Asymmetric Oil Prices and Trade Imbalances: Does the Source of the Oil Shock Matter?*

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October 27, 2019

Abstract

We examine the asymmetric effects of oil supply shocks, shocks to global real economic activity, and oil-specific demand shocks on the oil, non-oil and overall trade balances of a large sample of oil exporters and oil importers. Our empirical strategy accounts for endogenous oil prices, heterogeneous parameters, and error cross section dependence within a panel framework. We find that the pattern of asymmetries in the oil price-trade balance relationship depends on the source of the shock. For both oil exporters and oil importers, oil supply expansions are more important than oil supply disruptions; we discuss the role that Saudi Arabia plays in limiting the global effects of oil supply disruptions. Although increases in global demand deteriorate trade balances for oil importers and improve them for oil exporters, decreases in global demand have a similar, rather than an opposite effect. Our results corroborate the existing evidence that oil price increases only generate large global imbalances if they result from demand-side shocks; and we present new evidence that oil price decreases only benefit oil importers if they result from supply-side shocks.

JEL Classifications: C33, F41, Q43. O57.
Key Words: Asymmetry, Oil Supply, Oil Demand, Trade Balance.

* We would like to thank the Editor in charge of our paper and three anonymous referees for helpful suggestions. Corresponding author: km418@cam.ac.uk.

1. Introduction

Oil price shocks can have significant implications for macroeconomic performance because oil is necessary for most consumption and investment processes. Investigating the effects of oil shocks is particularly important given the recent fall in oil prices. This paper examines whether increases and decreases in oil supply and oil demand have asymmetric impacts on the oil, nonoil and overall trade balances of a large sample of oil exporting and oil importing countries.

Many studies have examined the effects of oil prices on the macroeconomy[1]. When the oil price collapse of 1986 failed to produce an economic boom in oil importing countries, researchers began to examine the possibility that the effects of oil prices on output growth are asymmetric, in that oil price increases are more important than decreases[2]. Apart from asymmetries, a new strand of the Oil Price Macroeconomy (OPM) literature has emphasized the importance of accounting for the sources of oil price shocks. This is because oil supply shocks and oil demand shocks have different implications for economic activity, and examining the impact of an average oil shock may be misleading (Kilian, 2009, Cashin et. al., 2014, Kilian and Murphy, 2014). In this paper, we argue that the response of external balances to asymmetric oil shocks differs for oil supply shocks and oil demand shocks.

Large global current account imbalances over the past three decades have led to a growing literature that examines how oil prices affect trade balances and how oil revenues are recycled in the global economy (Rebucci and Spatafora, 2006). This oil price-trade balance literature often distinguishes between the oil, nonoil and overall balances (Kilian et al., 2009, Bodenstein et al., 2011, Le and Chang, 2013, Allegret et al., 2015, Rafiq et al., 2016), and some studies also distinguish between the effects of oil supply and oil demand shocks (Kilian et al., 2009, Bodenstein et al., 2011, Allegret et al., 2015). However, asymmetric effects of oil prices on trade balances have received less attention. An exception is Rafiq et. al., (2016), who examine the differential effects of oil price increases and decreases on the trade balances of many countries, but do not distinguish between oil supply shocks and oil demand shocks. Their measure of an oil price change is, therefore, an average oil shock: an asymmetry in the effect of this shock may simply reflect differential impacts of supply and demand shocks on oil prices and trade balances.

This paper contributes to the literature by incorporating the sources of oil shocks in examining asymmetric effects of oil prices on external balances. This distinction is important because insights from the asymmetric OPM literature can lead us to assume that supply and demand shocks which reduce the oil price would have lower impacts than corresponding shocks that increase it. This is not necessarily the case; indeed, oil price decreases resulting from supply expansions can have large effects on the global economy, even if oil price increases resulting from supply disruptions have muted effects (see for instance Fattouh and Sen 2015; Mohaddes and Raissi, 2019; Jarrett et al., 2019). Recent studies have found asymmetric effects of oil supply and demand shocks on investor sentiment (He and Zhou, 2018) and on stock returns (Zhu et. al., 2017).

In this paper, we argue that there are valid reasons to expect asymmetries in the effects of oil supply and demand shocks on trade balances. First, an oil supply expansion can have a higher impact than a supply disruption; the latter can often be offset by counter-supply increases from other oil producers with adequate spare capacity. Second, a strong global economy can increase overall oil demand and deteriorate trade balances for oil importers, but the effects of weak global demand may depend on which countries are most affected. In particular, lower oil prices that result from a weak global economy can increase oil demand and deteriorate trade balances in oil importing countries where the economic downturn has little impact. Indeed, the emergence of China and India has diversified the global economy, so that economic recessions in developed countries is not necessarily associated with recessions in emerging markets. Third, to the extent that increases in oil-specific demand represent

[1] Kilian (2008, 2014) and Hamilton (2008, 2012) provide a review.

[2] Recent reviews of this literature can be found in Hamilton (2011) and Herrera et. al.,(2015)

precautionary oil demand driven by oil market uncertainty, a reduction in this demand merely represents oil market stability. This stability can itself increase spending on both oil and nonoil goods, deteriorating oil importers' trade balance, rather than improving it. The arguments are analogous for oil exporters.

