries' relatively limited access to international capital markets which discourages borrowing to smooth consumption in response to oil shocks.

Even though Kilian et al. (2009) recognise the importance of financial integration, they do not include it in their models and only infer its role through their estimates of the response of the nonoil balance and net foreign asset positions of countries. In addition, they do not consider the question of potential threshold levels of integration that may matter for the transmission of oil shocks. This question is of important practical relevance for many countries looking to reduce exposure to oil price fluctuations, and is supported by studies that have found threshold effects of financial integration on

[33] Kilian et al. (2007)

consumption smoothing (Kose et al. (2003), Kose et al. (2009) Kose et al. (2011)) [34]. This chapter aims to fill this gap in the oil price-trade balance literature by examining threshold effects of financial integration for Sub-Saharan African countries.

[34] Kose et. al. (2006) provides a review of the literature on the effects of financial integration on other macroeconomic variables and potential nonlinearities therein.

5.3. Data and Methodology:

5.3.1. The PSTR model:

This chapter utilises the Panel Smooth transition Regression (PSTR) model of González et al. (2005). It is a non-dynamic threshold model for heterogeneous panels with fixed effects. The PSTR is a generalisation of the Panel Threshold Regression (PTR) model of Hansen (1999). In the PTR model, coefficients in a fixed effects regression are allowed to take on different values depending on the value of the threshold variable. As long as the threshold variable is time varying, the observations on each individual and time period can be grouped discretely into different classes or regimes, depending on the endogenously determined threshold value. However, in the PTR model, the different groups of observations are clearly differentiated with clear borders based on the threshold value, so that the transition from one regime to another is discrete and abrupt. The PSTR model generalises this discrete allocation of observations, based on a logistic transition function, so that the transition is smooth and the coefficients change gradually from one regime to another, which is more desirable if a discrete allocation would result in too few observations in a certain regime. An alternative panel threshold model is that of Dang et al. (2012) which is an application of the Hansen (1999) PTR model to the Generalised Methods of Moments (GMM) estimator. Because of the GMM framework however, it requires a very large cross section dimension of the panel and a relatively smaller time dimension, which is contrary to the data structure in this chapter.

The PSTR model can be written as:

$$y_{i,t} = \alpha_i + \beta_0 x_{i,t} + (\beta_1 x_{i,t})G(q_{i,t};\ \gamma, c) + \mu_{i,t} \dots\dots\dots\dots(5.1)$$

Where $y_{i,t}$ is the observation on the dependent variable for country i at year t, α_i are the time invariant individual (fixed) effects, $x_{i,t}$ is a vector of explanatory variables that may contain the threshold variable, q. $G(.)$ is the transition function which depends on the slope parameter γ that determines the smoothness of the transition; and c which is a vector of threshold values. The transition function $G(.)$ is a logistic function normalised so that its values lie between 0 and 1. It is specified as:

$$G(q_{i,t};\ \gamma, c) = (1 + \exp(-\gamma \prod_{j=1}^{m} (q_{i,t} - c_j))^{-1} \dots\dots\dots\dots\dots(5.2)$$

Where m is the number of threshold values corresponding to the number of regimes. In equation 1, low and high values of the transition function are associated with regression coefficients β_0 and $\beta_0 + \beta_1$ respectively. As explained in González et al. (2005), the transition function is such that if m=1, then there are two extreme regimes, each associated with high and low values of $q_{i,t}$. Here, the transition of the coefficients from β_0 to $\beta_0 + \beta_1$ is single and monotonic as $q_{i,t}$ increases, with the transition centred around the threshold value c. In this case, if the slope coefficient $\gamma \to \infty$, the model collapses into the Hansen (1999) PTR with two regimes. If $\gamma \to 0$, the model collapses into a linear homogenous model with fixed effects. If there are more than two regimes, González et al. (2005) show that the PSTR model is the simple additive model:

$$y_{i,t} = \alpha_i + \beta_0 x_{i,t} + \sum_{j=1}^{r} \beta_j x_{i,t}\, G_j\left(q_{i,t}^{(j)};\, \gamma_j, c_j\right) + \mu_{i,t} \dots\dots\dots\dots (5.3)$$

Where $j = 1 \dots\dots\dots\dots r,\ r$ being the number of regimes.

The estimation of the PSTR model first entails testing for linearity because the model in equation 1 is not identified if the model is inherently linear.

5.3.2. Linearity Tests and Parameter Estimation

Testing the null hypothesis of a linear fixed effects model against the alternative of a PSTR model involves testing $\gamma = 0$ or equivalently $\beta_1 = 0$ in equation 5.1. Under the null, γ and the threshold value c are not identified. To avoid this problem, González et al. (2005) propose replacing $G(q_{i,t};\, \gamma, c)$ in equation 5.1 by its first order Taylor expansion around $\gamma = 0$. Subsequently, the null hypothesis can be tested with a heteroscedasticity robust LM test statistic which can have a Chi-square or F distribution, the latter being more appropriate for small samples (Colletaz and Hurlin, 2006)[35].

The procedure for the linearity tests proposed by González et al. (2005) is that, first, a linear fixed effects model is estimated and the null hypothesis of a linear model is tested against the alternative of a two regime PSTR model. If this null hypothesis is rejected, the two regime PSTR model is estimated, and the null hypothesis of a two regime model is tested against the alternative of a three regime model. If the null is again rejected, a three regime PSTR is estimated and the presence of an additional threshold is

[35] The use of computer programs by Gilbert Colletaz is gratefully acknowledged.

tested. This procedure is repeated until the first non-rejection of the null. In this study, up to a maximum of three regimes are considered.

González et al. (2005) show that, once linearity is rejected, estimating $\beta_{0,}\ \beta_1, \gamma$ and c in equation one is a straightforward application of the fixed effects and nonlinear least squares estimators. That is, the time invariant individual effects are eliminated and the model is subsequently estimated by nonlinear least squares. The values of the estimated parameters $\beta_{0,}\ \beta_1, \gamma$ and c are those that minimise the concentrated sum of squared errors.

5.3.3. The empirical model:

As in the previous two chapters, the imperfect substitutes trade balance model is used. The explanatory variables included are the terms of trade, the real oil price, a measure of financial integration[36], and a measure of world and domestic income. The robustness of the estimates to using alternative measures of these variables is later checked. The baseline PSTR model estimated is:

$$TB_{i,t} = \alpha_i + \beta_1 \Delta lnroilp_{i,t-1} + \beta_2 \Delta lntot_{i,t-1} + \beta_3 lnfint_{i,t-1} + \beta_4 \Delta lngdpdiff_{i,t-1} + \beta_5 \Delta lnroilp_{i,t-1} * OX + (\beta_6 \Delta lnroilp_{i,t-1} + \beta_7 \Delta lntot_{i,t-1} + \beta_8 lnfint_{i,t-1} + \beta_9 \Delta lngdpdiff_{i,t-1} + \beta_{10} \Delta lnroilp_{i,t-1} * OX\ ) G\left(lnfint_{i,t-1}{}^{j}; \gamma_j, c_j\right) + \varepsilon_{i,t} \ldots\ldots.. \quad (5.4)$$

Where $j = 1 \ldots \ldots \ldots \ldots r$, r being the number of regimes. $TB_{i,t}$ denotes the relevant component of the trade balance i.e. overall, non-oil or oil trade balance. OX in equation (5.4) is a dummy variable equal to 1 if the country is an oil exporter and zero otherwise. β_1, β_2, β_3, β_4, and β_5 are the coefficient estimates of the effects of the real oil price, terms of trade, financial integration, the income measure (the difference between world GDP and domestic GDP), and the interaction term between the real oil price and the oil exporter dummy, respectively, when financial integration is below its threshold value. Above the threshold value, the corresponding coefficient estimates are $\beta_1 + \beta_6$, $\beta_2 + \beta_7$, $\beta_3 + \beta_8$, $\beta_4 + \beta_9$ and $\beta_5 + \beta_{10}$. It is shown in Appendix E that using three panel unit root tests, the trade balance measures are stationary, and the measure of financial integration is stationary in two of the tests. The oil price is stationary in one test, and all other variables contain unit roots in all three tests. Thus, all the variables except the trade balance measures and the financial integration measure are used in their first

[36] A description of this measure is provided in the next section.

differences, and one lag is taken for all the explanatory variables to allow for delayed responses and to limit endogeneity issues.

The coefficient estimates from the model in equation 5.4 were found to be unstable and sensitive to changing the parameters of the model, so the PSTR model is estimated for oil importers and exporters separately. After appropriate linearity tests, the model estimated for each subsample is:

$$TB_{i,t} = \alpha_i + \beta_1 \Delta lnroilp_{i,t-1} + \beta_2 \Delta lntot_{i,t-1} + \beta_3 lnfint_{i,t-1} + \beta_4 \Delta lngdpdiff_{i,t-1} + (\beta_5 \Delta lnroilp_{i,t-1} + \beta_6 \Delta lntot_{i,t-1} + \beta_7 lnfint_{i,t-1} + \beta_8 \Delta lngdpdiff_{i,t-1}) G\left(lnfint_{i,t-1}{}^{j}; \gamma_j, c_j\right) + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots \text{(5.5)}$$

Where β_1, β_2, β_3, and β_4 are the coefficients of the real oil price, terms of trade, financial integration and the income measure when financial integration is below its threshold value. At higher levels of financial integration, the corresponding coefficient estimates are $\beta_1 + \beta_5$, $\beta_2 + \beta_6$, $\beta_3 + \beta_7$, $\beta_4 + \beta_8$.

A few of the methodological choices deserve special mention. First, including time dummies in the model above would be desirable in order to reduce cross section dependence by accounting for time varying common unobserved macroeconomic effects. However, when a full set of time dummies is included, they are all insignificant. This is not surprising as the model already contains the real oil price and the world GDP, both proxies for common macroeconomic shocks. The insignificant time dummies thus suggest that the model has already captured most of the time varying common unobserved effects[37]. This is not to say that the model does not suffer from cross section dependence, but it is likely greatly reduced. This is useful as methods to account for cross section dependence in panel threshold models are yet to be developed. Second, using the Real Effective Exchange Rate (REER) would have been more desirable, but data is unavailable for a lot of countries in the sample. The terms of trade is therefore used in the baseline models as it tracks the REER closely. However, it is shown that the results are robust to using the US dollar real exchange rate. In addition, it is also shown that the results are robust to replacing the US dollar real oil price with a measure of domestic real oil price for each country.

[37] I thank Markus Eberhardt for pointing this issue out for a different but similar model.

Third, the measure of financial integration used is the sum of foreign total assets and foreign liabilities as a proportion of GDP. Measures of financial integration can be either de facto or de jure measures. The former measure the actual level of integration in international markets quantitatively, while the latter are designed to capture legal restrictions on capital account liberalizations (Kose et al., 2009a, Quinn et al., 2011). Kose et al. (2009a) argue strongly in favour of using de facto measures of financial openness. They show that the two measures can be very different, as some countries may have a lot of capital controls on paper but still have high stocks and flows of assets and liabilities, because such controls are not always enforced. In the same way, a country may have few restrictions on capital flows but still be unable to attract actual foreign investments due to poor macroeconomic fundamentals. Kose et al. (2011) show that many countries have become more financially open in de facto terms irrespective of the capital controls in place. Essentially, the two measures capture different things and the de facto measure is the one relevant for the type of consumption smoothing and subsequent trade effects with which this chapter is concerned. As noted by Quinn et al. (2011), the measure used in this study from the Lane and Milesi-Ferretti (2007) data base is the industry standard for de facto measures, as it covers a large number of countries over a long period of time. It is also the measure adopted by Kilian et al. (2009) and Gnimassoun (2015) among others. The main alternative de facto measure available is the inward FDI flow data from the United Nations Conference on Trade and Statistics (UNCTADstat) data base. However, the measure used in this study also contains inward FDI flows.

Again, it can be argued that the levels of foreign assets and liabilities were affected by the 2008-2010 global financial crisis. If the crisis did play a role, then not accounting for it could bias the results, affecting both the estimated thresholds and models. To control for its potential effect, the robustness of the results is checked by including three time dummies corresponding to the 2008, 2009 and 2010 periods.

5.3.4. Data:

Annual data on all 46 SSA countries over the 1980-2011 period was collected from the World's Bank's World Development Indicators (WDI), the International Monetary Fund's World economic Outlook (WEO); International Financial Statistics (IFS); as well as Direction of Trade Statistics (DOTS). The sample period is limited to 2011 because the financial integration measure used is available only until this date. Details of the variables collected from each source are presented in Appendix F. The countries are categorised as oil importers or exporters based on their oil market status. One way of doing this is to consider the average proportion of total exports accounted for by oil exports. Allegret et al. (2014b) consider countries with oil exports over 10% of total exports as oil exporters, while Kilian et al. (2009) use a higher threshold of 20%. In this study, an intermediate value of 15% is adopted. However, as discussed in the previous chapter, a lot of SSA oil exporting countries import refined petroleum products, significantly affecting their effective oil exporter status. Thus, in addition to considering the proportion of oil exports in total exports, the average proportion of oil imports relative to oil exports is considered. In total, 10 of the 46 countries have oil exports over 15% of total exports on average over the sample period. These are Angola, Cameroon, Chad, Cote d'Ivoire, Republic of Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Nigeria and Sudan. Of these however, Cameroon and Cote d'Ivoire have average oil imports that are 122% and 101% of oil exports respectively. This implies that over the sample period, they have on average imported more oil than they have exported. In addition, Senegal oil exports are 10% of its total exports, but oil imports are 517% of oil exports. Finally, Togo has no available data over the entire sample period for oil exports. However, it is likely to have a similar figure as Senegal as they both export sizable refined petroleum products but import crude oil. This lack of data makes Togo's oil market status uncertain. Therefore, Cameroon, Cote d'Ivoire, Senegal and Togo are removed from the sample because their ambiguous oil market status.[38] Removing those countries leaves a sample of 34 oil importers and 8 oil exporters.

The PSTR methodology is better suited for balanced panels because it is unknown if the estimates will be valid for unbalanced panels (Colletaz and Hurlin, 2006). Therefore, the first 10 years and the last year are eliminated from the sample, as most of the countries have a lot of missing observations for various variables at the beginning of the sample. The sample is thus limited to the period 1990-2010. After doing this, only countries that have at least 75% of observations on all the variables relevant for the analysis are retained. This data balancing leads to the elimination of Sao-Tome and Principe, Sierra Leone, Liberia, Eritrea and Zimbabwe. The final sample therefore consists of a total of 37 countries over the 1990-2010 period, consisting of 8 oil exporters and 29 oil importers. The list of countries is presented in Appendix G.

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[38] This is similar to the approach taken by Kilian et al. (2009), where they removed Canada and the UK from their sample given their sizable oil exports but also well-diversified export base.

5.3.5. Variable transformations and measurements:

As in the previous chapters, the trade balance equations preferred in this chapter are the natural logarithms of the exports to imports ratio thus:

$$\left\{\ln(ttb)_{i,t} = \ln\left(\frac{tx_{i,t}}{tm_{i,t}}\right);\ \ln(ntb)_{i,t} = \ln\left(\frac{nx_{i,t}}{nm_{i,t}}\right);\ \ln(otb)_{i,t} = \ln\left(\frac{ox_{i,t}}{om_{i,t}}\right)\right\} \dots\dots\dots..(i)$$

Where $i = 1 \dots\dots n; t = 1 \dots\dots t$ are the number of countries and time periods respectively. ttb, ntb and otb denote the total (overall) trade balance, the non-oil trade balance and the oil trade balance respectively. $tx(tm), nx\ (nm),$ and $ox(om)$ denote total exports (imports), non-oil exports (imports) and oil exports (imports) respectively. Using this measure means that the oil trade balance for oil importers is undefined as $ox_{i,t} = 0$ for most of these countries. Since oil exporters also import some oil, their measure of oil trade balance is well defined. The robustness of the results are thus checked using alternative trade balance measures that have been used in the literature by, for example, Kilian et al. (2009) and Bodenstein et al. (2011). These measures are:

$$\left\{ttb_{i,t} = \left(\frac{tx_{i,t} - tm_{i,t}}{GDP_{i,t}}\right) * 100;\ ntb_{i,t} = \left(\frac{nx_{i,t} - nm_{i,t}}{GDP_{i,t}}\right) * 100;\ otb_{i,t} = \left(\frac{ox_{i,t} - om_{i,t}}{GDP_{i,t}}\right) * 100\right\} \dots\dots.(ii)$$

Where all variables are as defined earlier and in nominal terms, and $GDP_{i,t}$ is the nominal GDP. This measure allows an analysis of the oil trade balance of oil importers and takes into account size effects by normalising the measures by the GDP.

Other relevant variables used in the analysis are the terms of trade, the US dollar real oil price, the domestic real oil price, the US dollar real exchange rate (RER), the GDP differential measure and the financial integration measure. These variables are measured in the following way:

$$\left\{TOT_{i,t} = \frac{export\ price\ index_{i,t}}{import\ price\ index_{i,t}};\ ROILP_{i,t} = \frac{noilp_{i,t}}{CPI_{US;i,t}};\ DROILP_{i,t} = \frac{noilp_{i,t} * ner_{i,t}}{CPI_{d;i,t}};\ \ GDPDIFF_{i,t} = wgdp_{i,t} - dgdp_{i,t};\ RER_{i,t} = \frac{ner_{i,t} * CPI_{US;i,t}}{CPI_{d,i,t}};\ FINT_{i,t} = \frac{ta_{i,t} + tl_{i.t}}{GDP_{i,t}}\right\} \ldots\ldots\ldots \text{(iii)}$$

Where TOT is the terms of trade, $ROILP$ is the real US dollar oil price calculated as the nominal oil price in US dollars $noilp_{i,t}$ divided by the US CPI $CPI_{US;i,t}$. $DROILP$ is the domestic real oil price derived as the nominal US dollar oil price $noilp_{i,t}$ multiplied by the US dollar exchange rate $ner_{i,t}$ and divided the domestic CPI of each country $CPI_{d;i,t}$. $GDPDIFF$ is the difference between world GDP $wgdp_{i,t}$ and domestic GDP $dgdp_{i,t}$ of each country, both in 2005 constant US dollars. RER is the real exchange rate defined as the nominal US dollar exchange rate $ner_{i,t}$ multiplied by US CPI $CPI_{US;i,t}$ and divided by domestic CPI $CPI_{d,i,t}$, so that an increase means a depreciation.

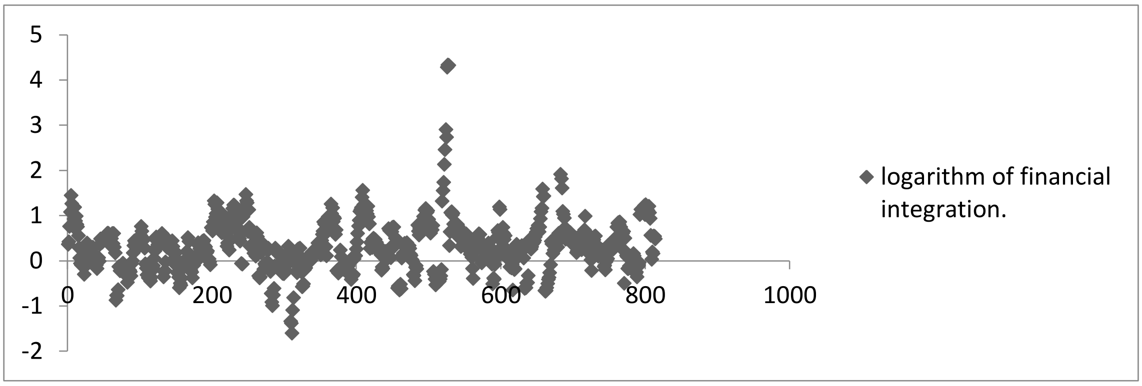
$FINT$ is the measure of financial integration derived from the updated and extended version of the dataset created by Lane and Milesi-Ferretti (2007). It is calculated as the sum of total foreign assets $ta_{i,t}$ and total foreign liabilities $tl_{i.t}$ as a ratio of nominal GDP. These encompass stocks of foreign portfolio equity assets and liabilities, stocks of Foreign Direct Investment (FDI) asset and liabilities, stocks of debt assets and liabilities, including portfolio debt assets and liabilities, financial derivatives stocks and liabilities, and foreign exchange reserves minus gold. All the data on assets, liabilities and GDP are in current US dollars, and consist of transactions and claims between a country's residents and non-residents.

Descriptive statistics of all the variables used in the analysis are provided in Table 5.1. Figure 5.1 shows a scatter plot of the financial integration measure for all the countries. This is useful for comparing the actual data with the estimated thresholds in the PSTR models. Finally, Figures 5.2a and 5.2b show the financial integration data for each country in the sample over the same period.

Table 5.1: Descriptive Statistics, full sample

					Quantiles			
Variable	n	Mean	S.D.	Min	0.25	Median	0.75	Max
Ln(ttb)	814	-0.5	0.94	-3.73	-0.96	-0.36	0.02	1.68
Ln(ntb)	735	-0.71	0.95	-6.68	-1.12	-0.42	-0.09	0.63
Ln(rop)	814	-0.93	0.51	-1.77	-1.35	-1.11	-0.46	0.07
Ln(fint)	814	0.32	0.57	-1.61	-0.05	0.29	0.60	4.33
Ln(tot)	814	4.65	0.3	3.45	4.51	4.61	4.78	5.64
Ln(gdp-differential)	814	9.17	1.36	5.16	8.45	9.12	10.11	12.28
TTB	814	-7.26	24.4	-118.41	-15.98	-8.57	0.5	92.53
NTB	751	-10.09	13.44	-84.66	-14.85	-7.95	-1.97	19.41
OTB	751	4.25	21.93	-53.76	-4.88	-2.82	-1.28	117.57

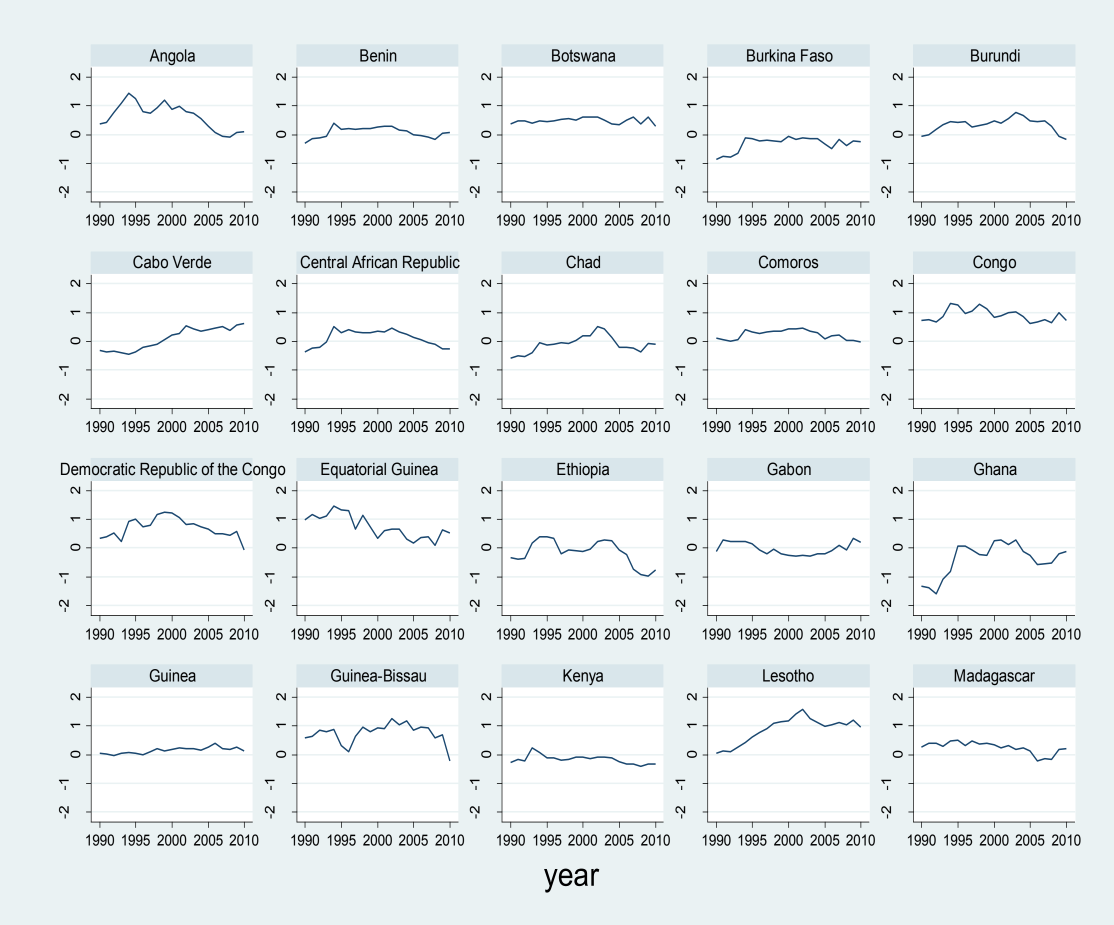
Figure 5.1 Financial integration, logarithm



Source: Author's calculations using the updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007). The figure above plots the logarithm of this measure the full sample over the 1990-2011

Notes: Financial integration here is calculated as the sum of total assets and liabilities as a ratio of GDP.

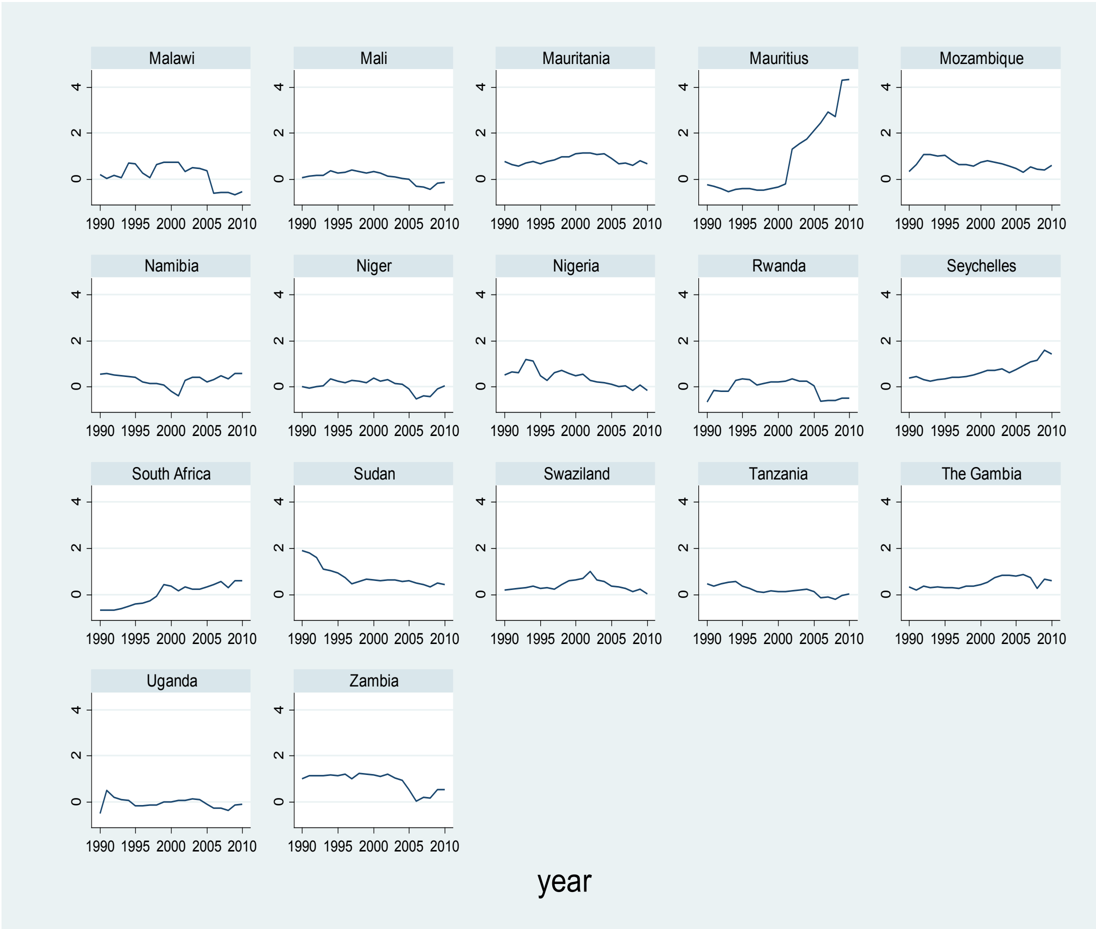
Figure 5.2a: Financial Integration by SSA country (Logarithm): 1990-2010)



Source: Author's calculations using the updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007). The figure above plots the logarithm of this measure the full sample over the 1990-2011

Notes: Financial integration here is calculated as the sum of total assets and liabilities as a ratio of GDP.

Figure 5.2b: Financial Integration by SSA country (Logarithm) (Cont'd): 1990-2010)



Source: Author's calculations using the updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007). The figure above plots the logarithm of this measure the full sample over the 1990-2011

Notes: Financial integration here is calculated as the sum of total assets and liabilities as a ratio of GDP.

5.4. Results:

5.4.1. Linearity tests:

Tables 5.2a, 5.2b and 5.2c show the results from linearity tests for the full sample, for oil importers, and for oil exporters respectively. As discussed in section 5.3.2, up to three regimes are considered and if the linearity is rejected in all cases, then the optimal number of regimes is selected based on the strongest rejection, as in González et al. (2005). For each subsample, the linearity tests based on three models are reported. These are the baseline models in equations 5.4 and 5.5, the models where the terms of trade is replaced with the real exchange rate (RER), and the models where the US dollar real oil price is replaced with the domestic real oil price. The results using the preferred trade balance measures, as in the equations in (i), as well as the trade balances measured as percentages of GDP, as in (ii), are reported in each table

Table 5.2a shows that for the full sample, the null hypotheses of linearity are rejected in favour of PSTR models for all but the oil trade balance as a percentage of GDP. For the latter, in all cases, the null hypothesis of a linear model cannot be rejected. Table 5.2b shows that for oil importers, linearity is rejected for all the models. Table 5.2c shows that for oil exporters, linearity is rejected only for the non-oil trade balance models using the real exchange rate and domestic real oil price. When the terms of trade is used, the threshold is insignificant.

Overall, the results show that the relationship between the oil price and the nonoil trade balance is nonlinear for all subsamples, with financial integration being the source of nonlinearity. For the full sample and for the oil exporters, the relationship is linear for the oil trade balance. This result is not surprising, as oil exporters (importers) should have oil trade surpluses (deficits) irrespective of their levels of integration. The effects of oil prices are nonlinear for the overall trade balance of oil importers, but not for oil exporters. To give an idea of the distribution of countries across the estimated thresholds, in Appendix H we group the countries into high, low and intermediate levels of financial integration based on their average levels of integration throughout the sample period and the estimated thresholds in the various models. Of course, given the logistic transition function, countries change regimes over time, so the grouping is for descriptive purposes only and does not reflect the countries in high or low regimes.

5.4.2. PSTR estimation results:

The results from the PSTR models are first presented using the preferred trade balance measures in (i). In a later section, the results are shown to be robust to using the alternative trade balance measures in (ii) which allow the estimation of the oil trade balance model for oil importers and the full sample. The results are then shown to be robust to the inclusion of the crisis dummies.

The logistic transition function means that the coefficients of the PSTR models cannot be directly interpreted as elasticities. However, their signs and statistical significance are economically meaningful and indicate the effect *on the elasticity* as the value of the threshold variable increases: a positive coefficient implies a higher effect, while a negative coefficient implies a lower effect.

Table 5.2a: Linearity Tests: Full sample ($\rho-$ values)

Dependent variable	Baseline model				Model with RER				Model with RER and domestic oil price			
	$m=0$	$m=1$	$m=2$	$m*$	$m=0$	$m=1$	$m=2$	$m*$	$m=0$	$m=1$	$m=2$	$m*$
Ln(ttb)	0.004	0.027	0.179	$m*=1$	0.000	0.000	0.533	$m*=2$	0.000	0.000	0.465	$m*=2$
Ln(ntb)	0.001	0.060	0.588	$m*=1$	0.000	0.004	0.285	$m*=1$	0.000	0.004	0.013	$m*=1$
OTB	0.691	---	---	$m*=0$	0.592	---	---	$m*=0$	0.312	---	---	$m*=0$
NTB	0.008	0.061	0.010	$m*=1$	0.008	0.010	0.024	$m*=1$	0.000	0.000	0.019	$m*=1$
TTB	0.030	0.162	---	$m*=1$	0.048	0.008	0.049	$m*=2$	0.006	0.000	0.083	$m*=2$

Table 5.2b: Linearity Tests: Oil importers ($\rho-$ values)

Dependent variable	Baseline model				Model with RER				Model with RER and domestic oil price			
	$m=0$	$m=1$	$m=2$	$m*$	$m=0$	$m=1$	$m=2$		$m=0$	$m=1$	$m=2$	$m*$
Ln(ttb)	0.001	0.234	---	$m*=1$	0.001	0.003	0.356	$m*=1$	0.001	0.003	0.355	$m*=1$
Ln(ntb)	0.000	0.107	---	$m*=1$	0.000	0.000	0.720	$m*=1$	0.000	0.000	0.721	$m*=1$
OTB	0.034	0.167	---	$m*=1$	0.004	0.130	---	$m*=1$	0.004	0.130	---	$m*=1$
NTB	0.004	0.043	0.005	$m*=1$	0.000	0.000	0.022	$m*=2$	0.000	0.000	0.022	$m*=2$
TTB	0.004	0.054	0.003	$m*=1$	0.007	0.000	0.051	$m*=2$	0.000	0.000	0.051	$m*=2$

Table 5.2c: Linearity Tests: Oil exporters ($\rho-$ values)

Dependent variable	Baseline model				Model with RER				Model with RER and domestic oil price			
	$m=0$	$m=1$	$m=2$	$m*$	$m=0$	$m=1$	$m=2$	$m*$	$m=0$	$m=1$	$m=2$	$m*$
Ln(ttb)	0.267	---	---	$m*=0$	0.181	---	---	$m*=0$	0.181	---	---	$m*=0$
Ln(ntb)	0.188	---	---	$m*=0$	0.484	0.016	0.326	$m*=2$	0.484	0.016	0.326	$m*=2$
Ln(otb)	0.814	---	---	$m*=0$	0.839	---	---	$m*=0$	0.839	---	---	$m*=0$
OTB	0.709	---	---	$m*=0$	0.562	---	---	$m*=0$	0.562	---	---	$m*=0$
NTB	0.113	---	---	$m*=0$	0.026	0.011	0.101	$m*=2$	0.027	0.011	0.100	$m*=2$
TTB	0.173	---	---	$m*=0$	0.171	---	---	$m*=0$	0.171	---	---	$m*=0$

Notes: m refers to the number of thresholds or regimes. m=0 refers to testing the null hypothesis of a linear model against the alternative of a PSTR model with two regimes. m=1 refers to testing the null hypothesis of a PSTR with two regimes against the alternative of a PSTR with three regimes. m=2 refers to testing the null hypothesis of a PSTR with three regimes against the alternative of a PSTR with four regimes. The optimal value of m, i.e. m*, is selected based on the strongest rejection of the null hypothesis. Ln(ttb) and Ln(ntb) refer to our preferred overall and nonoil trade balance measures in equations (i) respectively. OTB, NTB and TTB refer to the oil, nonoil and overall trade balances as a percentage of GDP, as in equations (ii).

5.4.2.1. The effects of oil prices on the trade balances of the full sample of SSA countries:

The first column of Table 5.3a shows the coefficients from the overall trade balance model for the full sample using the baseline model in equation (4). The threshold value of the logarithm of financial integration as a proportion of GDP is 0.66, which is 193.5% of GDP[39]. The second and third columns show the results using the real exchange rate and domestic real oil price respectively

The baseline model shows that the oil price effect on the overall balance is insignificant for both oil importers and exporters above and below the threshold value. This result is expected for the lower regime but not the upper regime, as higher levels of integration should be associated with higher overall trade balance response. The table shows that the effect of financial integration itself is nonlinear in an intuitive way: increased financial integration matters more for less financially integrated economies. For economies with higher levels of integration, the effect of further financial integration is diminished. This shows that less financially integrated economies have the most to gain from higher integration. The coefficients of the income measure across regimes imply that, at higher levels of financial integration, the effect of relative world income on the overall balance is higher. This is consistent with the notion that increased integration in global markets exposes countries to global income shocks.

The middle panel of Table 5.3a shows that the results are robust to using the real exchange rate instead of the terms of trade, with the added statistical significance of the income measure in the lower regime. The last column of Table 5.3a shows that the results are again robust to using the domestic real oil price instead of the US dollar real oil price. Here, the real exchange rate gains statistical significance in both regimes. The coefficients imply that at lower levels of financial integration, a real depreciation matters more for the trade balance than at higher levels. Since a real depreciation should make exports cheaper to foreigners while making imports more expensive, it should improve the trade balance. However, for economies that are well integrated in international financial markets, a real depreciation also has a potential valuation effect: it would alter the value of returns favourably, since foreign assets are usually

[39] Since the threshold value is expressed in natural logarithmic terms (see equation (ii)), its value expressed as a percentage is the exponential of the threshold value (in logs) multiplied by 100.

denominated in foreign currencies (especially the Dollar), and liabilities in domestic currency (Gourinchas and Rey, 2005). This effectively increases the income of these countries relative to less financially integrated ones, such that the reduction in their imports following a depreciation may be relatively less, leading to a lesser response of the trade balance.

Table 5.3a: Panel Smooth Regression Model estimates of the overall trade balance equation for SSA countries, 1990-2010.

Baseline Model			Model with RER			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	0.0097	0.1574	$\Delta lnroilp_{t-1}$	-0.0205	-0.2938	$\Delta lnroilp_{t-1}$	-0.1507	-0.6470
$lnfint_{t-1}$	0.1644***	3.1847	$lnfint_{t-1}$	0.2349***	2.7041	$lnfint_{t-1}$	0.5704***	2.9491
$\Delta lnroilp_{t-1} * OX$	0.2117	1.1113	$\Delta lnroilp_{t-1} * OX$	0.1582	0.7494	$\Delta lnroilp_{t-1} * OX$	-0.5333	-0.9795
$\Delta lntot_{t-1}$	-0.0122	-0.0913	$\Delta lnrer_{t-1}$	0.0388	0.3500	$\Delta lnrer_{t-1}$	0.7881**	2.0294
$\Delta gdpdiff_{t-1}$	-0.4231	-1.5197	$\Delta gdpdiff_{t-1}$	-0.8801***	-2.3661	$\Delta gdpdiff_{t-1}$	-3.8487***	-3.6009
$\Delta lnroilp_{t-1}$*G	0.2086	1.0867	$\Delta lnroilp_{t-1}$*G	0.2404	1.4098	$\Delta lnroilp_{t-1}$*G	0.3433	0.9342
$lnfint_{t-1}$*G	-0.2556***	-3.8507	$lnfint_{t-1}$*G	-0.2789***	-2.8081	$lnfint_{t-1}$*G	-0.6261***	-2.9376
$\Delta lnroilp_{t-1} * OX$*G	-0.4053	-0.9961	$\Delta lnroilp_{t-1} * OX$*G	0.1007	0.2710	$\Delta lnroilp_{t-1} * OX$*G	0.8908	1.2114
$\Delta lntot_{t-1}$*G	0.3426	1.1068	$\Delta lnrer_{t-1}$*G	-0.1207	-0.7609	$\Delta lnrer_{t-1}$*G	-1.3840***	-2.3800
$\Delta gdpdiff_{t-1}$*G	1.6513***	2.9039	$\Delta gdpdiff_{t-1}$*G	2.7193***	4.2656	$\Delta gdpdiff_{t-1}$*G	5.7929***	4.0002
Slope Coefficient $\hat{\gamma}$	13.34		Slope Coefficient $\hat{\gamma}$	14.36		Slope Coefficient $\hat{\gamma}$	10.97	
Theshold Value $\hat{c}$	0.66 (193.5%)		Theshold Value $\hat{c}$	0.65(191.5%)		Theshold Value $\hat{c}$	0.65(191.5%)	

Table 5.3b: Panel Smooth Regression Model estimates of the non-oil trade balance equation for SSA countries, 1990-2010.