We follow Kilian (2009) in decomposing oil shocks into three: oil supply shocks, oil demand shocks that reflect changes in global real economic activity i.e. aggregate demand shocks, and oil demand shocks that are specific to the oil market, such as precautionary or speculative oil demand. We then consider whether each of these shocks has asymmetric impacts on the oil, nonoil and overall balances of 25 oil exporters and 76 oil importers. We estimate three panel data models: Pooled Ordinary Least Squares (POLS), the Mean Group model of Pesaran and Smith (1995) and the Augmented Mean Group (AMG) model of Eberhardt and Teal (2010) and Bond and Eberhardt (2013). Our empirical strategy accounts for the endogeneity of oil shocks to the global economy, for heterogeneous responses among countries, and for Cross Section Dependence (CSD). Moreover, we estimate the degree of CSD in our data using the exponent of CSD of Bailey et. al., (2016), allowing us better judgement among alternative methods.

Our results show that the pattern of asymmetries depends on the source of the oil shock. We find strong asymmetries in the effects of oil supply shocks and shocks to global real economic activity. Whereas oil supply disruptions have muted impacts on trade balances for both oil exporters and importers, oil supply expansions have large effects. On the other hand, both increases and decreases in aggregate demand deteriorate trade balances for oil importers. Therefore, shocks that reduce the oil price have different impacts: oil supply expansions improve the oil balance for oil importers, but a fall in aggregate demand deteriorates it. These results enhance our understanding of asymmetric oil prices and have implications for policy: oil price increases only generate large imbalances if they result from demand-side shocks, and oil price declines only improve oil importers' trade balances if they result from oil supply expansions.

The remainder of this paper is organised as follows: Section 2 briefly discusses the literature on oil prices and external balances. Section 3 uses evidence from the data and literature to discuss the rationale for asymmetric impacts of oil demand and supply shocks on external balances. Section 4 discusses the methods and data. Section 5 presents the results and Section 6 provides some conclusions and policy recommendations.

2. Oil prices and external balances

Theoretically, Bodenstein et. al., (2011) build on the work of Backus and Crucini (2000) and examine the effects of oil prices on external balances using a Dynamic Stochastic General Equilibrium (DSGE) model. The model makes a distinction between the oil trade balance, the nonoil trade balance and the overall trade balance. When oil prices are high, the nonoil balance can facilitate the recycling of oil revenues from oil exporters to oil importers, helping to dampen overall trade imbalances. Bodenstein et. al., (2011) show that these effects depend on the source of the oil shock and the extent to which financial markets are incomplete: (i) oil supply shocks have lower impacts than oil demand shocks and technology shocks (ii) the higher the degree of market completeness, the lower the response of the nonoil balance.

Empirical studies on the oil price-trade balance relationship are few. Kilian et. al., (2009) considers the effects of oil supply shocks, oil-specific demand shocks and aggregate demand shocks on external balances for many countries. They find that an oil supply disruption causes a small and temporary oil price increase; an increase in oil specific demand causes an immediate, large and persistent oil price increase; and an increase in aggregate demand causes a delayed but persistent oil price increase. Accordingly, they find that, for oil importers, oil supply disruptions have muted impacts, whereas both oil specific demand shocks and shocks to global real economic activity cause large oil trade deficits. The three shocks, all associated with an oil price increase, lead to insignificant nonoil trade surpluses. The effects for oil exporters are generally analogous to those of oil importers. Le and Chang (2013) and Arouri et al. (2014) conduct country specific studies on the effects of oil prices on trade balances, but do not account for the source of oil price changes.

The studies above do not consider potential asymmetries in the effects of oil prices on the trade balance. Rafiq et. al., (2016) examines long-run asymmetric effects of oil prices on the oil, nonoil and overall balances for 28 oil exporting countries and 40 oil importing countries between 1980-2011. They find that an oil price decrease has a negative impact for oil importers and a positive impact for oil exporters. They argue that this reflects higher oil demand following an oil price fall. Since Rafiq et. al., (2016) do not differentiate between oil supply and oil demand shocks, the asymmetries they identify may be related to one shock but not the other. Indeed, as we will show, our results suggest that an oil price decrease is only detrimental to oil importers if it results from a fall in oil demand due to low global real economic activity. If the oil price fall results from an oil supply expansion, it will have the expected positive impacts for oil importers, as seen with the most recent oil price fall.

In sum, the oil price-trade balance literature has found that oil supply and demand shocks have different impacts on trade balances, but the literature has ignored potential asymmetries in these effects. Studies that consider these asymmetric effects of oil prices on the trade balance do not distinguish between oil supply and demand shocks. This paper bridges this gap in the literature by examining asymmetric impacts of oil supply shocks, oil demand shocks, and aggregate demand shocks on the trade balances of many oil exporting and oil importing countries.

3. Rationale for Asymmetric Responses of External Balances to Oil Supply and Demand Shocks

In the oil price-macroeconomy literature, the theoretical justifications for asymmetries in the effects of oil prices on output growth include the nonlinear roles of sectoral reallocation of labour and capital, of oil price uncertainty, and of monetary policy (see Herrera et. al., 2015). This literature, however, has no implications for asymmetries in the effects of oil shocks that are specific to oil supply, aggregate demand and oil market specific demand. In this section, we recount the theoretical channels of transmission of oil supply and demand shocks to the trade balance, and we use evidence from the data and implications from the empirical literature to provide potential sources of asymmetries in the effects of these shocks.

3.1. Oil Supply Shocks

The theoretical model in Bodenstein et.al., (2011) shows that, under incomplete financial markets and a low price elasticity of demand for oil, an oil supply disruption raises the price of oil and generates an oil trade deficit for oil importing countries. Since a higher oil price leads to a wealth transfer towards oil exporting countries, a supply disruption also generates a non-oil trade surplus for oil importers through higher demand for their exports by the now richer oil exporters. The impact on the overall trade balance of oil importers depends on the extent of the non-oil surplus, which is in turn determined by the degree of financial market completeness. The model predicts the exact opposite response of the trade balance of oil exporters. Other studies have also found indirect transmission mechanisms of oil shocks to the trade balance working through the level of economic activity in trading partner countries. In particular, oil exporting countries sometimes experience indirect negative effects of higher oil prices as a result of lower economic activity in their oil importing trading partners, while some oil importers benefit from oil price increases due to higher demand from their oil-exporting trading partners (see Korhonen and Ledyaeva, 2010; Taghizadeh-Hesary et al., 2013). This literature, however, has no implications for asymmetric impacts.

We argue that oil supply disruptions may have a lower effect than oil supply expansions, because an oil supply disruption from one country can be offset by increased oil production from countries with spare capacity. In practice, Saudi Arabia is the only oil producer that maintains large spare capacity which can be brought on quickly, and it often offsets supply disruptions from both OPEC and non-OPEC oil producers (Fattouh and Sen 2015; Fattouh 2014). The incentive for Saudi Arabia is to maximise both market share and oil revenues while stabilising the oil market.

Indeed, studies that explicitly model oil supply shocks have found that supply disruptions have negligible effects on the economy. Mohaddes and Pesaran (2016) find that supply disruptions from small oil producing countries have little impact on global output; Kilian (2009) and Kilian et. al., (2009) find that supply disruptions have muted effects on oil prices and external balances, and that most of the effects commonly attributed to these disruptions actually result from increases in precautionary oil demand. In addition, Fattouh (2014) shows that supply losses in the Middle East and North Africa (MENA) region during the 2011-2013 period did not affect oil prices because growth in oil supply from the U.S and Saudi made up for those losses.

By contrast, this counter-supply mechanism rarely governs oil supply expansions. Unlike for supply disruptions, there is no incentive for a single oil producer to cut supply while other producers reap the benefits. The most effective counter supply response would be a cooperative effort by *many* oil producers to cut supply, notably by Saudi-led OPEC. Historically, this has proved difficult because of a lack of internal cohesion within OPEC, the absence of a formal quota enforcement system in OPEC, and the risk of appropriation of the supply cut benefits by non-OPEC producers (Fattouh and Sen 2015). Indeed, after the early 1980s, the response of oil producers to supply expansions has been to maximise market share by expanding production, subject to capacity limits, to compensate their falling oil revenues (Mohaddes and Pesaran, 2017, Fattouh and Sen 2015). In contrast to the muted empirical effects of supply disruptions, Mohaddes and Raissi (2019) find that an oil supply expansion such as the recent US oil supply revolution has significant global macroeconomic consequences.

Figure 1 shows evidence in support of these arguments. Periods of OPEC supply disruptions, such as the 1990/1991 Persian Gulf War and the 2010/2011 Iranian sanctions, were more than offset by increased Saudi production, and periods of lower non-OPEC supply in 1989 and in 1992/1993 were offset by higher OPEC supply. By contrast, Saudi does not cut its supply during periods of OPEC and non-OPEC supply expansions, unless these periods coincide with weak oil demand or price targeting efforts by OPEC. For instance, Saudi cut supply in the early 1980s following weak demand from developed countries, in 1987 to help re-unite OPEC, in 1998/1999 during the Asian crisis, and in 2000/2001, 2006/2007 and 2009 in response to slowing US demand (see Baffes et. al., 2015 for a detailed account of these shocks). For all other periods of OPEC and non-OPEC supply expansions, Saudi either expands its own supply or leaves it unchanged.

Overall, therefore, oil supply disruptions may have lower impacts than oil supply expansions because counter-supply shocks can reduce the effects of supply disruptions, but are more difficult to achieve in the case of supply expansions.

3.2. Aggregate demand shocks

Theoretically, the transmission mechanism of aggregate demand shocks to the trade balance is quite different from that of oil specific demand and supply shocks. While an aggregate demand shock raises the price of oil and is associated with an oil trade deficit for oil importing countries, its effect on the nonoil trade balance is ambiguous (Bodenstein et. al., 2011; Kilain et. al., 2009). This is because an aggregate demand shock also provides an economic stimulus to oil importing countries, potentially leading to a non-oil trade deficit which can counteract the non-oil surplus implied by the higher price of crude oil. The opposite is true for oil exporters. In addition, indirect effects of oil price changes through trading partners (Taghizadeh-Hesary et al., 2013) may be stronger in the case of aggregate demand shocks, since these shocks have more direct implications for GDP and economic activity across countries.

Here, we argue that aggregate demand shocks can have asymmetric effects, in that both increases and decreases in global real economic activity can deteriorate trade balances for oil importers and improve them for oil exporters. Generally, global recessions emanate from globally important economies that also dominate oil demand: developed economies such as the US and EU, and emerging market economies such as China and India. The emergence of China as an important global economic player has diversified the world economy so that recessions in developed countries is not necessarily associated with recessions in emerging markets. Faced with lower commodity prices generated by a recession elsewhere, these countries can increase demand, leading to a deterioration in their trade balances.