Baseline Model			Model with RER			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	0.1095*	1.7704	$\Delta lnroilp_{t-1}$	0.1361	1.3775	$\Delta lnroilp_{t-1}$	0.0806	1.3125
$lnfint_{t-1}$	0.3548***	3.6228	$lnfint_{t-1}$	0.2056*	1.7612	$lnfint_{t-1}$	0.3980***	3.8016
$\Delta lnroilp_{t-1} * OX$	-0.3039	-0.9373	$\Delta lnroilp_{t-1} * OX$	-1.1273*	-1.9304	$\Delta lnroilp_{t-1} * OX$	-0.1957	-0.6495
$\Delta lntot_{t-1}$	-0.0196	-0.1097	$\Delta lnrer_{t-1}$	1.0967***	4.5396	$\Delta lnrer_{t-1}$	0.0811	0.4379
$\Delta gdpdiff_{t-1}$	-0.1907	-0.4838	$\Delta gdpdiff_{t-1}$	0.3682	0.3519	$\Delta gdpdiff_{t-1}$	-0.3454	-0.8517
$\Delta lnroilp_{t-1}$*G	1.3688	1.1254	$\Delta lnroilp_{t-1}$*G	0.0380	0.3019	$\Delta lnroilp_{t-1}$*G	-0.4387	-1.0150
$lnfint_{t-1}$*G	-0.4061***	-3.2181	$lnfint_{t-1}$*G	0.0070	0.0355	$lnfint_{t-1}$*G	-0.3810***	-2.7259
$\Delta lnroilp_{t-1} * OX$*G	8.6362	0.9328	$\Delta lnroilp_{t-1} * OX$*G	1.0831	1.4779	$\Delta lnroilp_{t-1} * OX$*G	6.1616***	3.1558
$\Delta lntot_{t-1}$*G	7.6723	1.4312	$\Delta lnrer_{t-1}$*G	-0.9216***	-2.9758	$\Delta lnrer_{t-1}$*G	-0.4597	-0.3734
$\Delta gdpdiff_{t-1}$*G	-8.7383	-1.3688	$\Delta gdpdiff_{t-1}$*G	-0.8480	-0.7449	$\Delta gdpdiff_{t-1}$*G	-1.3933	-0.7551
Slope Coefficient $\hat{\gamma}$	16.36		Slope Coefficient $\hat{\gamma}$	222.97		Slope Coefficient $\hat{\gamma}$	32.05	
Theshold Value $\hat{c}$	1.38(397.5%)		Theshold Value $\hat{c}$	-0.044(95.7%)		Theshold Value $\hat{c}$	1.236(344.2%)	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5.3b shows the response of the full sample's nonoil trade balance. Here the threshold is much higher at 1.38 or 397.5% of GDP. This indicates that the lower threshold for the overall balance reflects the inclusion of the oil balance for which there is no threshold. The baseline model shows that the effect of an oil price increase on the nonoil trade balance of oil importers is positive and significant below the threshold. This is consistent with expectations: oil price increases matter only for less financially integrated economies' non-oil trade balances. More integrated economies are able to smooth consumption and avoid fluctuations in their non-oil balances by accessing foreign capital. This is consistent with Bodenstein et al. (2011). The effect is insignificant for oil importers in the upper regime and for oil exporters in both regimes. The coefficient of financial integration again indicates that increasing integration is more important for less integrated economies. The terms of trade and income measures have no significant effects across regimes.

However, the middle panel shows that this oil price effect is not robust to using the real exchange rate instead of the terms of trade. Here the coefficients are insignificant for oil importers in both regimes and negative for oil exporters in the lower regime. The latter result implies that an oil price increase matters less for the nonoil balance of less financially integrated oil exporters, inconsistent with expectations. The effects of a real depreciation again point to valuation effects. Financial integration is only significant in the lower regime, but it is again positive. The last column of Table 5.3b shows the results using the real exchange rate and the domestic real oil price as opposed to the US dollar real oil price. Financial integration continues to have positive effects below the threshold and negative effects above it. Contrary to expectations, it appears here that oil price increases matter more for oil exporters with levels of integration higher than the threshold value, and the coefficient in the lower regime loses statistical significance. All other variables are also insignificant.

Clearly, the models estimated appear unstable and the coefficients of some variables are not robust to changing the parameters of the model. The results for oil exporters are particularly weak and unexpected. To identify the source of this inconsistency therefore, the oil importer and oil exporter sub-samples are considered separately.

5.4.2.2. The effects of oil prices on the trade balance of SSA oil importers:

Table 5.4a shows estimates from for oil importers' overall trade balance. In the baseline model, the threshold value of financial integration is 0.597, which is 181.7% of GDP.

This is close to the estimated threshold for the full sample. The second and third columns show the results using the real exchange rate and domestic real oil price respectively. In the baseline model, the coefficient of the real oil price is not significant for the overall trade balance in both regimes. Again, this insignificant effect is expected for the lower regime but not the upper regime. The effects of financial integration are consistent with the results from the full sample, as increased integration becomes less important at higher levels of integration. Here again, the effects of the income measure indicate that higher relative world income is more important for more financially integrated economies. It is seen from the middle column of Table 5.4a that using the real exchange rate instead of the terms of trade, a real oil price increase still has no effects on the overall trade balance in both regimes. The effects of financial integration and the real exchange rate also remain the same. The last column of Table 5.4a shows that using the domestic real oil price instead of the US dollar real oil price does not change the results.

Table 5.4b shows the response of oil importers' non-oil trade balance. Again, the baseline model is presented in the first column. As in the full sample, the threshold value here is higher at 0.831, or 229.6% of GDP. The coefficients of the oil price show that oil prices are more important for the nonoil balance below the threshold. This is consistent with expectations: when the oil price increases, these economies need to run larger non-oil trade surpluses to offset their oil trade deficits because they are constrained in borrowing abroad to smooth consumption. In line with Bodenstein et al. (2011) and Kilian et al. (2009), the more financially integrated the economy, the more it is able to avoid fluctuations in its non-oil trade balance through accessing foreign capital. Accordingly, the nonoil trade balance shows a lower response to increased oil prices in the upper regime. The effects of the income measure and financial integration are consistent with those found for the overall balance. The second and third columns of Table 5.4b show that the results are robust to using the real exchange rate and the domestic real oil price. As with the overall trade balance, the coefficients of a real depreciation point to valuation effects.

5.4.2.3. The effects of oil prices on the trade balance of SSA oil exporters:

As shown in Table 5.2c, linearity tests for oil exporters show that there are no significant threshold effects for the oil, nonoil and overall trade balances using the baseline model. Threshold effects are only apparent for the non-oil trade balance using the real exchange rate and domestic real oil price. This linearity helps explains the unstable and inconsistent results using the full sample. With only 8 oil exporters, the number of observations is limited such that even in the full sample, only a small number of observations belonging to oil exporters remain in each regime over time. That some of these oil exporters have oil imports up to 55% of total exports further complicates the results.

Still, the PSTR model is estimated for the non-oil trade balance using the real exchange rate and the domestic real oil price, since the thresholds are significant in these cases. Results are presented in Table 5.5. An oil price increase has a negative and significant coefficient when financial integration is below the threshold value of 0.69 or 199% of GDP. The effect is however positive and significant above the threshold. This implies that the effects oil prices increase with the level of financial integration. This is contrary to expectations, as the non-oil balances of more financially integrated oil exporters should respond less to oil price increases. Financial integration itself has no significant impact in both regimes. The income measure has a positive coefficient below the threshold and a negative one above it, contrary to the results obtained for oil importers. It suggests that for oil exporters, the effect of increased relative world income is higher for less financially integrated economies. A real depreciation has positive effects below the threshold and negative effects above it, again pointing to possible valuation effects. The results using the domestic real oil price are very similar, as shown in the second column. Taken together, the oil price effect for oil exporters is inconsistent with expectations and does not support the findings of Kilian et al. (2009) or Bodenstein et al. (2011). This is not surprising since the nonlinearity identified is not robust to using the terms of trade or, as will be shown, to controlling for the 2008-2010 global financial crisis.

Table 5.4a: Panel Smooth Regression Model estimates of the overall trade balance equation for oil importing SSA countries, 1990-2010.

Baseline Model			Model with RER			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	-0.0086	-0.1468	$\Delta lnroilp_{t-1}$	-0.0243	-0.3653	$\Delta lnroilp_{t-1}$	-0.0243	-0.3649
$lnfint_{t-1}$	0.1272***	2.5718	$lnfint_{t-1}$	0.2486***	4.2835	$lnfint_{t-1}$	0.2486***	4.2834
$\Delta lntot_{t-1}$	-0.1489	-1.0022	$\Delta lnrer_{t-1}$	0.5164***	3.4372	$\Delta lnrer_{t-1}$	0.5407***	3.4310
$\Delta gdpdiff_{t-1}$	0.0916	0.4117	$\Delta gdpdiff_{t-1}$	-0.3601	-1.1071	$\Delta gdpdiff_{t-1}$	-0.3602	-1.1073
$\Delta lnroilp_{t-1}$*G	0.2137	1.3432	$\Delta lnroilp_{t-1}$*G	0.1785	1.0160	$\Delta lnroilp_{t-1}$*G	0.1783	1.0151
$lnfint_{t-1}$*G	-0.1320*	-1.9240	$lnfint_{t-1}$*G	-0.2744***	-3.2328	$lnfint_{t-1}$*G	-0.2744***	-3.2326
$\Delta lntot_{t-1}$*G	0.3444	0.8052	$\Delta lnrer_{t-1}$*G	-1.1426***	-2.5085	$\Delta lnrer_{t-1}$*G	-1.3212***	-2.7868
$\Delta gdpdiff_{t-1}$*G	1.5973**	2.0323	$\Delta gdpdiff_{t-1}$*G	2.0761**	2.1927	$\Delta gdpdiff_{t-1}$*G	2.0763**	2.1928
Slope Coefficient $\hat{\gamma}$	325.99		Slope Coefficient $\hat{\gamma}$	6.43		Slope Coefficient $\hat{\gamma}$	6.43	
Theshold Value $\hat{c}$	0.597(181.7%)		Theshold Value $\hat{c}$	0.476(161%)		Theshold Value $\hat{c}$	0.477(161%)	

Table 5.4b: Panel Smooth Regression Model estimates of the non-oil trade balance equation for oil importing SSA countries, 1990-2010.

Baseline Model			Model with RER			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	0.2149***	2.7842	$\Delta lnroilp_{t-1}$	0.1184*	1.6737	$\Delta lnroilp_{t-1}$	0.1184*	1.6734
$lnfint_{t-1}$	0.2534*	1.7941	$lnfint_{t-1}$	0.3616***	6.1455	$lnfint_{t-1}$	0.3616***	6.1458
$\Delta lntot_{t-1}$	-0.3451	-1.3565	$\Delta lnrer_{t-1}$	0.4640***	2.7568	$\Delta lnrer_{t-1}$	0.3457**	1.9689
$\Delta gdpdiff_{t-1}$	-0.3931*	-1.8522	$\Delta gdpdiff_{t-1}$	-1.1591***	-3.0924	$\Delta gdpdiff_{t-1}$	-1.1593***	-3.0927
$\Delta lnroilp_{t-1}$*G	-0.1504	-0.8026	$\Delta lnroilp_{t-1}$*G	-0.0124	-0.0582	$\Delta lnroilp_{t-1}$*G	-0.0126	-0.0591
$lnfint_{t-1}$*G	-0.2169*	-1.6610	$lnfint_{t-1}$*G	-0.4166***	-5.1454	$lnfint_{t-1}$*G	-0.4166***	-5.1457
$\Delta lntot_{t-1}$*G	0.5352	1.1172	$\Delta lnrer_{t-1}$*G	-1.2955***	-2.3287	$\Delta lnrer_{t-1}$*G	-1.2833**	-2.1708
$\Delta gdpdiff_{t-1}$*G	2.7210***	3.6524	$\Delta gdpdiff_{t-1}$*G	3.7486***	3.0036	$\Delta gdpdiff_{t-1}$*G	3.7490***	3.0037
Slope Coefficient $\hat{\gamma}$	999.31		Slope Coefficient $\hat{\gamma}$	3.53		Slope Coefficient $\hat{\gamma}$	3.53	
Theshold Value $\hat{c}$	0.831(229.6%)		Theshold Value $\hat{c}$	0.624(186.6%)		Theshold Value $\hat{c}$	0.624(186.6%)	

$^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Table 5.5: Panel Smooth Regression Model estimates of the non-oil trade balance equation for oil exporting SSA countries, 1990-2010.

Model with RER			Model with RER and domestic real oil		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	-2.0383***	-3.1723	$\Delta lnroilp_{t-1}$	-2.0384***	-3.1740
$lnfint_{t-1}$	-4.5747	-0.8948	$lnfint_{t-1}$	-4.5782	-0.8957
$\Delta lnrer_{t-1}$	5.1091***	5.1264	$\Delta lnrer_{t-1}$	7.1496***	4.8753
$\Delta gdpdiff_{t-1}$	28.8447***	4.8889	$\Delta gdpdiff_{t-1}$	28.8557***	4.8877
$\Delta lnroilp_{t-1}$*G	1.7013***	2.0952	$\Delta lnroilp_{t-1}$*G	1.7019***	2.0968
$lnfint_{t-1}$*G	4.7839	1.0645	$lnfint_{t-1}$*G	4.7872	1.0655
$\Delta lnrer_{t-1}$*G	-3.0294***	-2.5398	$\Delta lnrer_{t-1}$*G	-4.7331***	-2.7237
$\Delta gdpdiff_{t-1}$*G	-	-5.0408	$\Delta gdpdiff_{t-1}$*G	-	-5.0395
Slope	3774.71		Slope	3774.71	
Theshold Value (	0.688(199		Theshold Value (	0.688(199	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

5.4.2.4. Robustness to alternative trade balance measures:

Tables 5.6a, 5.6b and 5.6c show the coefficient estimates from the PSTR model for the full sample using the overall, nonoil and oil trade balances as percentages of GDP respectively. Tables 5.7a, 5.7b and 5.7c report the corresponding results for oil importers. Results are again presented using the real exchange rate and terms of trade. For oil exporters, the transition function using these measures has no variance, indicating that most of the observations lie in one regime and the PSTR cannot be estimated. This again likely reflects the limited sample size.

It can be seen that for the full sample's overall trade balance, the oil price still has no effect for both oil importers and exporters above and below the threshold. Financial integration maintains a positive effect below the threshold and a negative effect above it.

Robustness to Alternative Trade Balance Measures: Full Sample

Table 5.6a: Panel Smooth Regression Model estimates of the overall trade balance (as a percentage of GDP) equation for SSA countries, 1990-2010.

Baseline model			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta \mathrm{lnroilp}_{t-1}$	1.1020	0.9627	$\Delta \mathrm{lnroilp}_{t-1}$	2.5142	0.8692
lnfint_{t-1}	4.9900***	3.4972	lnfint_{t-1}	10.0873***	3.1457
$\Delta \mathrm{lnroilp}_{t-1} * \mathrm{OX}$	2.6021	0.7814	$\Delta \mathrm{lnroilp}_{t-1} * \mathrm{OX}$	-2.8226	-0.3713
$\Delta \mathrm{lntot}_{t-1}$	4.1430	1.5034	$\Delta \mathrm{lnrer}_{t-1}$	1.0276	0.1692
$\Delta \mathrm{gdpdiff}_{t-1}$	-12.2202	-1.0659	$\Delta \mathrm{gdpdiff}_{t-1}$	-55.2593***	-2.5825
$\Delta \mathrm{lnroilp}_{t-1}$*G	-2.0112	-0.2468	$\Delta \mathrm{lnroilp}_{t-1}$*G	-3.7464	-0.4582
lnfint_{t-1}*G	-9.1102***	-3.6306	lnfint_{t-1}*G	-13.6866***	-3.2898
$\Delta \mathrm{lnroilp}_{t-1} *$ OX*G	3.8076	0.3933	$\Delta \mathrm{lnroilp}_{t-1} *$ OX*G	25.7876	1.3657
$\Delta \mathrm{lntot}_{t-1}$*G	6.7905	0.5734	$\Delta \mathrm{lnrer}_{t-1}$*G	-18.2809	-1.0195
$\Delta \mathrm{gdpdiff}_{t-1}$*G	100.7932***	2.1871	$\Delta \mathrm{gdpdiff}_{t-1}$*G	149.3858***	2.9541
Slope Coefficient $\hat{\gamma}$	7.51		Slope Coefficient $\hat{\gamma}$	7.28	
Theshold Value $\hat{c}$	0.97(263.8)		Theshold Value $\hat{c}$	0.98(263.8%)	

$^{*} p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$

Table 5.6b: Panel Smooth Regression Model estimates of the nonoil trade balance (as a percentage of GDP) equation for SSA countries, 1990-2010.

Baseline model			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta \mathrm{lnroilp}_{t-1}$	1.6473*	1.7444	$\Delta \mathrm{lnroilp}_{t-1}$	1.7865*	1.7824
lnfint_{t-1}	2.8560***	2.7691	lnfint_{t-1}	3.1852***	3.0135
$\Delta \mathrm{lnroilp}_{t-1} * \mathrm{OX}$	-4.7523***	-2.2604	$\Delta \mathrm{lnroilp}_{t-1} * \mathrm{OX}$	-5.0551***	-2.3505
$\Delta \mathrm{lntot}_{t-1}$	-1.2156	-0.5021	$\Delta \mathrm{lnrer}_{t-1}$	-0.9331	-0.5006
$\Delta \mathrm{gdpdiff}_{t-1}$	8.4656	1.0966	$\Delta \mathrm{gdpdiff}_{t-1}$	8.1054	1.0478
$\Delta \mathrm{lnroilp}_{t-1}$*G	-12.1350	-1.5217	$\Delta \mathrm{lnroilp}_{t-1}$*G	-7.7838	-1.1164
lnfint_{t-1}*G	-5.3821***	-3.6106	lnfint_{t-1}*G	-5.8394***	-3.5912
$\Delta \mathrm{lnroilp}_{t-1} *$ OX*G	113.7918***	3.9222	$\Delta \mathrm{lnroilp}_{t-1} *$ OX*G	76.6206***	3.4604
$\Delta \mathrm{lntot}_{t-1}$*G	-20.5705	-0.9849	$\Delta \mathrm{lnrer}_{t-1}$*G	22.6110	1.3407
$\Delta \mathrm{gdpdiff}_{t-1}$*G	101.6070***	4.2776	$\Delta \mathrm{gdpdiff}_{t-1}$*G	89.6058***	3.9511
Slope Coefficient $\hat{\gamma}$	27.4		Slope Coefficient $\hat{\gamma}$	27.12	
Theshold Value $\hat{c}$	1.25(349%)		Theshold Value $\hat{c}$	1.24(345.6%)	

$^{*} p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$

Table 5.6c: Panel Smooth Regression Model estimates of the oil trade balance (as a percentage of GDP) equation for SSA countries, 1990-2010.

Baseline model			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	-1.1074**	-2.0634	$\Delta lnroilp_{t-1}$	-2.2406	-1.1546
$lnfint_{t-1}$	1.6167	1.4097	$lnfint_{t-1}$	4.1027	1.0177
$\Delta lnroilp_{t-1} * OX$	7.7290***	2.5973	$\Delta lnroilp_{t-1} * OX$	12.2510***	2.6340
$\Delta lntot_{t-1}$	6.4521***	2.8500	$\Delta lnrer_{t-1}$	-4.8537	-0.9439
$\Delta gdpdiff_{t-1}$	-19.3771**	-2.3094	$\Delta gdpdiff_{t-1}$	-40.2705***	-2.3505
$\Delta lnroilp_{t-1}$*G	-1.1223	-0.3486	$\Delta lnroilp_{t-1}$*G	2.9946	0.7113
$lnfint_{t-1}$*G	-5.6070***	-2.9154	$lnfint_{t-1}$*G	-6.5182**	-2.2217
$\Delta lnroilp_{t-1} *$ OX*G	-5.9200	-0.4683	$\Delta lnroilp_{t-1} *$ OX*G	-0.4557	-0.0271
$\Delta lntot_{t-1}$*G	2.7964	0.2189	$\Delta lnrer_{t-1}$*G	-13.6071	-0.9726
$\Delta gdpdiff_{t-1}$*G	58.2129	1.1284	$\Delta gdpdiff_{t-1}$*G	50.2996	1.0319
Slope Coefficient $\hat{\gamma}$	387.7		Slope Coefficient $\hat{\gamma}$	1349.35	
Theshold Value $\hat{c}$	1.02(277.3%)		Theshold Value $\hat{c}$	1.013(275.4%)	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Robustness to Alternative Trade Balance Measures: Oil importers

Table 5.7a: Panel Smooth Regression Model estimates of the overall trade balance (as a percentage of GDP) equation for oil importing SSA countries, 1990-2010.

Baseline model			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	-2.1147	-0.4948	$\Delta lnroilp_{t-1}$	9.3431	1.0162
$lnfint_{t-1}$	-7.6017	-1.2082	$lnfint_{t-1}$	13.9392**	4.0849
$\Delta lntot_{t-1}$	-26.9110*	-1.6927	$\Delta lnrer_{t-1}$	22.3524	1.0603
$\Delta gdpdiff_{t-1}$	-4.7126	-1.0382	$\Delta gdpdiff_{t-1}$	-126.7633***	-3.4749
$\Delta lnroilp_{t-1}$*G	2.4155	0.5206	$\Delta lnroilp_{t-1}$*G	-16.9185	-1.0003
$lnfint_{t-1}$*G	5.3652	1.1948	$lnfint_{t-1}$*G	-16.5638***	-4.1112
$\Delta lntot_{t-1}$*G	22.5615	1.4170	$\Delta lnrer_{t-1}$*G	-42.2378	-1.0508
$\Delta gdpdiff_{t-1}$*G	22.8613	1.7150	$\Delta gdpdiff_{t-1}$*G	257.3528***	3.6666
Slope Coefficient $\hat{\gamma}$	24240.67		Slope Coefficient $\hat{\gamma}$	3.32	
Theshold Value $\hat{c}$	0.30(135%)		Theshold Value $\hat{c}$	1.09(297.4%)	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5.7b: Panel Smooth Regression Model estimates of the nonoil trade balance (as a percentage of GDP) equation for oil importing SSA countries, 1990-2010.