The literature has found that the effects of global recessions across countries depend on the origin of the recession- effects are higher for countries with close economic ties to the slowing economy. For instance, it is argued that China's resilience during the GFC limited global economic contraction by reducing the exposure of countries with close economic ties to China (Roach, 2017, Cashin et al., 2017). Empirically, Cashin et. al., (2017) find that a slowdown in China's GDP growth has muted impacts on developed countries, despite increased trade links over the past few decades. Similarly, International Monetary Fund (2014) find that output shocks emanating from China, EU and US have insignificant impacts on India, just as output shocks in India do not affect these countries. It thus appears that during global recessions, some important oil importers remain rich enough to take advantage of lower oil prices by increasing oil demand.

To illustrate the heterogeneous impacts of global recessions during episodes of oil price changes, Figure 2 presents real world GDP growth, changes in the real oil price, and GDP growth in China and the US. Baffes et al., (2015) provide a historical account oil shocks associated with changes in global demand. The period of high oil prices attributed to strong global demand, 2002-2005, is also associated with strong economic growth in both China and the US. On the other hand, periods of lower oil prices associated with weak global demand are the early 1980s recession, the 1990/1991 US recession, the 1997/1998 Asian crisis, the 2000/2001 US recession, and the 2008/2009 GFC. Figure 2 shows that each period of oil price decline driven by a slower US economy is associated with very strong growth in China. Similarly, during the Asian crisis that saw one of the most dramatic fall in oil prices, the US maintained robust growth rates.

Overall, therefore, lower oil prices driven by weak global demand will have heterogeneous impacts on countries: trade balances may deteriorate for oil importers that remain rich during the global recession. Our empirical strategy accounts for this heterogeneity in estimating an average effect of lower aggregate demand for both oil importers and exporters.

3.3. Oil-Specific Demand Shocks

Theoretically, the transmission mechanism of oil-demand shocks that are specific to the oil market, such as precautionary oil demand resulting from uncertainty about a future supply shortfall, is qualitatively similar to that of oil supply shocks (see section 3.1), but this shock can lead to a more persistent oil trade deficit for oil importers (Bodenstein et. al., 2011; Kilian et. al., 2009).[3]

[3] Studies have shown that speculative oil demand played a major role in the sustained oil price increases between early 1980's and 2011 (Taghizadeh-Hesary, 2016), and also after the Global Financial Crisis, when weak US dollar exchange rates drove investors to invest in oil and other commodity markets (Taghizadeh-Hesary and Yoshino, 2014).

Oil specific demand shocks may also have asymmetric impacts on the trade balance. To the extent that an increase in oil specific demand is associated with oil market uncertainty and volatility in oil prices, as advanced by Kilian (2009), it should increase the oil price and deteriorate the trade balances of oil importers while improving those of oil exporters. If, however, a decrease in oil specific demand simply reflects lower oil market volatility and more certain expectations about future oil supply, it may not significantly lower the price of oil. In fact, lower volatility can be associated with lower precautionary savings and higher spending on both oil and nonoil goods; it encourages irreversible consumption and investment expenditure (Bernanke, 1980, Bloom, 2009, Kilian and Vigfusson 2011b). This implies that oil price increases resulting from precautionary oil demand may have a higher impact than oil price decreases resulting from lower precautionary oil demand.

Overall, therefore, the literature and data point to possible asymmetries in the effects of oil supply shocks, aggregate demand shocks, and oil specific demand shocks on external balances. We proceed to estimate these effects in the following section.

4. Methods and Data

This paper uses a two-step procedure to estimate the asymmetric impacts of oil supply and demand shocks on external balances. In the first stage, we decompose oil shocks into oil supply shocks, shocks to global real economic activity, and oil market specific demand shocks. In the second stage, we estimate the linear and asymmetric effects of these shocks on the trade balances of oil importing and exporting countries.

4.1. Decomposing oil price shocks.

To decompose the oil shocks, we follow Kilian (2009) and estimate a Structural Vector Autoregressive (SVAR) model for the real oil price using data on global crude oil production, global real economic activity and the real oil price. We use monthly data from 1974 to 2016 and estimate the following SVAR:

$$A_0 Y_t = \gamma + \sum_{i=1}^{24} A_i Y_{t-i} + \varepsilon_t \text{..... (1)}$$

Where Y_t is a vector of three variable thus:

$$Y_t = (\Delta prod_t, grea_t, rop_t) \text{............ (2)}$$

Where $\Delta prod_t$ is the percent change in global crude oil production, $grea_t$ is Kilian (2009) index of global real economic activity. Kilian (2009) derives this as the detrended average growth rates of dry cargo single voyage freight rates. It is designed to capture global aggregate demand for all industrial commodities, including oil. rop_t is the log real oil price and ε_t is a vector of serially and mutually uncorrelated structural innovations. We include up to two years' worth of lags to allow for delayed responses in the VAR[4]. We assume A_0^{-1} has a recursive structure and we rely on the identifying assumptions in Kilian (2009). In particular, we assume that in setting oil supply, oil exporters can respond to lagged changes in oil prices, global real economic activity and oil production, but will not respond to changes to oil market specific demand within the same month due to uncertainty in crude oil markets. We also assume that oil price increases resulting from oil specific demand shocks will not affect global real economic activity within the same month given the typically sluggish response of global real aggregates to oil market shocks (Kilian et. al., 2009). Finally, we assume that changes in the

[4] We follow Kilian et. al. (2009) in choosing a maximum lag of 24 months. Note that and using alternative lag order selection methods does not change the main results.