Baseline model			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	2.2855**	2.1734	$\Delta lnroilp_{t-1}$	1.7634*	1.6635
$lnfint_{t-1}$	5.1532***	2.6857	$lnfint_{t-1}$	5.5692***	3.8224
$\Delta lntot_{t-1}$	-2.3515	-0.8432	$\Delta lnrer_{t-1}$	-0.2914	-0.1328
$\Delta gdpdiff_{t-1}$	-2.9485	-0.8336	$\Delta gdpdiff_{t-1}$	0.6333	0.1538
$\Delta lnroilp_{t-1}$*G	-2.0373	-0.5838	$\Delta lnroilp_{t-1}$*G	-2.7475	-1.3158
$lnfint_{t-1}$*G	-8.2233***	-4.1389	$lnfint_{t-1}$*G	-6.7999***	-4.1977
$\Delta lntot_{t-1}$*G	-0.8471	-0.0883	$\Delta lnrer_{t-1}$*G	-15.838***	-2.5149
$\Delta gdpdiff_{t-1}$*G	41.9524***	2.4809	$\Delta gdpdiff_{t-1}$*G	68.7264***	5.8675
Slope Coefficient $\hat{\gamma}$	814.5		Slope Coefficient $\hat{\gamma}$	1036.4	
Theshold Value	0.80(222.6%)		Theshold Value	1.0(271.8%)	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5.7c: Panel Smooth Regression Model estimates of the oil trade balance (as a percentage of GDP) equation for oil importing SSA countries, 1990-2010.

Baseline model			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	-1.0581***	-3.0825	$\Delta lnroilp_{t-1}$	-1.6643***	-4.1587
$lnfint_{t-1}$	0.4166	1.0571	$lnfint_{t-1}$	0.3134	0.8196
$\Delta lntot_{t-1}$	-0.6672	-0.7873	$\Delta lnrer_{t-1}$	4.1073***	5.5919
$\Delta gdpdiff_{t-1}$	2.8799	1.6221	$\Delta gdpdiff_{t-1}$	3.6313***	2.4238
$\Delta lnroilp_{t-1}$*G	-1.9437	-1.0575	$\Delta lnroilp_{t-1}$*G	-0.8543	-0.4445
$lnfint_{t-1}$*G	-2.6900***	-4.0107	$lnfint_{t-1}$*G	-2.5804***	-3.9987
$\Delta lntot_{t-1}$*G	-1.8025	-0.6110	$\Delta lnrer_{t-1}$*G	-7.5943*	-1.7110
$\Delta gdpdiff_{t-1}$*G	3.3567	0.4087	$\Delta gdpdiff_{t-1}$*G	3.0356	0.3681
Slope Coefficient $\hat{\gamma}$	8.34		Slope Coefficient $\hat{\gamma}$	6.63	
Theshold Value	0.82(227%)		Theshold Value	0.81(224.8%)	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

For the full sample's non-oil trade balance, oil importers with levels of financial integration below the threshold value still respond more to oil price increases while oil exporters respond less, consistent with previous results. The effects of financial integration and the income measure in both regimes are also robust. For the oil trade balance, it has already been shown that there is no threshold in the relationship between the variables. However, for completeness, it is shown that below the threshold, oil exporters (importers) respond positively (negatively) to oil price increases in the model using the terms of trade. The effect for oil importers however becomes insignificant if the real exchange rate is used.

For the oil importer subsample, tables 5.7a, 5.7b and 5.7c show that using the alternative trade balance measures does not change the results. Oil price increases still have insignificant effects on the overall trade balance below and above the threshold; and both financial integration and the income measure maintain their effects when the real exchange rate is used. When the terms of trade are used the effects are insignificant. For their non-oil trade balance, the oil price coefficient is still positive and significant below the threshold and insignificant above it, consistent with expectations. The effects of financial integration, the income measure, and the real exchange rate are also robust. Overall therefore, the results are robust to using these alternative trade balance measures.

5.4.2.5. Robustness to the inclusion of crisis dummies:

Here, the robustness of the results to including dummy variables for the 2008-2010 period is checked. The corresponding linearity tests are shown in the Appendix I. It can be seen that all the previous results regarding the presence of thresholds are confirmed. In addition, when the dummies are included, the oil trade threshold for oil importers disappears. This reinforces the result that the relationship between the oil price and the oil trade balance does not depend on a financial integration threshold, as expected. For oil exporters the threshold for the nonoil balance is still not robust to using the terms of trade instead of the real exchange rate.

Tables 5.8a and 5.8b show the estimated coefficients from the PSTR model for the full sample's overall and nonoil trade balance when the crisis dummies are included. The dummies for the overall trade balance are insignificant. However, for the nonoil trade balance, they are significant at the 10% level. Here, the real oil price maintains its positive and significant coefficient in the lower regime for oil importers. Although this is the expected impact, it is clearly not robust to using the real exchange rate and, as previously seen, to omitting the crisis dummies. For oil exporters, the oil price effects are insignificant below the threshold and significantly positive above it, but only when the real exchange rate specification is used. The coefficients of financial integration are different compared to the model without the dummies for oil exporters. This effect is also not robust to using the real exchange rate. Thus, as before, the results using the full sample are unstable and sensitive to changing the parameters of the model. For the full sample's overall trade balance, the sign and significance of the financial integration and income differential variables are consistent with the previous results, as are the insignificant effects of oil prices across regimes. The coefficients on the real exchange rate however become insignificant.

Robustness to including the 2008-20010 crisis dummies

Table 5.8a: Panel Smooth Regression Model estimates of the overall trade balance equation for the full sample of SSA countries (with crisis dummies), 1990-2010.

Baseline Model			Model with RER		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	0.086	1.317	$\Delta lnroilp_{t-1}$	0.083	1.330
$lnfint_{t-1}$	0.147***	2.868	$lnfint_{t-1}$	0.188***	3.63
$\Delta lnroilp_{t-1} * OX$	0.230	1.204	$\Delta lnroilp_{t-1} * OX$	0.206	1.109
$\Delta lntot_{t-1}$	-0.004	-0.028	$\Delta lnrer_{t-1}$	0.016	0.174
$\Delta gdpdiff_{t-1}$	-0.427	-1.504	$\Delta gdpdiff_{t-1}$	-0.516	-1.717
$\Delta lnroilp_{t-1}$*G	0.202	1.077	$\Delta lnroilp_{t-1}$*G	0.220	1.241
$lnfint_{t-1}$*G	-0.243***	-3.701	$lnfint_{t-1}$*G	-0.271***	-3.9
$\Delta lnroilp_{t-1} *$ OX*G	-0.459	-1.127	$\Delta lnroilp_{t-1} *$ OX*G	-0.055	-0.159
$\Delta lntot_{t-1}$*G	0.308	1.008	$\Delta lnrer_{t-1}$*G	-0.105	-0.751
$\Delta gdpdiff_{t-1}$*G	1.666***	2.923	$\Delta gdpdiff_{t-1}$*G	2.182***	3.64
2008Dummy	-0.071	-0.998	2008Dummy	-0.072	-1.066
2009Dummy	-0.104*	-1.701	2009Dummy	-0.101*	-1.704
2010Dummy	0.112*	1.700	2010Dummy	0.117*	1.779
Slope Coefficient $\hat{\gamma}$	14.55		Slope Coefficient $\hat{\gamma}$	16.5	
Theshold Value $\hat{c}$	0.660 (193.48%)		Theshold Value	0.654 (192.3%)	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5.8b: Panel Smooth Regression Model estimates of the nonoil trade balance equation for the full sample of SSA countries (with crisis dummies), 1990-2010.

Baseline Model			Model with RER		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	1.342***	3.525	$\Delta lnroilp_{t-1}$	0.076	0.533
$lnfint_{t-1}$	-0.892**	-2.08	$lnfint_{t-1}$	0.182	1.453
$\Delta lnroilp_{t-1} * OX$	1.195*	1.678	$\Delta lnroilp_{t-1} * OX$	-1.052*	-1.846
$\Delta lntot_{t-1}$	-1.678***	-2.56	$\Delta lnrer_{t-1}$	0.968**	3.876
$\Delta gdpdiff_{t-1}$	-3.945	-0.603	$\Delta gdpdiff_{t-1}$	-0.022	-0.019
$\Delta lnroilp_{t-1}$*G	-1.557***	-4.79	$\Delta lnroilp_{t-1}$*G	0.051	0.372
$lnfint_{t-1}$*G	0.573**	2.488	$lnfint_{t-1}$*G	0.032	0.164
$\Delta lnroilp_{t-1}$ * OX*G	0.000	0.000	$\Delta lnroilp_{t-1}$ * OX*G	0.985	1.398
$\Delta lntot_{t-1}$*G	2.149**	1.981	$\Delta lnrer_{t-1}$*G	-0.820***	-2.638
$\Delta gdpdiff_{t-1}$*G	4.543	0.662	$\Delta gdpdiff_{t-1}$*G	-0.492	-0.416
2008Dummy	0.102	0.592	2008Dummy	-0.071	-0.978
2009Dummy	0.124	0.724	2009Dummy	-0.103	-1.162
2010Dummy	0.127	0.279	2010Dummy	-0.157	-0.953
Slope Coefficient $\hat{\gamma}$	6228.792		Slope Coefficient $\hat{\gamma}$	224.952	
Theshold Value $\hat{c}$	0.935 (254.7%)		Theshold Value $\hat{c}$	-0.045 (104.6%)	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5.9a: Panel Smooth Regression Model estimates of the overall trade balance equation for the of SSA oil importers (with crisis dummies), 1990-2010.

Model with RER			Model with RER and domestic real oil price		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	0.071	0.742	$\Delta lnroilp_{t-1}$	0.016	0.258
$lnfint_{t-1}$	0.142	0.749	$lnfint_{t-1}$	0.216***	3.627
$\Delta lntot_{t-1}$	-0.215	-0.729	$\Delta lnrer_{t-1}$	0.385***	2.846
$\Delta gdpdiff_{t-1}$	0.009	0.042	$\Delta gdpdiff_{t-1}$	-0.243	-0.862
$\Delta lnroilp_{t-1}$*G	0.318*	1.897	$\Delta lnroilp_{t-1}$*G	0.178	1.032
$lnfint_{t-1}$*G	-0.139	-0.981	$lnfint_{t-1}$*G	-0.239***	-2.740
$\Delta lntot_{t-1}$*G	0.330	0.686	$\Delta lnrer_{t-1}$*G	-1.010**	-2.259
$\Delta gdpdiff_{t-1}$*G	1.845**	2.380	$\Delta gdpdiff_{t-1}$*G	1.944**	2.144
2008Dummy	-0.012	-0.122	2008Dummy	-0.144**	-1.969
2009Dummy	0.063	0.524	2009Dummy	-0.043	-0.624
2010Dummy	0.344***	3.287	2010Dummy	0.049	0.657
Slope Coefficient $\hat{\gamma}$	2006.31		Slope Coefficient $\hat{\gamma}$	7.36	
Theshold Value $\hat{c}$	0.596 (181.48%)		Theshold Value	0.51 (166.53%)	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5.9b: Panel Smooth Regression Model estimates of the nonoil trade balance equation for the of SSA oil importers (with crisis dummies), 1990-2010.

Baseline Model			Model with RER		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	0.231***	3.620	$\Delta lnroilp_{t-1}$	0.205***	3.264
$lnfint_{t-1}$	0.199***	3.598	$lnfint_{t-1}$	0.330***	5.606
$\Delta lntot_{t-1}$	-0.133	-0.843	$\Delta lnrer_{t-1}$	0.321**	2.289
$\Delta gdpdiff_{t-1}$	-0.262	-1.313	$\Delta gdpdiff_{t-1}$	-0.761***	-2.60
$\Delta lnroilp_{t-1}$*G	-0.103	-0.603	$\Delta lnroilp_{t-1}$*G	-0.011	-0.056
$lnfint_{t-1}$*G	-0.240***	-3.147	$lnfint_{t-1}$*G	-0.394***	-4.81
$\Delta lntot_{t-1}$*G	0.169	0.359	$\Delta lnrer_{t-1}$*G	-1.116**	-2.001
$\Delta gdpdiff_{t-1}$*G	3.116***	3.385	$\Delta gdpdiff_{t-1}$*G	3.594***	3.040
2008Dummy	-0.085	-1.247	2008Dummy	-0.060	-0.899
2009Dummy	-0.044	-0.602	2009Dummy	-0.013	-0.183
2010Dummy	0.172**	2.371	2010Dummy	0.178***	2.438
Slope Coefficient $\hat{\gamma}$	12.56		Slope Coefficient $\hat{\gamma}$	4.21	
Theshold Value	0.838 (231.17%)		Theshold Value	0.71 (203.4%)	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5.10: Panel Smooth Regression Model estimates of the nonoil trade balance equation for the of SSA oil exporters (with crisis dummies), 1990-2010.

Model with TOT			Model with RER		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
$\Delta lnroilp_{t-1}$	-0.929	-1.120	$\Delta lnroilp_{t-1}$	-0.914	-1.111
$lnfint_{t-1}$	-4.301	-1.212	$lnfint_{t-1}$	-4.289	-1.200
$\Delta lnrer_{t-1}$	4.948***	4.702	$\Delta lnrer_{t-1}$	3.995***	3.332
$\Delta gdpdiff_{t-1}$	19.663***	4.827	$\Delta gdpdiff_{t-1}$	19.542***	4.831
$\Delta lnroilp_{t-1}$*G	0.603	0.680	$\Delta lnroilp_{t-1}$*G	0.586	0.668
$lnfint_{t-1}$*G	5.485	1.527	$lnfint_{t-1}$*G	5.476	1.515
$\Delta lnrer_{t-1}$*G	-3.820***	-3.27	$\Delta lnrer_{t-1}$*G	-3.196**	-2.591
$\Delta gdpdiff_{t-1}$*G	-20.728***	-5.04	$\Delta gdpdiff_{t-1}$*G	-20.607***	-5.05
2008Dummy	0.415*	1.775	2008Dummy	0.415*	1.776
2009Dummy	0.044	0.174	2009Dummy	0.028	0.112
2010Dummy	-0.711*	-1.722	2010Dummy	-0.710*	-1.718
Slope Coefficient $\hat{\gamma}$	7001.9		Slope Coefficient $\hat{\gamma}$	21985.1	
	-			-	
Theshold Value $\hat{c}1$	0.14(86.93%)		Theshold Value $\hat{c}1$	0.14(86.93%)	
Theshold Value $\hat{c}2$	0.07(107.3%)		Theshold Value $\hat{c}2$	0.08(108.3%)	

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Tables 5.9a and 5.9b show the results for oil importers' overall and nonoil trade balances. Here, only the 2010 dummies are important. For oil importers, the previous results remain unchanged: those with levels of financial integration below the threshold have their nonoil trade balances significantly more responsive to oil price increases, while those with higher levels of integration remain unaffected. Apart from the effect of the oil price, the signs and significance of the income variable; the financial integration variable; as well as the real exchange rate across regimes remain the same. For the overall trade balance, the effects of the oil price are generally insignificant across regimes. The only exception is the positive coefficient in the upper regime, which is significant at the 10% level. Although it is in line with expectations, this effect is clearly not robust to using the real exchange rate. The previous significant impacts of financial integration are maintained when the real exchange rate specification is used. The sign and significance of the real exchange rate and the income differential measure are also in line with previous results.

The estimated model for the nonoil trade balance of oil exporters in shown in Table 5.10. Here, the 2008 and 2010 dummies are significant. The effects of oil prices and financial integration become insignificant when the crisis dummies are included, but the real exchange rate and income differential variables maintain their signs and significance across regimes and specifications. Thus, the oil price effect identified for oil exporters is not robust to the inclusion of the crisis dummies.

Overall, the results for oil importers regarding the effects of oil prices on the non-oil trade balance are robust to controlling for the global financial crisis. For the oil exporter subsample as well as the full sample, the results are unstable. The finding of a linear relationship between the real oil price and the oil trade balance for all groups of countries is robust, as is the linear relationship for oil exporters' overall trade balances.

5.5. Discussion of Results:

Together, the results show that the effects of oil prices on the non-oil and overall trade balances of SSA oil importing countries depend on the degree of integration in international financial markets. For oil exporters, only the nonoil trade response depends on financial integration, and even this nonlinearity is not robust to alternative model specifications. It is found that oil importers below the estimated threshold levels of integration behave closer to what would be obtained under the Bodenstein et al. (2011) model in financial autarky. Their nonoil trade balances are more responsive, indicating that these countries have to run nonoil surpluses to offset oil trade deficits when the oil price increases. Those with higher levels of integration are however able to avoid fluctuations in their non-oil balances through their access to foreign capital. These results are consistent with Bodenstein et al. (2011)'s theoretical model and Kilian et al. (2009)'s empirical findings. The results for oil importers is robust to using the real exchange rate instead of the terms of trade; using the domestic real oil price as opposed to the US dollar real oil price; using alternative trade balance measures; and controlling for the 2008-2010 global financial crisis. It is found that, despite a lower nonoil trade response, the overall trade balance of highly integrated oil importers is unresponsive to oil price increases. This suggests that although their nonoil trade response is lower *relative* to less integrated economies, it is not so low as to allow the oil trade response to dominate. This is plausible since, compared to the advanced country sample in Kilian et al. (2009), these countries are still not very integrated.

Interestingly, it is found that the level of financial integration not only influences the oil price effects, but also the effects of relative world income, real exchange rate and financial integration itself. It is shown that the trade balances of countries with higher levels of integration are more affected by increases in world income relative to domestic income. This is consistent with the view that higher financial integration increases exposure to global income shocks (Kose et al., 2006). The differential effects of a real exchange rate depreciation across financial integration regimes points to the importance of valuation effects in limiting the response of the trade balance to real depreciations. That highly integrated economies' nonoil and overall trade balances respond less to a depreciation shows they are able to exploit the changes in the values of asset returns caused by the depreciation. This in turn helps in sustaining imports despite their relatively higher prices. This finding is consistent with Gourinchas and Rey (2005). Finally, financial integration itself is shown to have positive coefficients below the threshold but negative above it. This implies that increased integration matters more for less integrated economies than for highly integrated ones, a finding consistent with Ahmed and Suardi, (2009) for African countries.

5.6. Conclusions:

This chapter has examined the role of financial integration in determining the effects of oil prices on the trade balances of Sub Saharan African countries. International financial integration serves as a potential means of smoothing consumption in response to oil shocks, by providing access to foreign capital. This issue is particularly important given the increased volatility of oil prices, the negative implications of oil price increases for SSA countries' terms of trade, and their dependence on traded goods for consumption and investment. The Panel Smooth Transition Regression (PSTR) model of González et al. (2005) is estimated for 29 oil importers and 8 oil exporters over 1990-2010 period.

It was found that for oil importers, the effects of oil price increases on the non-oil and overall trade balances depend on a financial integration threshold. In particular, while the non-oil balance of those below the threshold levels of integration was found to be more responsive to oil price increases, more integrated economies remained unaffected. The findings for the oil importers support the view that higher financial integration aids in consumption smoothing in the face of terms of trade and income shocks such as those associated with oil price increases. For oil exporters, -the response of the nonoil trade balance was found to vary with financial integration, but this nonlinearity did not prove to be robust to alternative model specifications. The unstable results for oil exporters may be because the models are necessarily estimated with a smaller than desired sample size. For both oil importers and exporters, the effects of a real exchange rate depreciation; higher relative world income; and financial integration on the trade balance were also found to depend on the level of financial integration. The effects of a real depreciation across thresholds is consistent with the view that more financially integrated economies are able to reap the benefits of valuation changes on their foreign asset holdings when the exchange rate depreciates; the effects of relative world income indicate that more financially integrated economies have a higher exposure to changes in global income levels; and the effects of increasing financial integration show that less financially integrated economies benefit more from higher integration. These results are consistent with those reported in the literature (Gourinchas and Rey, 2005, Kose et al., 2003, Kilian et al., 2009, Bodenstein et al., 2011 Ahmed and Suardi, 2009).

The findings open up unexplored avenues for future research. For instance, it will be interesting if threshold levels of financial integration are identified using larger global data consisting of all countries for which data is available. Taking advantage of a larger panel dataset, a range of threshold methods can be applied, and a robust threshold can be identified, which will serve as a yardstick for developing countries seeking to reduce exposure to oil shocks.

The findings also have important policy implications for SSA countries. To be better able to diversify risks and smooth consumption in the face of terms of trade and income shocks associated with oil price increases, SSA oil importers should increase financial openness. This is because the consumption smoothing benefits of financial integration only become apparent when certain threshold levels are reached. However, it should be noted that this improved consumption smoothing may be at the cost of an overall trade balance fluctuation; and that increased integration itself potentially exposes the country to global income shocks. Whether the benefits will outweigh the risks is also an issue that is worthy of future research.