oil price that are not due to changes in aggregate demand or oil supply are driven by oil market specific changes in demand.[5]

The reduced form errors $e_t = A_0^{-1}\varepsilon_t$ can be written as:

$$\begin{pmatrix} e_t^{\Delta prod} \\ e_t^{grea} \\ e_t^{rop} \end{pmatrix} = \begin{pmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{21} & 0 \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{os} \\ \varepsilon_t^{agd} \\ \varepsilon_t^{od} \end{pmatrix} \text{..... (3)}$$

Where ε_t^{os} refers to crude oil supply shocks, ε_t^{agd} refers to shocks to global aggregate demand for all industrial commodities (or aggregate demand shocks), and ε_t^{od} refers to oil market specific demand shocks. The latter would capture changes in precautionary demand for oil, for example in response to uncertainty and changing expectations regarding future oil supply (Kilian et. al., 2009). Positive values for ε_t^{agd} and ε_t^{od} represent increases in aggregate demand and oil specific demand, and imply an increase in the price of oil. By contrast, positive values for ε_t^{os} represent higher oil supply and imply a decrease in the price of oil. Regarding the effects of these shocks on oil prices, Kilian (2009) and Kilian et. al., (2009) show that oil supply disruptions have a small and transitory impact on real oil prices, while oil specific and aggregate demand increases have a large and sustained oil price effect.

To include these monthly shocks in our panel data regressions, where we use annual data from 1980-2011, we take the annual averages of the shocks, as in Kilian et. al., (2009) and Chen and Hsu (2012):

$$\hat{\xi}_t^{\ i} = \frac{1}{12}\sum_{m=1}^{12} \hat{\varepsilon}_{t,m}^{i} \ , i = 1, \ldots, 3 \text{ .... (4)}$$

Where $\hat{\xi}_t^{\ i}$ is the annual average of $\hat{\varepsilon}_{t,m}^{i}$, the ith structural shock of the mth month in year t; $i = 1 \ldots 3$ correspond to oil supply shocks, aggregate demand shocks, and oil market specific demand shocks. As discussed in Kilian et. al., (2009), decomposing oil price changes in this way enables us to allow for reverse causality between global income levels and the price of oil, so that we depart from the bulk of the OPM literature that assumes exogenous oil prices. Figure 3 shows the evolution of the oil shocks over the 1980-2011 period.

4.2. Model Estimations

Before estimating the panel regressions, we first examine the time series properties of the data. We divide our sample into three sub-samples: oil exporters, high and middle-income oil importers, and a full sample of oil importers. We examine high and middle-income oil importers separately to facilitate comparison with previous studies, particularly Kilian et. al. (2007, 2009) and Rafiq et. al. (2016). For each sub-sample, we test for unit roots and co-integration using a variety of methods- discussions of these tests and the associated results are presented in Appendix A. Overall, the results indicate a mix of stationary and non-stationary variables, and no co-integration. We therefore focus on estimating short-run relationships using all variables in first difference except the oil shocks; these shocks are stationary and their first differences have no straightforward interpretation.

We first estimate the following linear panel regression model

$$\Delta TB_{i,t} = \beta_1 \hat{\xi}_{t-1}^{os} + \beta_2 \hat{\xi}_{t-1}^{agd} + \beta_3 \hat{\xi}_{t-1}^{od} + \beta_4 \Delta \log{(RER)_{i,t-1}} + \beta_5 \Delta \log{(GDP)_{i,t-1}} + \lambda_i + \mu_t \text{ .... (5)}$$

[5] This decomposing method may be unable to explain the correlation between speculative shocks and aggregate demand shocks. For instance, an expansionary monetary policy that reduces the interest rate may lead to an increase in investment and hence aggregate demand. At the same time, a reduced interest rate lowers the cost of borrowing and may increase the demand for credit and other commodities, including oil (speculative demand). We thank an anonymous reviewer for pointing this out.

Where $\Delta TB_{i,t}$ is the change in the overall trade balance, oil trade balance or non-oil trade balance of country i at year t, all measured as a proportion of GDP. $\hat{\xi}_{t-1}^{os}$, $\hat{\xi}_{t-1}^{agd}$ and $\hat{\xi}_{t-1}^{od}$ are lagged oil supply shocks, aggregate demand shocks, and oil specific demand shocks. We include a one year lag to ensure that the shocks are predetermined with respect to the trade balance[6]. $RER_{i,t-1}$ is the lagged real US dollar exchange rate of country i, $GDP_{i,t-1}$ is the lagged real GDP of country i, λ_i is a linear time trend to capture the impact of stationary time varying omitted variables, and μ_t is the error term. Although the monthly structural shocks from the SVAR model (1) are orthogonal, there is some correlation between the average annual shocks, as shown in Appendix F. Therefore, we include all the shocks in one model to limit potential omitted variable bias, rather than adopting an equation-by-equation approach.