Chapter 6: Conclusions

This thesis has examined the effect of oil prices on the trade balances of Sub-Saharan African (SSA) countries. Particularly, it has empirically investigated how this effect is mediated by three factors: oil price volatility, real exchange rates, and international financial integration. Oil price volatility has been shown to induce asymmetries in the effects of oil prices on economic growth, but its role has not been investigated for the trade balance of any country. Real exchange rates and international financial integration have been shown theoretically to influence the effects of oil prices on the trade balance, but this has not been examined empirically for any country. This thesis has contributed to the literature by employing advanced and appropriate econometric techniques to examine how oil price volatility, real exchange rates and financial integration affect the oil price- trade balance relationship; and by doing this for SSA countries that are oil dependent, rely heavily on trade for growth and have received little attention in the literature.

To investigate the role of oil price volatility in mediating the effects of oil prices on the trade balance, this thesis utilized data on the oil, nonoil and overall trade balance of the largest SSA oil exporter, Nigeria. The primary focus was to determine whether the level of oil price volatility induces nonlinearities in the way the trade balance responds to oil prices. Accordingly, the Threshold Vector Autoregressive Model (TVAR) advanced by Balke (2000) was employed. This model allows a comprehensive analysis of nonlinearities because asymmetries of positive and negative shocks, as well as non-proportional effects of large and small shocks, are allowed within the threshold model. Oil price volatility was set as the threshold variable and the impact of oil price level and volatility shocks on the trade balance were allowed to depend on this threshold. It was found that the effects of oil price level shocks on the trade balance are more dramatic in periods of high oil price volatility. However, no robust asymmetries were found between the effects oil price increases and decreases, nor were there consistent differences in the magnitudes of the effects across the volatility threshold. Much stronger nonlinearities were found in the response of the trade balance to oil price volatility shocks. In particular, it was found that these shocks have a larger impact when oil price volatility is high. In addition, decreases in volatility were found to have larger impacts than increases. The results also showed that the initial impact of higher volatility on the trade balance is only negative when volatility has exceeded its threshold. Overall therefore, this thesis provides evidence that high oil price volatility propagates the effects of oil price volatility shocks on the trade balance and makes the effects of oil price level shocks more dramatic. Unlike the findings of studies on economic growth however, volatility does not induce asymmetries in the effects of oil price level shocks on the trade balance. The findings also show that trade volumes are more affected by reduced oil price volatility than increased volatility. This could be because volatility is the norm in the oil market, such that it is increased stability that signals a favourable global economic condition and stimulates trade. Indeed, the findings indicate that higher oil price stability stimulates trade in both oil and nonoil goods.

In examining how real exchange rates influence the effects of oil prices on the trade balance, this thesis used bilateral panel data on 8 SSA countries -3 oil exporters, 4 oil importers- and 11 major trading partners. Theoretically, Bodenstein et al. (2011) showed that exchange rate adjustments enable the nonoil trade balance to respond to oil price increases in a way that partly offsets the response of the oil trade balance, potentially leaving the overall trade balance unchanged. In other words, the real exchange rate could help in limiting the effects of oil prices on the overall trade balance. If this prediction holds, then it is possible for economies to limit the response of their trade balances to oil shocks through exchange rate management. This thesis tested this theory by employing the Pesaran (2006) Common Correlated Effects Mean Group (CCEMG) estimators. These estimators are ideal for two reasons: first, they allow heterogeneous impacts of oil prices and bilateral exchange rates to be examined for each country vis-à-vis each trading partner; second, they address the problem of unobserved common effects in panel data. Both issues have been ignored in previous studies on the oil price-trade balance relationship. It was found that on aggregate, SSA countries are predominantly unaffected by oil prices both in the long run and short run. However, individual specific bilateral estimates show heterogeneous oil price impacts, with positive and negative effects for both oil importers and exporters. The effects are however predominantly positive even for the oil importers. It was found that, for bilateral trade balances where the oil price effect is positive, subsequent real exchange rate changes are unlikely to further influence traded quantities, such that appreciations have positive effects and depreciations have negative effects on the trade balance. Conversely, where the oil price effect on the trade balance is negative, subsequent depreciations succeed in improving the trade balance, and appreciations deteriorate it. Thus, a deteriorating trade balance is more likely to be governed by the Marshall Lerner condition. Consistent with these findings, the results also showed that bilateral exchange rate depreciations tend to reduce both the positive and negative effects of oil prices on the trade balance, while appreciations reinforce these effects. The insignificant aggregate effects of oil prices for both oil exporters and importers, along with the predominantly positive bilateral impacts for oil importers, indicate a highly responsive nonoil trade balance, potentially due to the trade characteristics of these countries, and their low level of integration in international financial markets. The latter factor has been shown to limit consumption smoothing opportunities and necessitate a large nonoil trade adjustment to offset the effects of oil prices on the oil trade balance (Bodenstein et al., 2011).

Motivated by these findings, the third contribution of the thesis was to explicitly investigate the role of international financial integration in determining the response of the trade balance to oil prices. Theoretically, Bodenstein et al. (2011) have shown that with a given oil trade response to oil prices, the higher the level of international financial risk sharing, the lower the response of the nonoil trade balance, and thus the higher the effect of oil prices on the overall trade balance. This is so because higher international risk sharing means that oil importers can borrow from abroad to smooth consumption when the oil price is high, such that they do not require a large nonoil trade surplus to finance their oil trade deficit. In the same way, oil exporters can save oil revenue windfalls abroad rather than increasing spending on nonoil imports, again limiting the response of the nonoil balance. To investigate this prediction, this thesis employed annual data on the oil, nonoil and overall trade balances of 37 SSA countries- 8 oil exporters and 29 oil importers. The focus of the analysis was twofold: first, to examine whether the level of international financial integration matters for the transmission of oil shocks; and second, to determine how much financial integration is needed for economies to avoid large nonoil balance fluctuations. Accordingly, this thesis again uses a threshold modelling approach. The Panel Smooth Transition Regression (PSTR) model of Gonzalez et al. (2005) is employed because it allows heterogeneous effects of oil prices for all countries depending on their levels of financial integration, and it is best suited to the data structure compared to other panel threshold models. It was found that SSA oil importers with levels of financial integration below the estimated thresholds have to sustain large fluctuations in their nonoil trade balances when the oil price rises, but those above the threshold are less affected. For SSA oil exporters, the results were unstable and not robust to alternative model specifications, probably due to the small sample size. The main implication therefore is that, in line with Bodenstein et al. (2011), SSA oil importers will benefit from increasing financial openness. This will allow them greater access to foreign capital and increase nonoil consumption smoothing opportunities.

Overall, the findings of this thesis have important policy implications for SSA countries. The results from examining the role of oil price volatility show that decreases in oil price volatility tend to increase both oil and nonoil trade for Nigeria, suggesting that increased oil price stability is important for investment and consumption expenditure. Also, the results suggest that policy makers only need to be concerned about rising oil price volatility if it occurs in an already volatile environment. From investigating the role of real exchange rates, it was revealed that for the major Sub-Saharan Africa countries, bilateral exchange rate devaluation can be used as a policy tool to cushion negative effects of oil prices on the trade balance. However, where the bilateral trade balance is improved by oil price changes, exchange rate changes cannot be relied upon to reduce trade imbalances. The results also suggest that for these countries, the nonoil trade balance is likely to be the most responsive to oil prices, partly due to their limited access to foreign funds. Indeed, for oil importers, it was found that low levels of financial integration necessitate a large nonoil adjustment in response to oil price increases. If this is to be avoided and consumption smoothed, greater financial openness is needed for these countries. Increased openness, however, comes with the potential risks of exposure to global income and financial shocks. A careful risk-benefit analysis may therefore be necessary.

This thesis has also opened up new avenues for future research. For instance, theoretical models of the effects of oil price volatility on the trade balance should take into account the underlying volatility environment, as the findings of this thesis have shown that a threshold level of volatility is important. Second, a deeper investigation into the influence of real exchange rate adjustments in the transmission of oil shocks is necessary, preferably using oil and nonoil bilateral trade data. This would provide better insight into the role of exchange rates in this context. Third, more empirical studies are needed, for example using global data, to establish threshold levels of financial integration beyond which its consumption smoothing role becomes apparent. This would serve as a yardstick for developing countries seeking to limit their exposure to oil shocks. A study into whether the benefits of increased financial integration outweigh the potential risks of exposure to global shocks is also worthy of future research. Finally, since all the three issues investigated have not been examined for other countries, it will be fruitful to address the same questions for other economies. This will not only facilitate comparison but will also yield policy implications for these countries.

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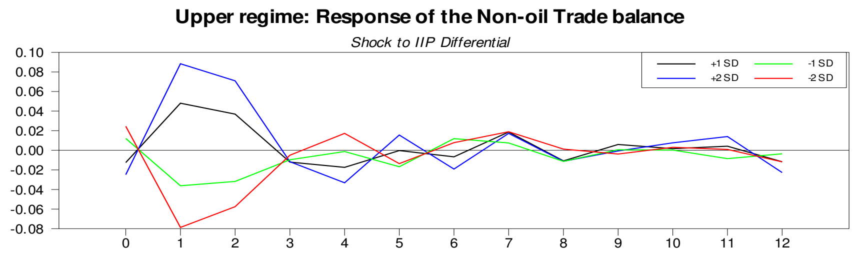
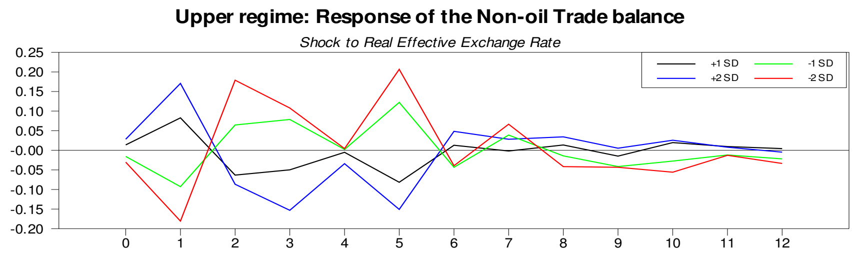
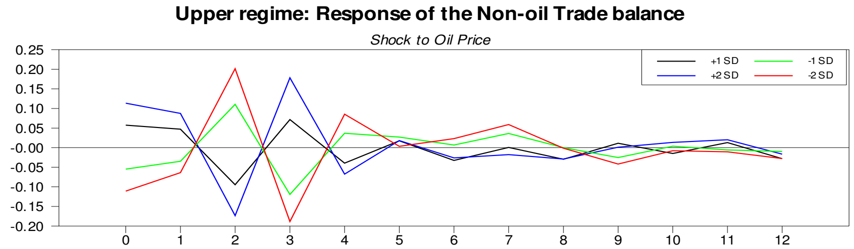
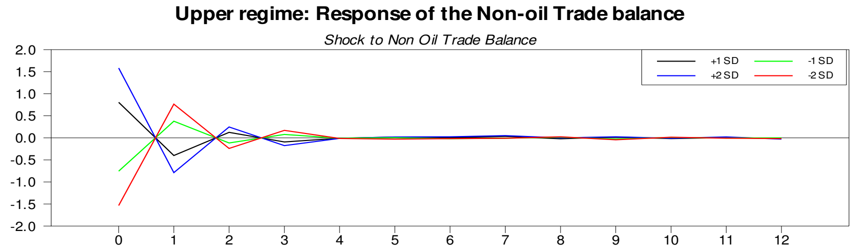
Appendices:

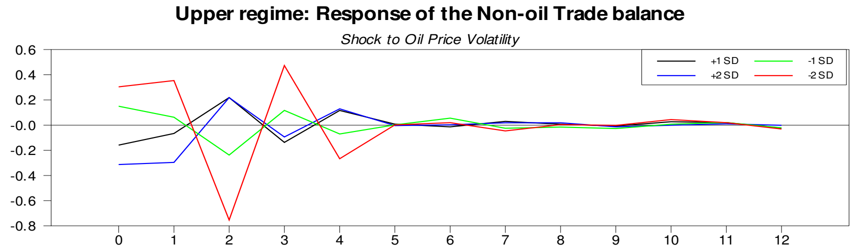
Appendix A: Response of Nigeria's Nonoil, Oil and Overall Trade Balances to shocks- Conditional on Volatility Regimes:



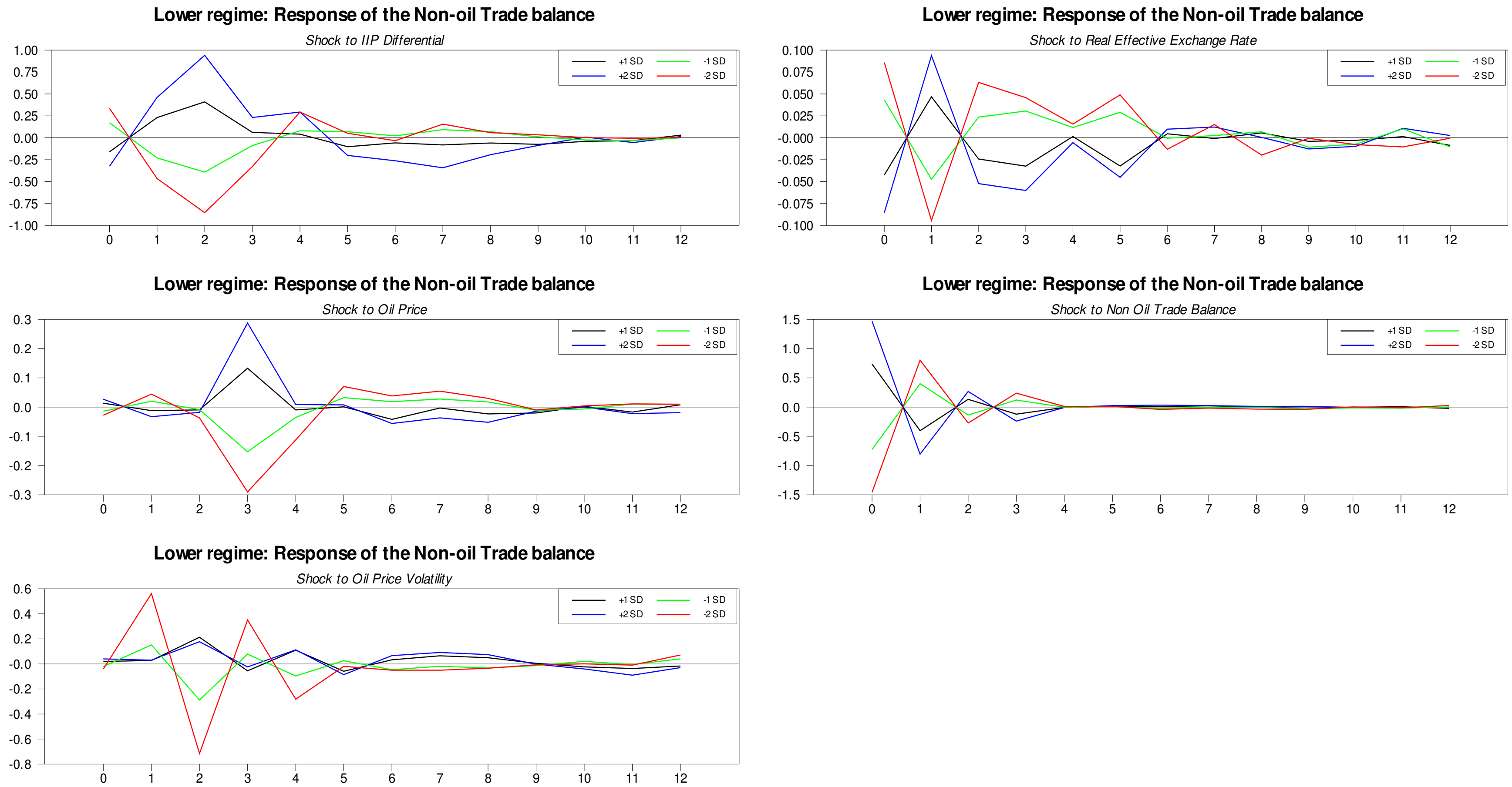








Response of the Non oil Trade Balance to Shocks,Conditional on Volatility Regime(Standard deviation)



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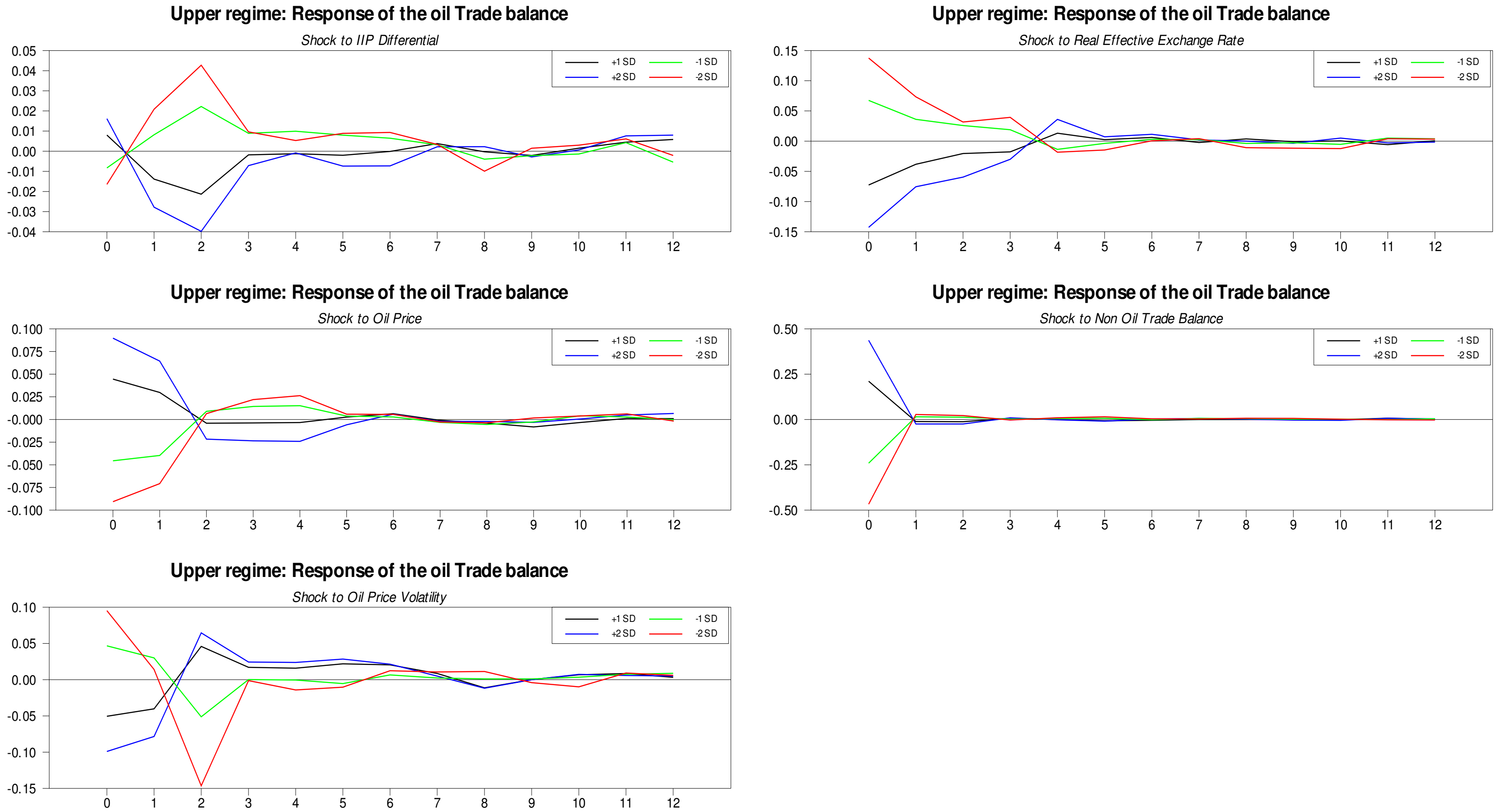

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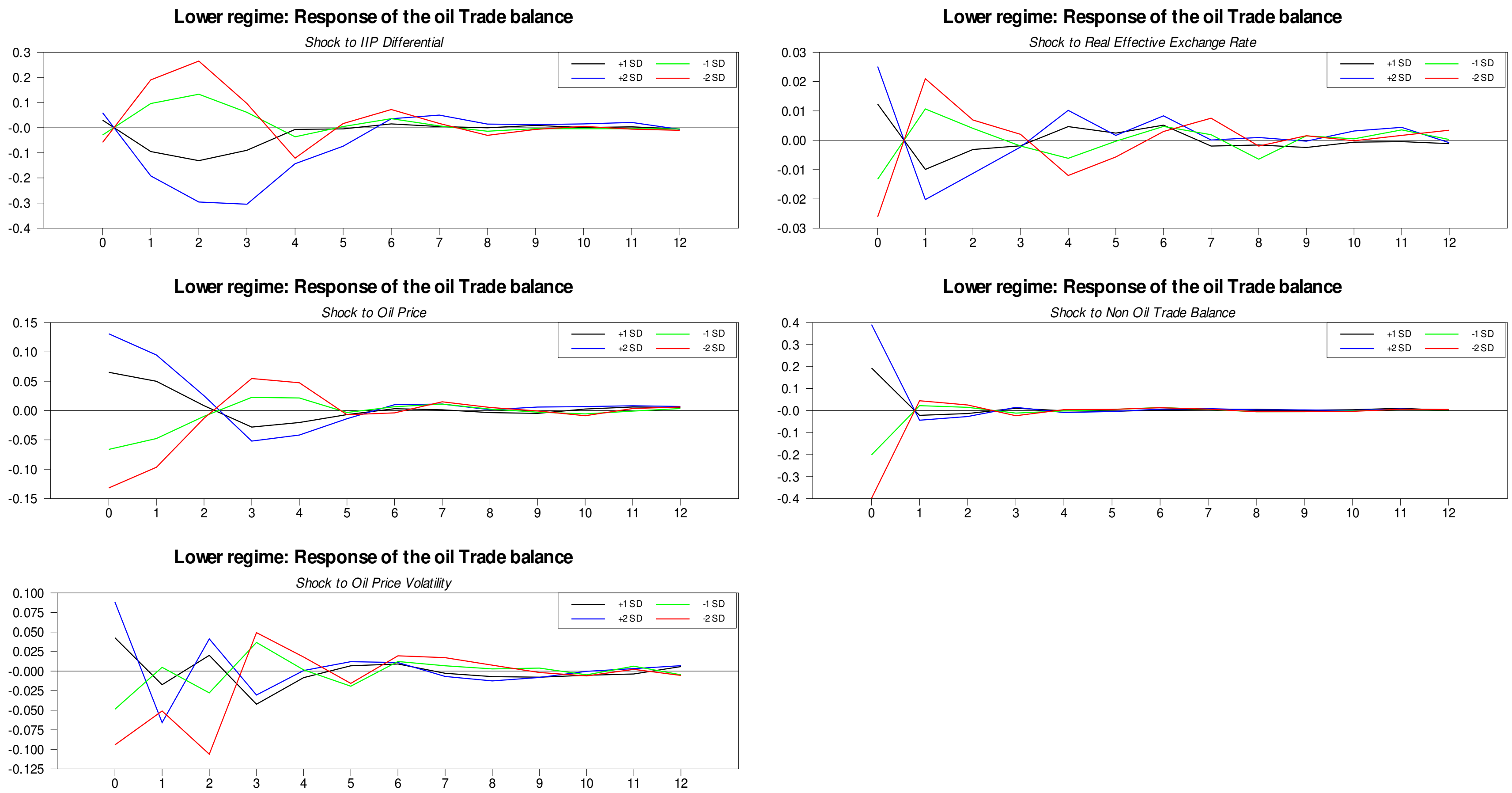
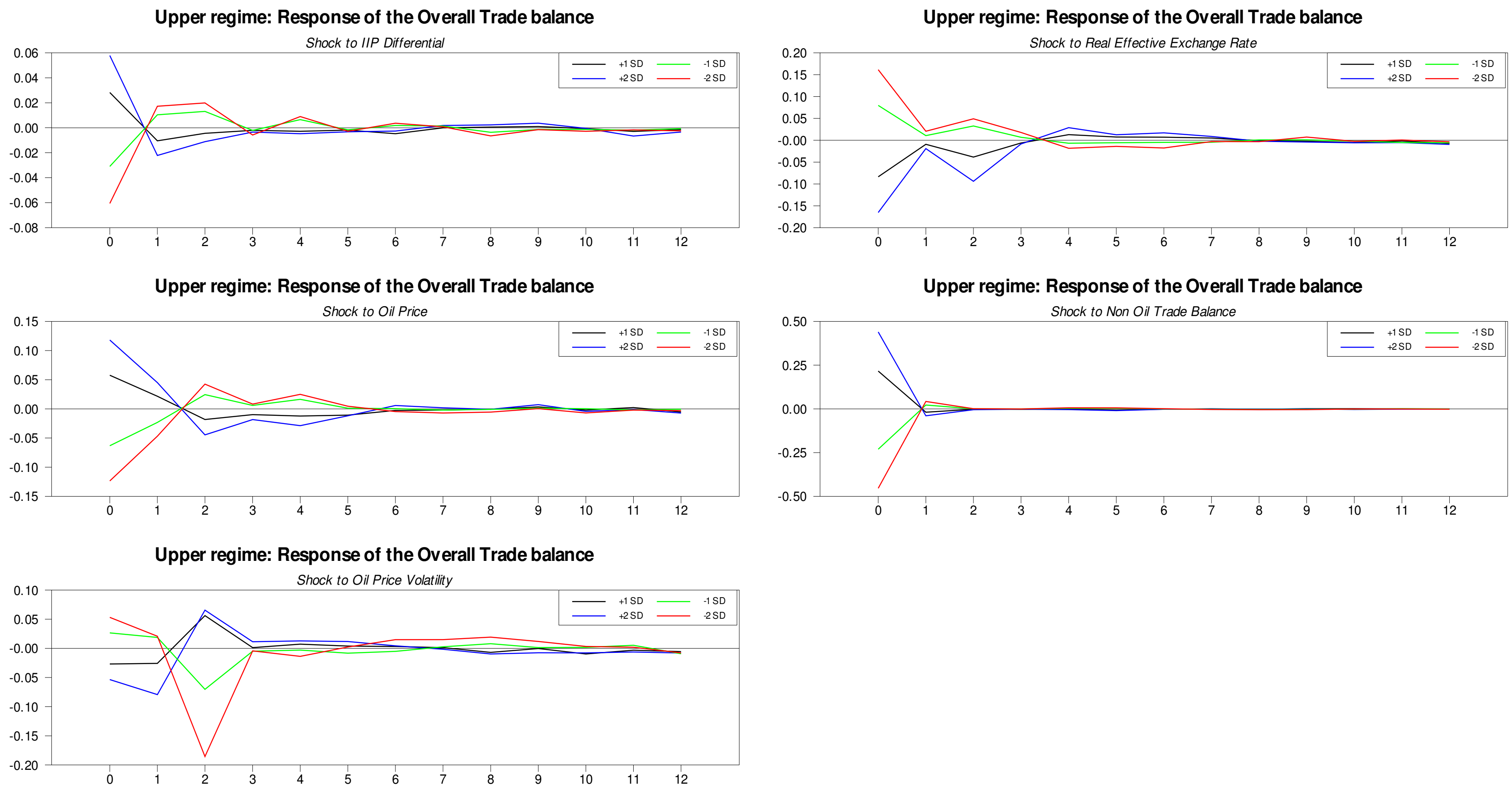
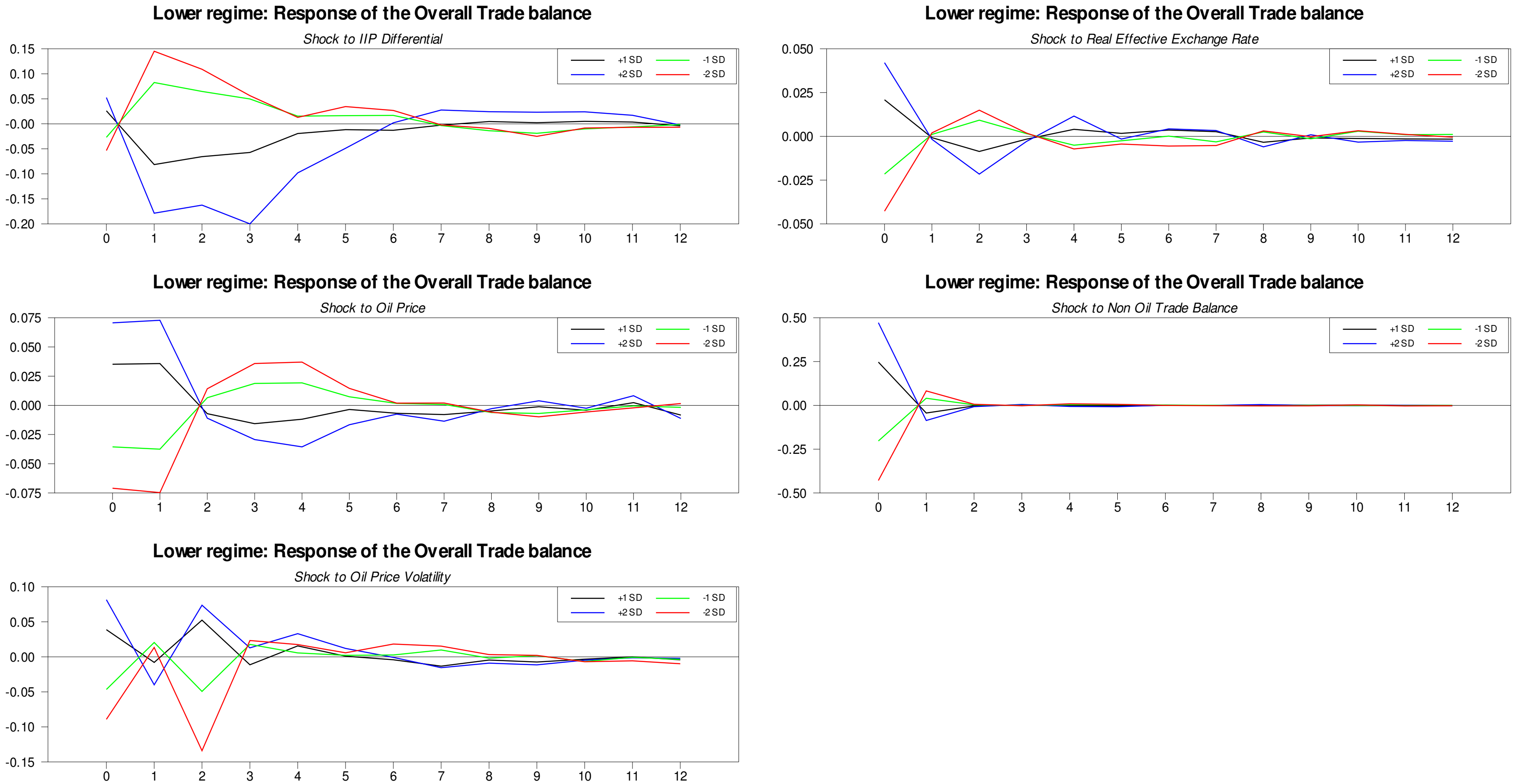


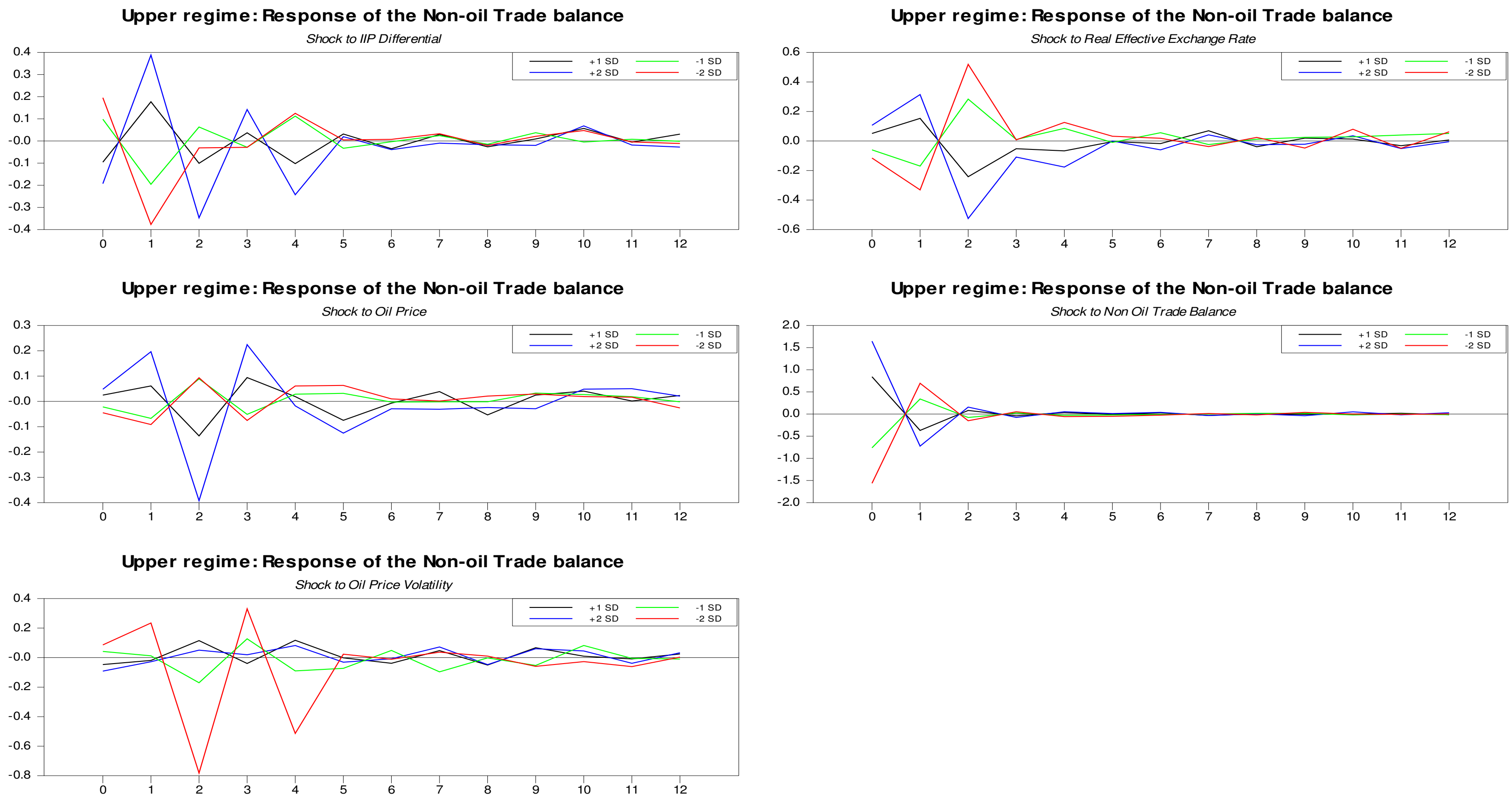
Response of the oil Trade Balance to Shocks,Conditional on Volatility Regime(Standard deviation)



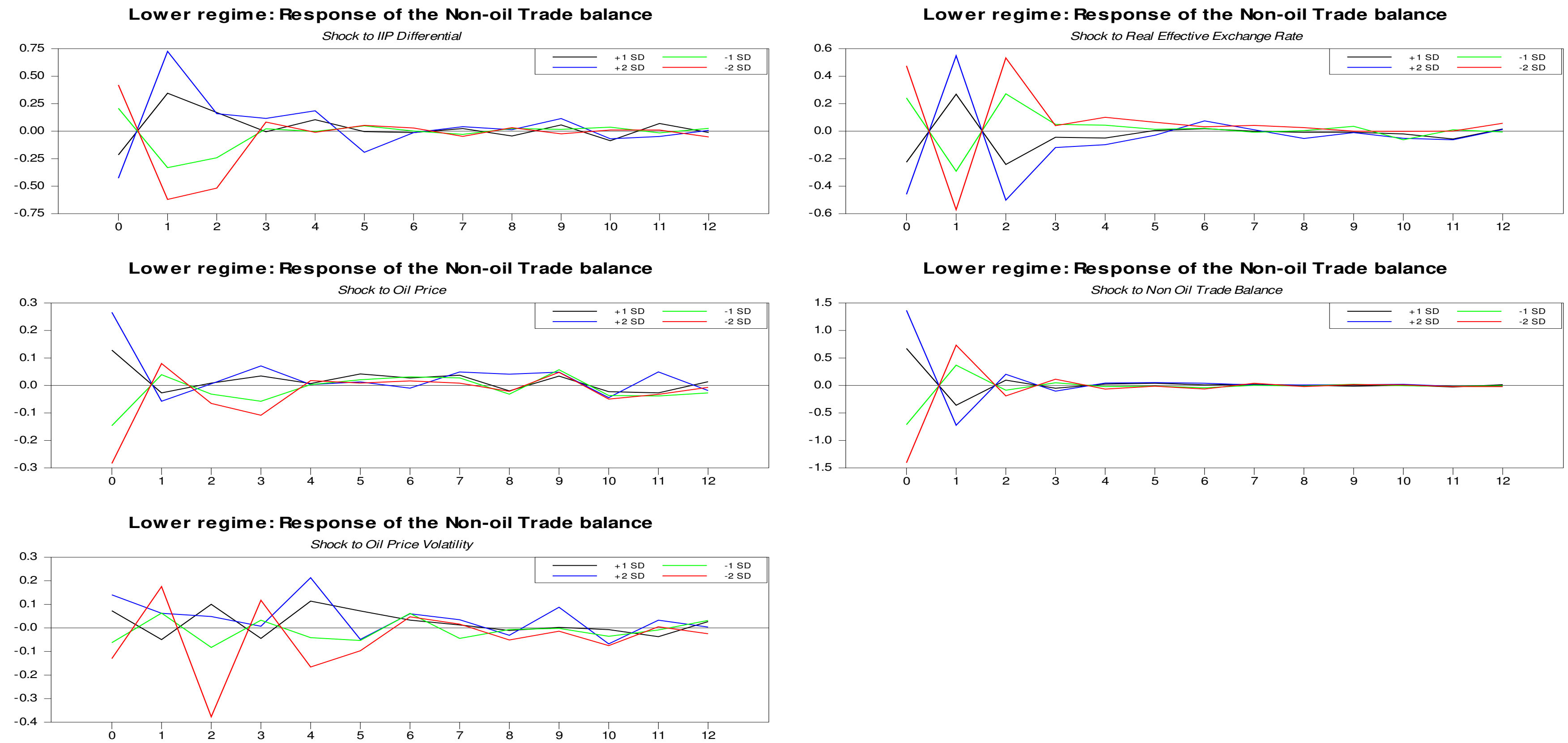
Response of the Overall Trade Balance to Shocks,Conditional on Volatility Regime(Standard deviation)



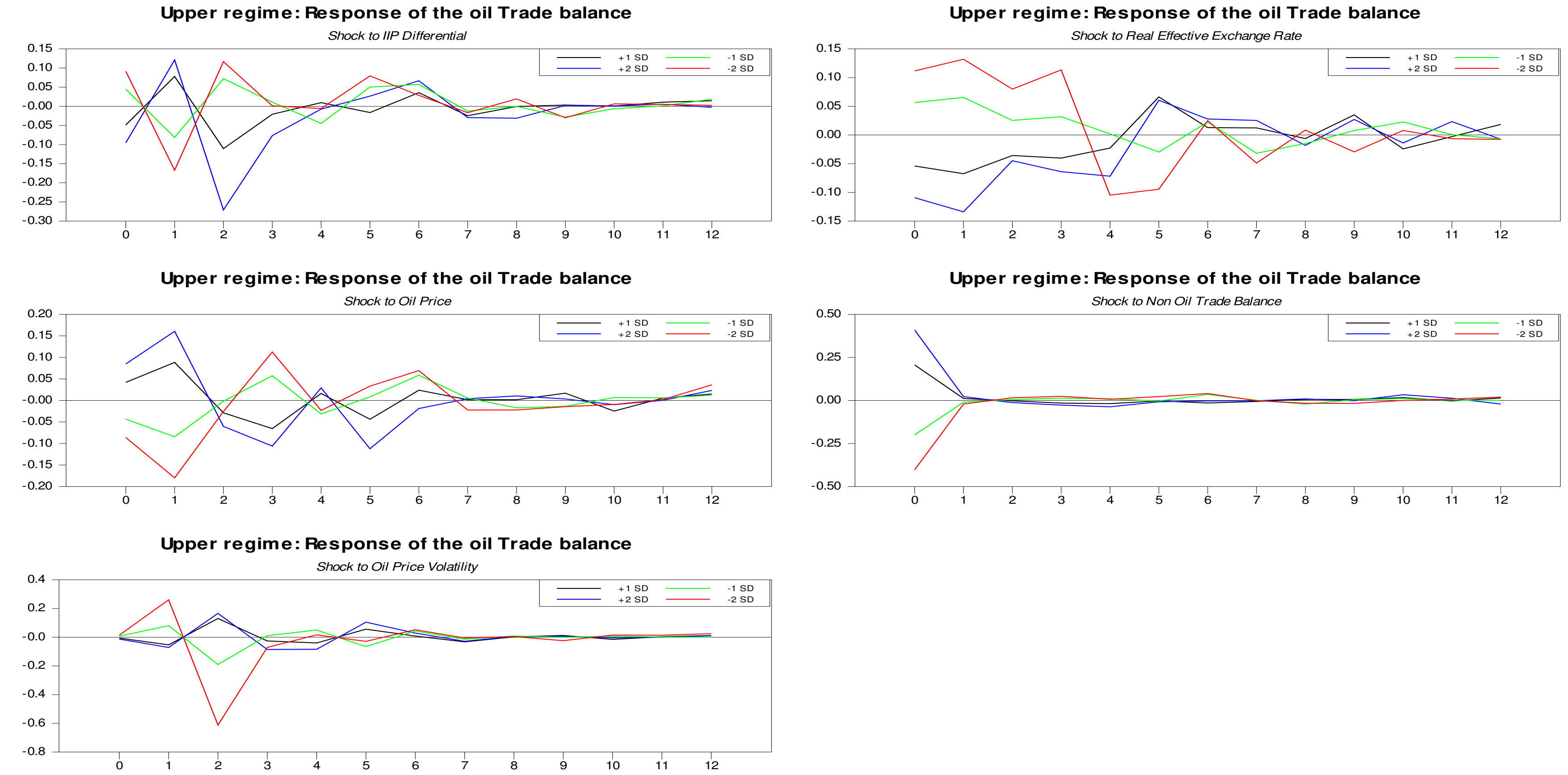
Response of the Overall Trade Balance to Shocks,Conditional on Volatility Regime(Standard deviation)