To estimate the asymmetric models, we define positive and negative oil shocks thus:

$$\xi_{t-1}^{i+} = \begin{cases} \xi_{t-1}^{i} \ if \ \xi_{t-1}^{i} > 0 \\ 0 \ if \ \xi_{t-1}^{i} \leq 0 \end{cases}, i = 1, \dots, 3 \quad \text{and} \quad \xi_{t-1}^{i-} = \begin{cases} \xi_{t-1}^{i} \ if \ \xi_{t-1}^{i} \leq 0 \\ 0 \ if \ \xi_{t-1}^{i} > 0 \end{cases}, \ i = 1, \dots, 3 \text{……… (6)}$$

Where $\xi_{t-1}^{i}, i = 1, \dots, 3$ refers to oil supply shocks, aggregate demand shocks and oil specific demand shocks. We then estimate the following asymmetric models:

$$\Delta TB_{i,t} = \beta_1 \hat{\xi}_{t-1}^{os+} + \beta_2 \hat{\xi}_{t-1}^{os-} + \beta_3 \hat{\xi}_{t-1}^{agd+} + \beta_4 \hat{\xi}_{t-1}^{agd-} + \beta_5 \hat{\xi}_{t-1}^{od+} + \beta_6 \hat{\xi}_{t-1}^{od-} + \beta_7 \Delta \log{(RER)}_{i,t-1} + \beta_8 \Delta \log{(GDP)}_{i,t-1} + \lambda_i + \mu_t \text{ ……. (7)}$$

Where $\Delta TB_{i,t}$ is the overall trade balance, oil trade balance or non-oil trade balance of country i at year t. $\hat{\xi}_{t-1}^{os+}$ and $\hat{\xi}_{t-1}^{os-}$ are positive and negative shocks to oil supply, $\hat{\xi}_{t-1}^{od+}$ and $\hat{\xi}_{t-1}^{od-}$ are positive and negative shocks to oil specific demand, and $\hat{\xi}_{t-1}^{agd+}$ and $\hat{\xi}_{t-1}^{agd-}$ are positive and negative shocks to global real economic activity; other variables are as previously defined.

We first estimate equations (5) and (7) by Pooled Ordinary Least Squares (POLS) and Mean Group (MG) models, the latter developed in Pesaran and Smith (1995). While the POLS model assumes that the effects of oil shocks are homogenous across countries, we report its results because, in its first difference representation, Eberhardt and Teal (2008) show that it is well behaved under CSD. The MG model assumes heterogeneous effects, for instance due to different levels of exposure to oil shocks. Both models ignore potential Cross Section Dependence (CSD). CSD occurs when the coefficients and residuals of different countries are correlated with one another due to common, unobserved, time variant shocks that have heterogeneous impacts on countries. If CSD exists and is unaccounted for, it can lead to identification problems by introducing some correlation between the error term and the regressors; POLS and MG models would be inconsistent. We test for CSD using the methods in Pesaran (2004, 2015). In testing for CSD, however, it is important to distinguish between weak and strong dependence, as only strong dependence causes problems for inference (Chudik et. al., 2011, Pesaran, 2015). This is especially important in this paper because we already include crude oil supply and demand shocks as well as a proxy for global real income. Potentially, these variables can account for common macroeconomic factors in our models.

[6] Kilian et. al., (2009) argue that even the contemporaneous values of these annual shocks are predetermined with respect to trade balances, and show that this assumption generally holds for the US, the country for which it is least likely to hold. However, they still find some contemporaneous feedback between US oil trade balance and oil specific demand shocks. It is also difficult to rule out contemporaneous feedback between oil supply shocks and oil exporters' trade balances. Therefore, unlike in Kilian et. al., (2009), we do not include contemporaneous shocks in our regressions to better rule out contemporaneous feedback.

To estimate the extent of CSD in our data, we follow the method in Bailey et. al., (2016). They develop the exponent of CSD, α , as a measure of the degree of cross section dependence. α lies between 0 and 1: $0 \leq \alpha < 0.5$ represents weak CSD, and $0.5 \leq \alpha < 1$ represents different degrees of strong dependence. This method is useful in testing for CSD because Pesaran (2015) shows that, when the cross-section dimension of the data, N , is much larger than the time dimension, T, the implicit null of the Pesaran (2004) CSD test is weak dependence, where $0 \leq \alpha < 0.5$, so that rejecting the CD test is rejecting both independence and weak dependence. However, when N and T are of the same order of magnitude, as in this paper, the CSD test loses power and its implicit null becomes $0 \leq \alpha < 0.25$; the test tends to over-reject independence/weak dependence in the region $0.25 \leq \alpha < 0.5$ (Pesaran, 2015). Rejection of the test is, therefore, not equivalent to rejecting weak dependence. Thus, in addition to testing for CSD, we estimate the Bailey et. al., (2016) bias corrected exponent of CSD for all the variables as well as the residuals from POLS and MG models. Table 1 presents the CD tests and exponents of CSD for the variables; those for the regression residuals are presented in the the next section. We find evidence of strong dependence in real GDP, oil trade balance and overall trade balances for all groups of countries, but nonoil balances and real exchange rates are only weakly cross-sectionally correlated. As expected, the oil shocks are perfectly cross-sectionally correlated. In the regression models (5) and (7), we show in the next section that the residuals for POLS and MG models display varying degrees of both weak and strong dependence.