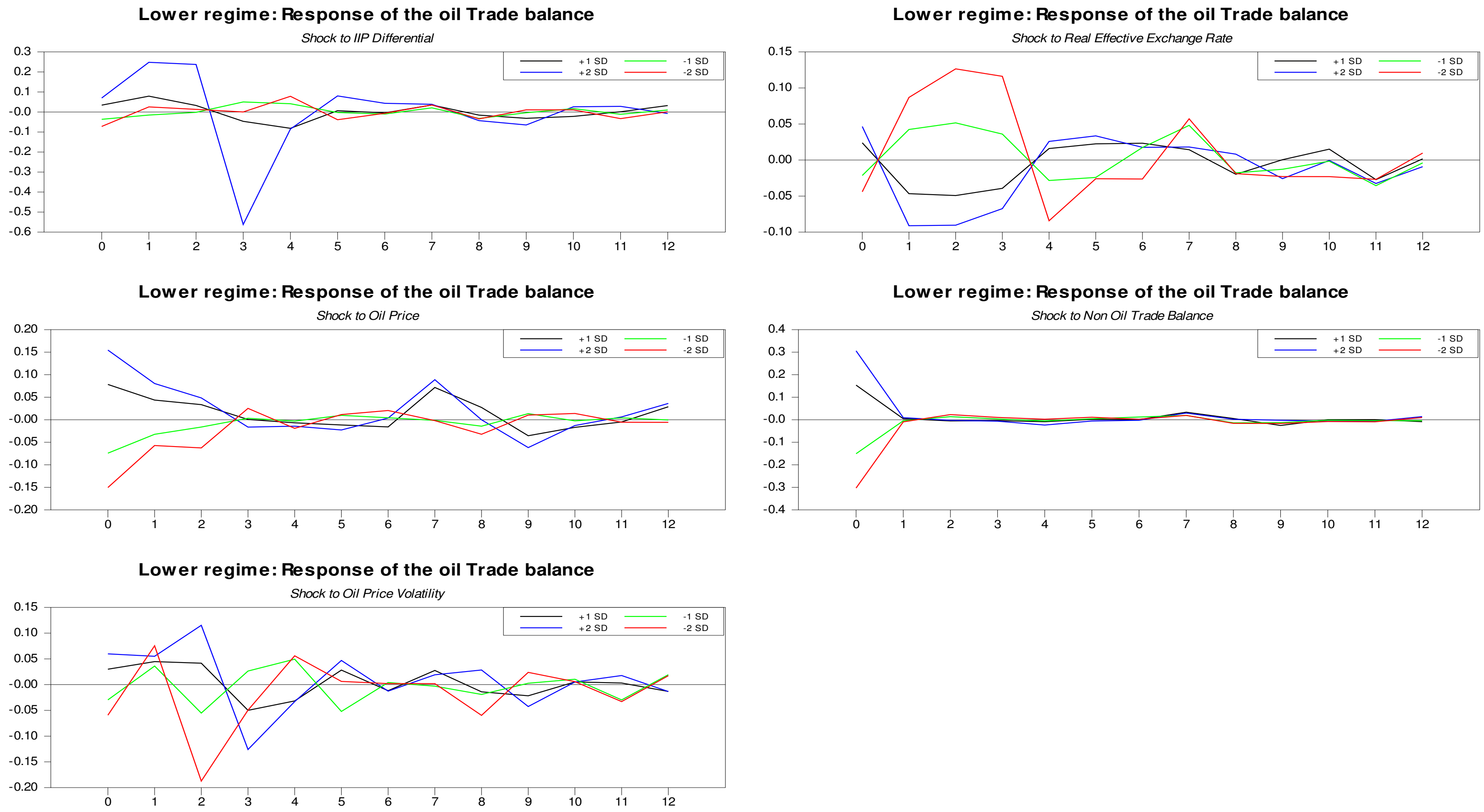
Response of Non Oil Trade Balance to Shocks, Conditional on Volatility Regime- (GARCH)



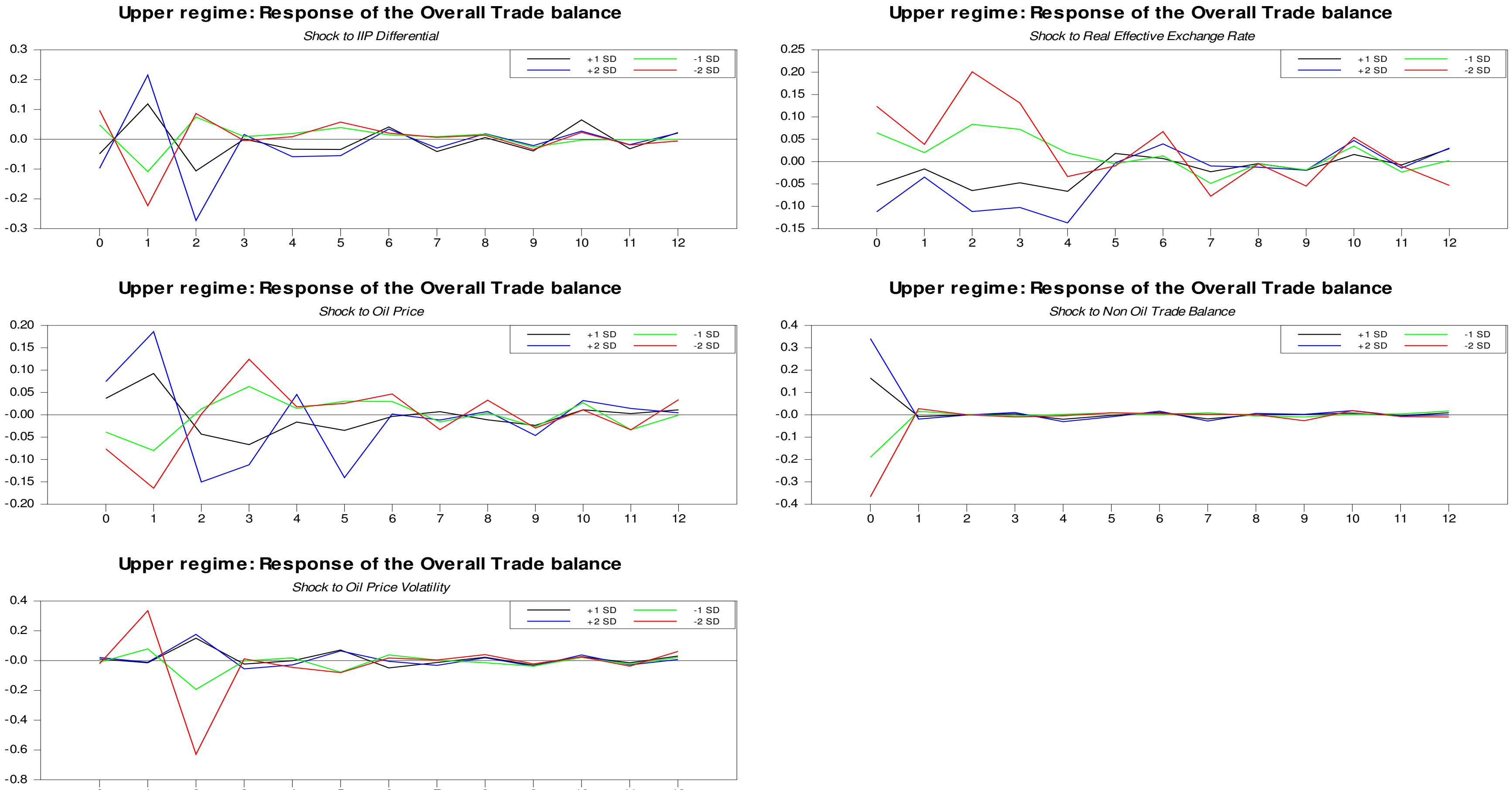
Response of Non Oil Trade Balance to Shocks, Conditional on Volatility Regime- (GARCH)



Response of the oil Trade Balance to Shocks, Conditional on Volatility Regime-(GARCH)



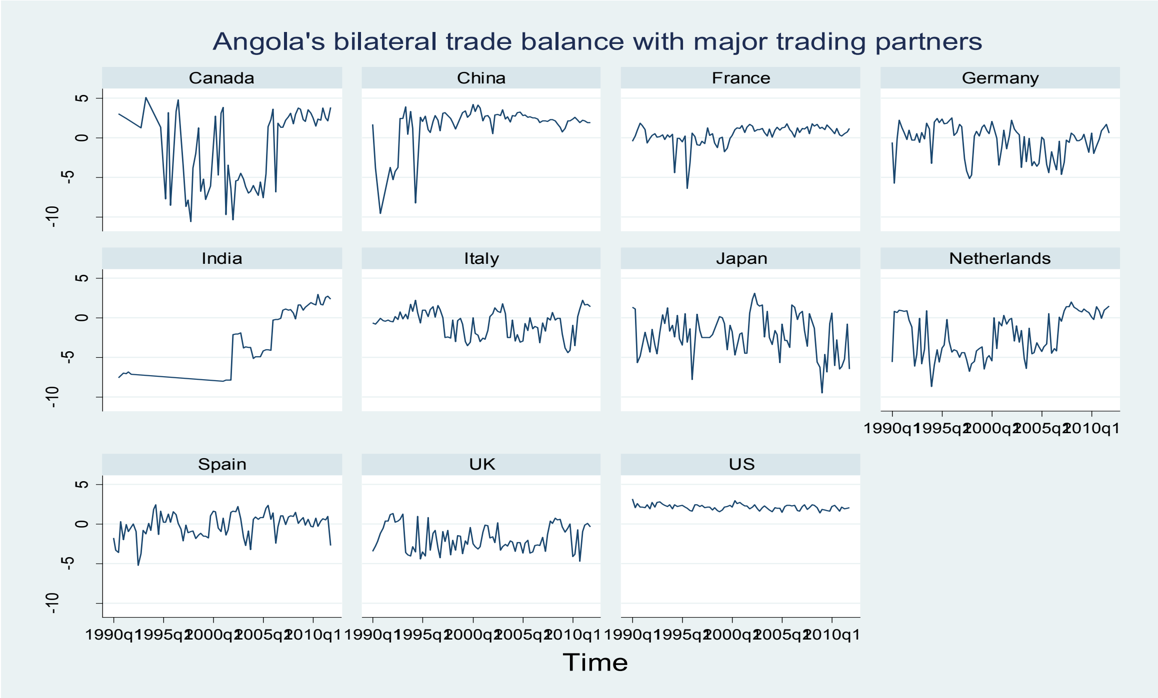
Response of the oil Trade Balance to Shocks, Conditional on Volatility Regime- (GARCH)



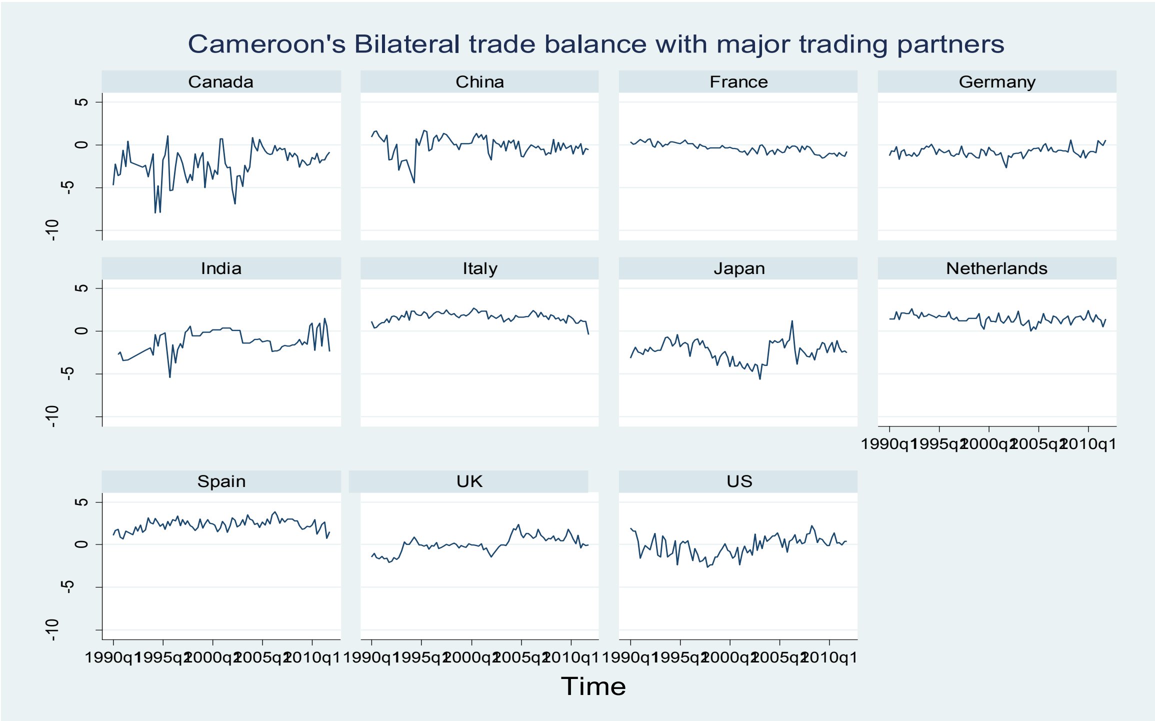
Response of the Overall Trade Balance to Shocks, Conditional on Volatility Regime- (GARCH)

Response of the Overall Trade Balance to Shocks, Conditional on Volatility Regime- (GARCH)

Appendix B: SSA countries and their bilateral trade balances with major trading partners:



Source: Author's Calculations using data from International Monetary Funds' Direction of Trade Statistics.



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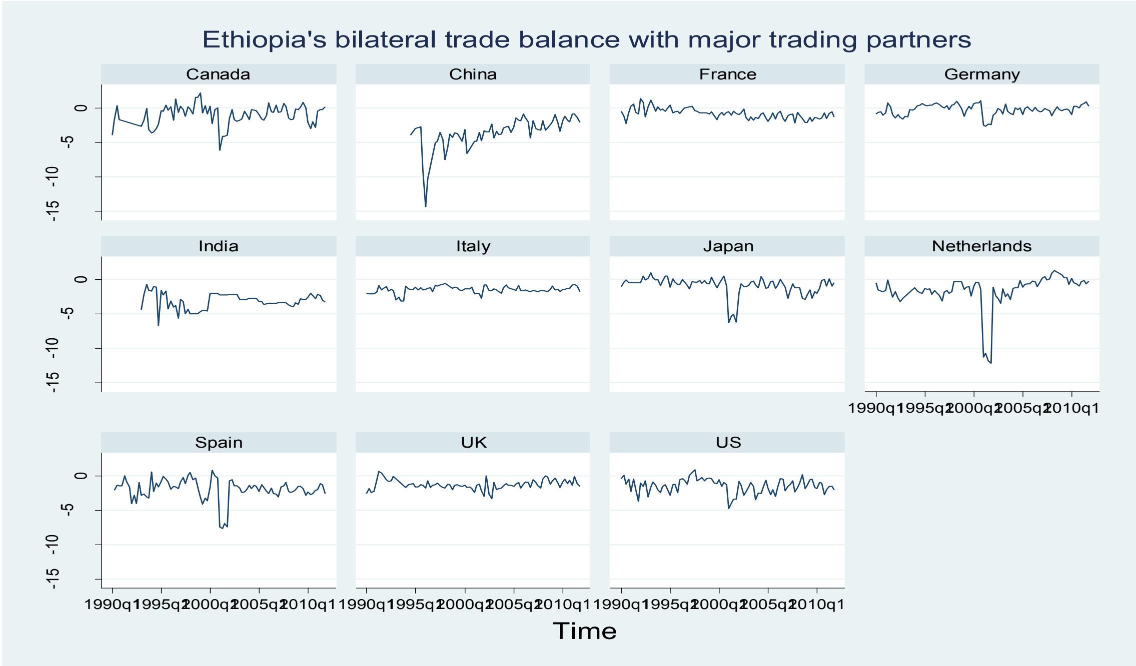

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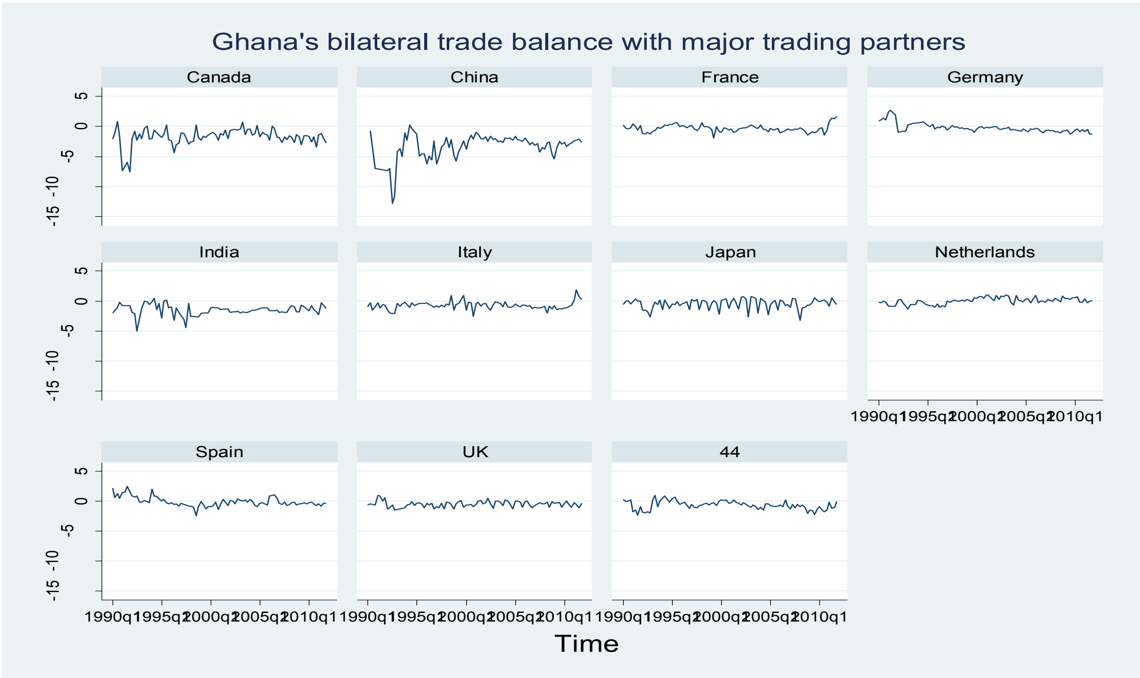

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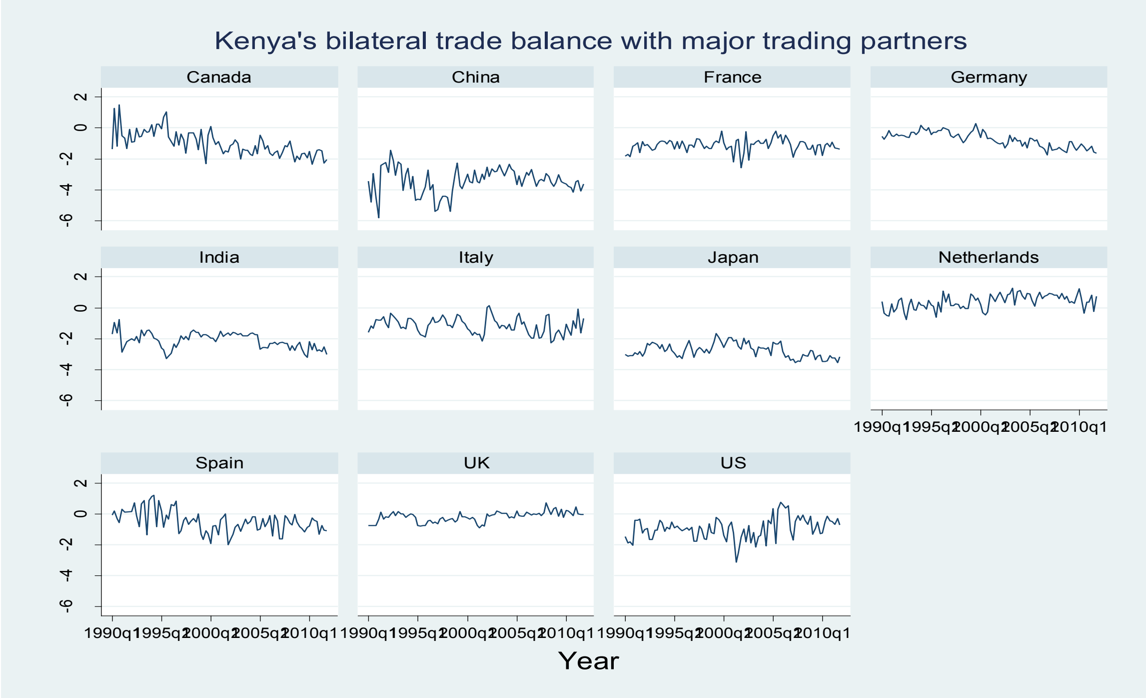
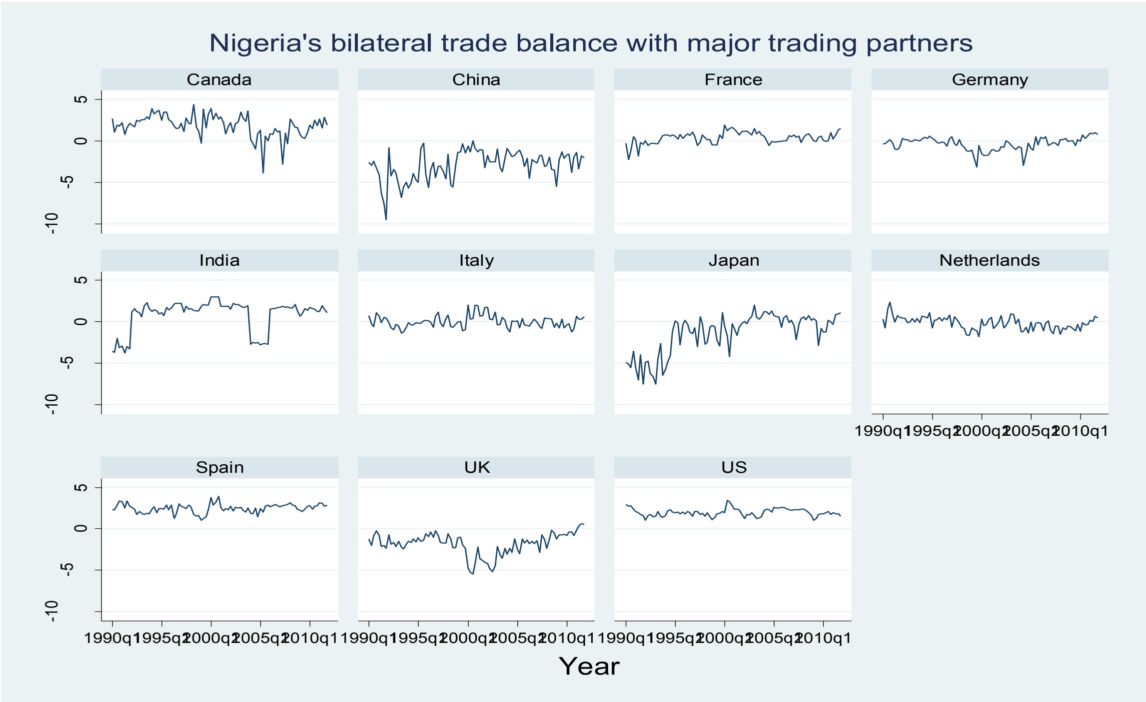


Source: Author's Calculations using data from International Monetary Funds' Direction of Trade Statistics.



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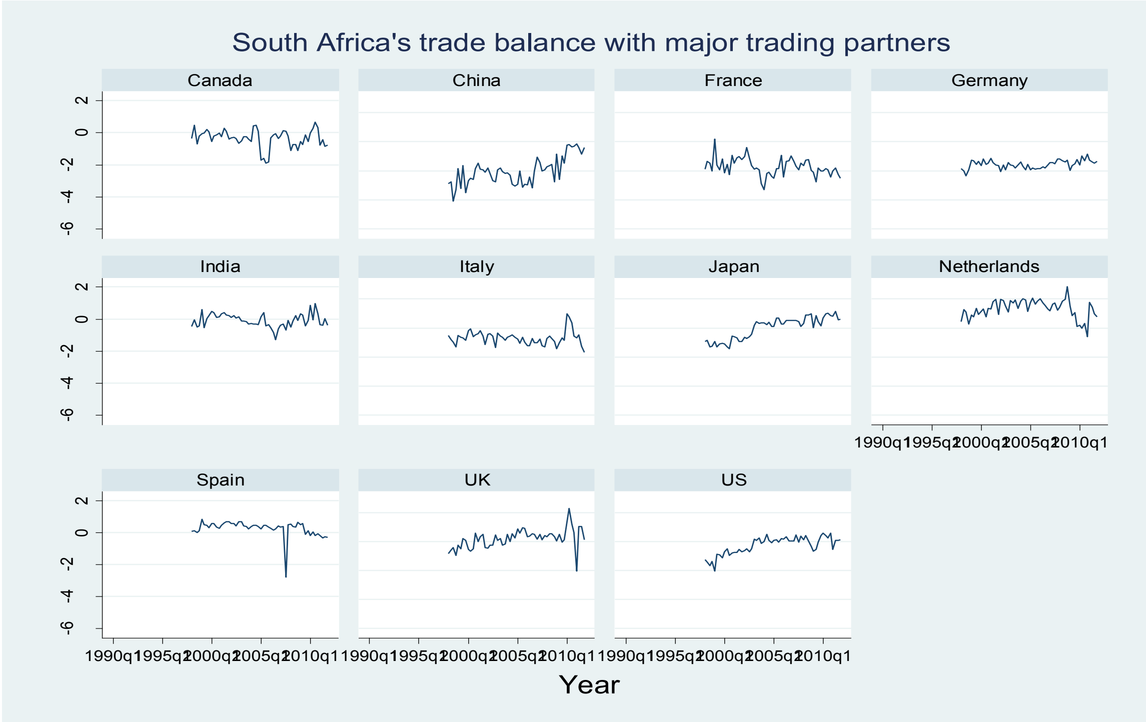

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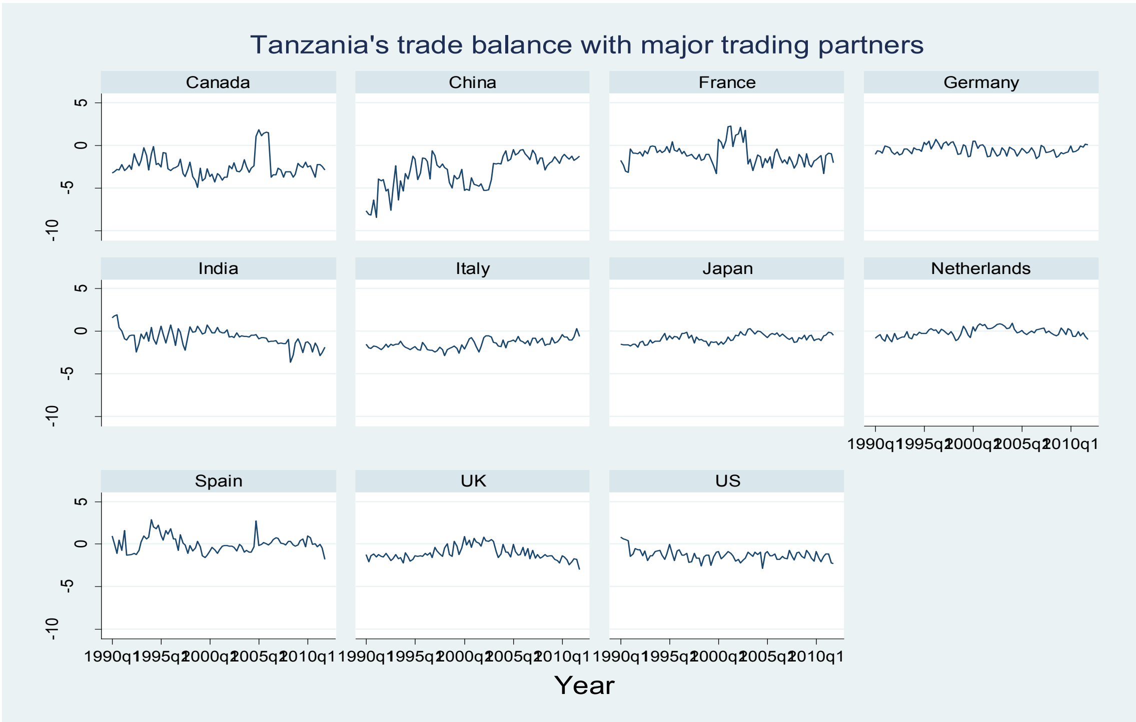

Source: Author's Calculations using data from International Monetary Funds' Direction of Trade Statistics.

Appendix C: Descriptive Statistics

	Angola				Cameroon			
	mean	SD	min	max	mean	SD	min	max
Trade Balance	-.016111	2.060801	-13.47279	10.82011	.0067863	.9401589	-6.904539	6.158983
RER	.0103856	.4999176	-1.330062	7.193141	.0204803	.316244	-.1969948	7.57404
Real Oil Price	.0069381	.424199	-1.252226	1.299446	.0171655	.1557313	-.7095728	.418601
Foreign Income	.0071508	.0086834	-.0264969	.0373459	.0070882	.0084562	-.0264969	.0373459
Domestic Income	.0165173	.0276826	-.1097374	.0558243	.0063418	.0070178	-.0144844	.0126858
Observations	795				923			

	Ethiopia				Ghana			
	mean	SD	min	max	mean	SD	min	max
Trade Balance	.0033985	1.171595	-9.846349	11.04876	.0048547	.9147921	-5.824139	7.433585
RER	.0235097	.3278264	-.2977157	7.525371	.0218146	.308352	-.1952667	7.485463
Real Oil Price	.0213204	.1717651	-.6500229	.8220717	.0180779	.1631681	-.664416	.4627022
Foreign Income	.0068349	.0080847	-.0264969	.0373459	.007232	.0084995	-.0264969	.0373459
Domestic Income	.0142623	.0170214	-.0411644	.0552158	.0135467	.006676	.0050945	.0457954
Observations	893				947			

	Kenya				Nigeria			
	mean	SD	min	max	mean	SD	min	max
Trade Balance	-.0025567	.5836638	-2.430815	3.385756	.0197573	1.02238	-5.11513	8.622837
RER	.0076307	.3106623	-.2669356	7.493796	.0132211	.4068748	-.4277097	8.85859
Real Oil Price	.0038576	.1671712	-.6913333	.4598918	.0094357	.2218769	-.6105766	1.355754
Foreign Income	.0073072	.008587	-.0264969	.0373459	.0072828	.0085418	-.0264969	.0373459
Domestic Income	.0076421	.005936	-.0038319	.0216751	.0132611	.0184495	-.0154438	.1079197
Observations	946				953			

	South Africa				Tanzania			
	mean	SD	min	max	mean	SD	min	max
Trade Balance	.00321	.3705764	-3.155076	3.25893	-.0017695	.8098516	-5.202265	4.508404
RER	.0285751	.3876653	-.23476	7.532501	.0150131	.3059141	-.2344995	7.413122
Real Oil Price	.0305131	.1471437	-.6120074	.2913617	.0109711	.1682127	-.6623492	.4339528
Foreign Income	.0070852	.0090504	-.0264969	.0373459	.0073693	.0086276	-.0264969	.0373459
Domestic Income	.0083142	.0052152	-.0110207	.0137978	.0123577	.0054623	.000761	.0197849
Observations	605				955			

Appendix D: Price Elasticities of Oil Demand for Sample SSA Countries.

Pooled mean group estimation of the price elasticity of demand for oil - 1990-2011

Oil Importers- Ethiopia, Ghana, Kenya & Tanzania

Long run estimates	
Real Oil price	-0.0645*
	(-1.73)
Real GDP	1.271***
	(14.30)
Short run estimates	
Error correction	-0.507**
	(-3.05)
Real oil price	0.0859***
	(2.61)
Real GDP	-0.641
	(-1.45)
Constant	-2.248*
	(-1.85)
N	105

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Oil exporters- Angola, Cameroon & Nigeria

Long run estimates	
Real Oil price	-0.0675
	(-0.71)
Real GDP	0.0599
	(0.46)
Short run estimates	
Error correction	-0.222
	(-0.78)
Real oil price	0.0255
	(1.49)
Real GDP	0.296***
	(3.50)
Constant	1.201
	(0.89)
N	63

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: The sample consists of the countries examined in Chapter 4. All variables are in natural logarithmic terms. The dependent variable is oil consumption, thousands of barrels per day, obtained from the United States Energy Information Agency database. The real oil price and real GDP data are from the IMF IFS. All data are annual from 1990-2011. The oil demand equation estimated is:

$$lnD_{it} = \propto_i + \delta lnD_{i,t-1} + \beta_1 lnROP_{i,t} + \beta_2 lnGDP_{i,t} + \varepsilon_{i,t}$$

Where D, ROP and GDP are oil consumption, real oil price, and real domestic GDP respectively. This oil demand equation is frequently used to estimate price and income elasticities – See Cooper (2003) ,Jobling and Jamasb (2015) and references therein.

Appendix E- Unit Root Tests:

Variable	IPS Test statistic	MW test statistic	CIPS test statistic
Ln(ttb)	-3.914***	51.344	-0.849
	(0.000)	(0.979)	(0.198)
Ln(ntb)	-3.774***	206.129***	0.571
	(0.000)	(0.000)	0.716
TTB	-1.692**	99.986**	-2.210**
	(0.045)	(0.024)	(0.014)
NTB	-2.573***	129.884***	-2.596***
	(0.005)	(0.000)	(0.005)
OTB	-3.634***	158.934***	-3.8181***
	(0.000)	(0.000)	(0.001)
Ln(fint)	-1.368*	73.173	-1.391*
	(0.086)	(0.505)	(0.082)
Ln(tot)	-1.25	62.975	0.094
	(0.450)	(0.816)	(0.537)
Ln(gdpdiff)	2.496	63.372	2.981
	(0.994)	(0.94)	(0.999)
Ln(roilp)	-2.184**	80.184	26.228
	(0.014)	(0.291)	(1.000)
Ln(rer)	1.275	70.928	0.680
	(0.899)	(0.580)	(0.752)

Notes: All tests have the null hypothesis that the series have unit toots, against the alternative of stationary series. A time trend is included in all tests and the number of lags that minimises the AIC is selected. IPS test statistic is the Im et al. (2003) Z statistic. CIPS is the test for unit roots in heterogeneous panels which allows for cross-section dependence by augmenting ADF tests with cross sectional averages of the individual series, as proposed by Pesaran (2007). MW combines the p-values from N independent unit root tests, as developed by Maddala and Wu (1999). The tests are conducted for the full sample with N=37, T=21.

Appendix F- Data sources

Variable	**Source**
Oil exports and imports, Billions of US $	IMF WEO
Total exports and imports, Billions of US $	IMF DOTS
Nominal US$ exchange rates	IMF IFS
Consumer Price Indices	IMF WEO
World and domestic GDP in constant 2005 US $	WDI
Nominal GDP, Billions of US $	WEO
Terms of Trade index	WDI
Total assets and Liabilities, Millions of US $	Updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007)
Oil price	IMF IFS

Notes: IMF- International Monetary Fund; WEO- World Economic Outlook; DOTS- Direction of Trade Statistics; IFS- International Financial Statistics; WDI- World Bank's World Development Indicators

Appendix G- List of sample countries:

Oil Importing SSA countries	Oil exporting SSA countries
Benin	Angola
Botswana	Chad
Burkina Faso	Democratic Republic of Congo
Burundi	Republic of Congo
Cabo Verde	Equatorial Guinea
Central African Republic	Gabon
Comoros	Nigeria
Ethiopia	Sudan
Ghana	
Guinea	
Guinea Bissau	
Kenya	
Lesotho	
Madagascar	
Malawi	
Mali	
Mauritania	
Mauritius	
Mozambique	
Namibia	
Niger	
Rwanda	
Seychelles	
South Africa	
Swaziland	
Tanzania	
The Gambia	
Uganda	
Zambia	

Notes: Countries are those that have at least 75% of observations on all relevant variables over the 1990-2010 period. Oil exporters are those that have average oil exports at least 15% of total exports; and oil imports less than 100% of oil exports.

Appendix H: Grouping of countries by average levels of international financial integration, 1990-2011

Low average integration: Below 160% of GDP	Intermediate average integration: Between 160% and 200% of GDP	High average integration: Above 200% of GDP
Benin Botswana Burkina Faso Burundi Cabo Verde Central African Republic Chad Comoros Eritrea Ethiopia Gabon Ghana Guinea Kenya Madagascar Malawi Mali Namibia Niger Nigeria Rwanda Sierra-Leone South Africa Swaziland Tanzania The Gambia Uganda	Angola Democratic Republic of Congo Mozambique	Congo Equatorial Guinea Guinea-Bissau Lesotho Liberia Mauritania Mauritius Seychelles Sudan São Tomé and Principe Zambia

Notes: The Table groups our sample countries into high, intermediate and low integration levels based on the estimated threshold levels of integration which range from around 160% of GDP to 397% of GDP, depending on the estimated models, and on whether the dependent variable is the nonoil balance or overall balance. 200% of GDP is chosen as the cut off for high integration because the estimated thresholds are close to this figure in many cases. The grouping is done based on the average level of integration for each country over the sample period, and is intended to give an idea of the distribution of countries, on average, across regimes. However, it does not represent the countries included in any one model since countries switch between low and high volatility regimes over time depending on their level of integration during each year, and the model then uses observations on all countries in each regime.

Appendix I: Linearity tests for models when controlling for the 2008-2009 crisis.

Linearity Tests: Full sample with time dummies ($\rho - \text{values}$)

Dependent variable	Baseline model				Model with RER			
	$m = 0$	$m = 1$	$m = 2$	$m*$	$m = 0$	$m = 1$	$m = 2$	$m*$
Ln(ttb)	0.004	0.064	0.177	$m* = 1$	0.000	0.000	0.470	$m* = 1$
Ln(ntb)	0.023	0.120	---	$m* = 1$	0.000	0.024	0.281	$m* = 1$
OTB	0.336	---	---	$m* = 0$	0.757	---	---	$m* = 0$
NTB	0.031	0.045	0.011	$m* = 1$	0.018	0.018	0.036	$m* = 2$
TTB	0.066	0.277	---	$m* = 1$	0.079	0.035	0.053	$m* = 2$

Linearity Tests: Oil importers with time dummies ($\rho - \text{values}$)

Dependent variable	Baseline model				Model with RER			
	$m = 0$	$m = 1$	$m = 2$	$m*$	$m = 0$	$m = 1$	$m = 2$	$m*$
Ln(ttb)	0.002	0.400	---	$m* = 1$	0.002	0.028	0.378	$m* = 1$
Ln(ntb)	0.000	0.183	---	$m* = 1$	0.000	0.004	0.544	$m* = 1$
OTB	0.383	---	---	$m* = 0$	0.112	---	---	$m* = 0$
NTB	0.013	0.109	---	$m* = 1$	0.007	0.000	0.045	$m* = 2$
TTB	0.051	0.187	---	$m* = 1$	0.005	0.019	0.129	$m* = 1$

Linearity Tests: Oil exporters with time dummies ($\rho - \text{values}$)

Dependent variable	Model with RER and domestic real oil price				Model with RER			
	$m = 0$	$m = 1$	$m = 2$	$m*$	$m = 0$	$m = 1$	$m = 2$	$m*$
Ln(ttb)	0.173	---	---	$m* = 0$	0.489	---	---	$m* = 0$
Ln(ntb)	0.039	0.193	0.369	$m* = 2$	0.039	0193	0.369	$m* = 2$
Ln(otb)	0.953	---	---	$m* = 0$	0.953	---	---	$m* = 0$
OTB	0.976	---	---	$m* = 0$	0.953	---	---	$m* = 0$
NTB	0.004	0.031	0.36	$m* = 1$	0.016	0.012	0.104	$m* = 2$
TTB	0.172	---	---	$m* = 1$	0.276	---	---	$m* = 0$

Notes: m refers to the number of thresholds or regimes. m=0 refers to testing the null hypothesis of a linear model against the alternative of a PSTR model with two regimes. m=1 refers to testing the null hypothesis of a PSTR with two regimes against the alternative of a PSTR with three regimes. m=2 refers to testing the null hypothesis of a PSTR with three regimes against the alternative of a PSTR with four regimes. The optimal value of m, i.e. m*, is selected based on the strongest rejection of the null hypothesis. Ln(ttb) and Ln(ntb) refer to our preferred overall and nonoil trade balance measures in equations (i) respectively. OTB, NTB and TTB refer to the oil, nonoil and overall trade balances as a percentage of GDP, as in equations (ii). Note that for the oil exporter subsample, only the models that show a significant threshold are shown. Evidently the threshold is not robust to using the terms of trade in place of the real exchange rate. For the full sample and oil importer subsample, the results are significant in a similar way when using the TOT or RER in combination with the domestic real oil price. These results are available upon request.