To correct for bias resulting from the models with strong dependence, we estimate the Augmented Mean Group (AMG) model of Eberhardt and Teal (2008, 2010) and Bond and Eberhardt (2013). Applying the AMG model to (5) and (7) yields the first difference AMG model developed in Eberhardt and Teal, (2008). The AMG model accounts for CSD through a twostep method. First, the models in (5) and (7) are estimated in first differences by POLS, including first differenced year dummies. Second, the coefficients on the differenced year dummies are collected and included as an additional variable in MG models. These differenced year dummy coefficients capture the evolution of unobserved common factors over time: the Common Dynamic Process (CDP). In its first difference version, the AMG model augments the MG model with the first difference of the CDP (Eberhardt and Teal, 2008). The AMG estimators allow for parameter heterogeneity and error cross section dependence, and perform as well as Pesaran et. al., (2006) Common Correlated Effects Mean Group Estimator (CCEMG) in panels with CSD (Bond and Eberhardt, 2013). We choose the AMG over the CCEMG model because the latter produces highly counter intuitive and unstable results, with most p-values approaching unity, suggesting that the data rejects the model. This is perhaps because models (5) and (7) already contain more common variables than country specific ones. Since the CCE-type estimators further augment the models with cross section averages of the trade balance, real exchange rate and real GDP, they result in an 8-variable linear model, or an 11-variable asymmetric model, where only two variables, RER and GDP, are individual specific. We thus prefer the more parsimonious AMG model that eliminates CSD without the need for more than one additional variable.

4.3. Data

We use annual data from 1980-2011 for a sample of 25 oil exporting countries, 43 high and middle-income oil importing countries, and a full sample of 76 oil importing countries. We classify countries as oil exporters based on two rules: (i) average oil exports over 1980-2011 are at least 20% of total exports, as in Kilian et. al., (2007, 2009) and (ii) average oil imports are less than 50% of oil exports. The latter rule eliminates oil exporters that have considerable oil imports, for example due to poorly developed refineries or depletion of oil reserves during the sample period. The countries eliminated are Bahrain, Egypt, Indonesia, and Mexico. The first column of Appendix B shows the list of oil exporters in our sample. Of the countries that do not satisfy rules (i) and (ii), we define oil importers as countries whose average oil exports are less than average oil imports over the period. This eliminates countries where average oil exports are lower than 20% of total exports, but oil trade balances are, on average, positive. The countries eliminated are Argentina, Canada, Cote d'Ivoire, Denmark, Malaysia, Singapore and the United Kingdom[7]. The second panel of Appendix B shows the full sample of oil importers. Furthermore, we classify high-income oil importers as US, Japan and developed Europe, as in Kilian et. al., (2009). Of the remaining oil importers, we follow Kilian et. al, (2007) and define middle income countries as those whose average PPP-weighted GDP is greater than the median value in our sample. These countries, along with the high-income group, constitute our sample of high and middle-income oil importers; these are listed in the third panel of Appendix B. The high and middle-income group excludes many low-income commodity exporters. Examining the effects on high and middle-income oil importers is important because studies have found that high-income countries sometimes respond differently to oil price shocks. For instance, Taghizadeh-Hesary et al. (2016) find that GDP growth of the U.S and Japan (high-income countries) responds more to oil price shocks relative to GDP growth in China (emerging economy), whereas oil price fluctuations have a higher impact on China's inflation rate relative to the U.S and Japan. Our sample of high and middle-income oil importers allow us to investigate such differences in the effects of oil shocks as they relate to external balances.[8]

Appendix C provides the data sources, Appendix D presents the variable measurements, Appendix E provides descriptive statistics, and Appendix F presents pairwise correlations between the variables.

5. Results

We present the results from linear models (5) for oil exporters, high and middle-income oil importers, and the full sample of oil importers, as well as the corresponding results from nonlinear models (7). We present estimates from the POLS, MG and AMG models for each sub-sample. In discussing the results, we give less weight to the AMG in models where the MG or POLS results indicate low CSD, i.e., where $0 < \alpha \leq 0.5$. Where $\alpha > 0.5$ i.e. strong dependence, we prefer the AMG.

5.1. Linear Models

Table 2 shows the linear estimation results for oil exporters. As expected, oil supply expansions deteriorate the oil trade balance and overall trade balance. The nonoil balance, however, is unaffected. Increases in aggregate demand and oil specific demand improve oil and overall balances. The nonoil balance tends to improve with oil-specific demand shocks, but is unaffected by aggregate demand shocks. Unresponsive nonoil balances indicate a high degree of international financial risk

[7] Eliminating countries with ambiguous oil market status over the sample period also limits the degree to which countries 'switch' status from oil exporters to oil importers, or vice versa, over the sample period.
[8] Examining low-income oil importers separately does not provide significantly different results from those of the full oil importer sample.

sharing (Bodenstein et. al., 2011, Kilian et. al., 2009). All the oil shocks have the expected impacts on the trade balances of oil exporters, and are in line with the findings in Kilian et. al., (2009).

For high and middle-income oil importers, Table 3 show that the effects of oil shocks reflect the results for oil exporters. The oil trade balance and the overall trade balance improve with oil supply expansions and deteriorate with increases in aggregate demand and oil-specific demand. The nonoil balance is unaffected by supply shocks and oil-specific demand shocks, but it deteriorates with aggregate demand shocks. This reflects the fact that higher aggregate demand not only increases the price of oil, but of nonoil commodities as well, leading to a nonoil deficit for commodity importers. This result is in line with Kilian et. al., (2009) and Bodenstein et. al., (2011).

For the full sample of oil importers, Table 4 shows that the effects of all three shocks on the oil and overall trade balance remain the same as those for the high and middle-income group. Aggregate demand shocks continue to deteriorate the nonoil balance, suggesting that the inclusion of many low-income commodity exporters does not alter the average nonoil response for oil importers. However, oil supply expansions improve the nonoil balance. Since this positive effect was insignificant for the high and middle-income group, it suggests that commodity exports increase with oil supply expansions, perhaps because a lower oil bill raises real purchasing power and hence demand for nonoil commodities.

Overall, results from the linear models are consistent with expectations and with the findings of previous studies. Next, we turn to the nonlinear models in (7).

5.2. Nonlinear Estimation Results

5.2.1. Oil Exporters

Table 5 shows the results for the nonlinear models in (7) for oil exporters. Oil supply expansions still deteriorate the oil and overall trade balances, but the effect is significant only for POLS and MG models, but not the AMG. Oil supply disruptions, however, have limited impacts: both the MG and AMG models show insignificant oil trade responses, while the POLS model shows a positive impact that is smaller than the effect of supply expansions. For nonoil and overall trade balances, the MG model shows a positive impact of supply disruptions and, for the overall balance, the effect is smaller than that of supply expansions. POLS and AMG models show no significant effects of supply disruptions on the nonoil and overall trade balances. Generally, the results suggest that oil supply expansions are more important than supply disruptions for oil exporters. This is consistent with the view that counter supply shocks limit the impact of supply disruptions.

In response to an increase in aggregate demand, all three models show a statistically significant improvement in the oil and overall balances of oil exporters; the effect on the nonoil trade balance is insignificant. The effects of lower aggregate demand on oil and overall balances tend to be positive for the POLS and MG models, suggesting that lower real economic activity increases oil demand. However, as shown by the estimate of α, these models are affected by a moderately high degree of CSD. The AMG model shows no significant impact of lower global real economic activity, suggesting that once CSD is accounted for, oil exporters need not be concerned about lower aggregate demand for commodities.

Increases in oil specific demand, such as precautionary demand for oil, improve the oil, nonoil and overall balances of oil exporters; these effects are significant in the POLS and MG models but not in the AMG model, and so are not robust to CSD. Lower precautionary oil demand deteriorates the oil balance in the AMG model. The POLS and AMG show a deterioration of the nonoil balance, and all three models show a deterioration of the overall balance. Overall, therefore, lower precautionary oil demand is the most associated with oil, nonoil and overall trade deficits for oil exporters.

5.2.2. High and Middle-Income Oil Importers:

Table 6 shows the results from nonlinear models in (7) for high and middle-income oil importers. Oil supply expansions lead to an improvement in the oil and overall balances. The nonoil balance also improves but this effect is significant only in the POLS model. Oil supply disruptions have more limited effects, with the MG model showing a small oil balance deterioration and the POLS model showing an overall balance deterioration. The effects of supply disruptions are insignificant in all other cases. Overall, as with oil exporters, the results for high and middle-income oil importers show that oil supply expansions are more important than supply disruptions

Across all three models, both increases and decreases in aggregate demand deteriorate oil and overall trade balances for high and middle-income oil importers and, in most cases, the effect of demand decreases are generally larger than those of increases. The nonoil balance also deteriorates, but the effect is significant only in the POLS models. While a trade balance deterioration is expected with higher aggregate demand, the effects of lower aggregate demand suggest that strong demand for commodities is maintained by some oil importers despite recessions in others, as discussed in Section 2.

All three models show that increases in precautionary oil demand deteriorate the oil and overall trade balances for high and middle-income oil importers, although the oil trade response is insignificant in the AMG model. Lower precautionary oil demand improves the oil and overall balances in the AMG model, but not in the POLS and MG.

5.2.3. Full sample of oil Importers:

Table 7 shows the nonlinear results for the full sample of oil importers. As expected, oil supply expansions improve the oil and overall trade balances across all three models, although the overall trade response is insignificant in the AMG model. As with the high and middle-income group, the nonoil balance also improves, with the effect significant in the POLS model. Oil supply disruptions deteriorate the oil trade balance. However, this effect is smaller than the effects of supply expansions, and is insignificant in the AMG model. The nonoil and overall balances are unaffected by supply disruptions across all three models. Again, it appears that supply expansions are more important than supply disruptions.

Increases in aggregate demand deteriorate the oil and overall trade balance across the three models, but the overall trade response is mostly insignificant. The nonoil balance is unaffected by higher aggregate demand. Across the three models, decreases in aggregate demand deteriorate the oil, nonoil and overall balances, but the effects are insignificant in the AMG model. These results are in line with those of the high and middle-income group, and suggest that lower commodity prices, driven by economic recessions in some countries, lead to higher commodity spending by other countries whose income growth remains strong.

Increases in precautionary oil demand deteriorate the oil and overall balances across all three models, although the overall trade response is insignificant in the AMG. The nonoil balance is unaffected by higher precautionary oil demand. In response to lower precautionary oil demand, the MG and AMG models show an oil trade deterioration, and the AMG additionally shows a nonoil and overall trade deterioration. As discussed in Section 2, it appears that lower precautionary oil demand, associated with oil market stability, increases consumption and investment spending on both oil and nonoil goods. This asymmetry is evident for the full sample of oil importers, but not for oil exporters or high and middle-income oil importers.

Overall, our results show asymmetries in the effects of supply and demand shocks in the oil market. Oil supply expansions are more important than supply disruptions for both oil exporting and oil importing countries' trade balances. For oil importers, lower global real economic activity deteriorates, rather than improves, the trade balance. The effects of precautionary oil demand are less conclusive, but point to possible asymmetries for oil importers, where lower precautionary demand is associated with a deterioration, rather than an improvement, in oil and overall balances.

5. Conclusions and policy implications

This paper has examined the asymmetric impacts of oil supply shocks, aggregate demand shocks, and oil-specific demand shocks on trade balances for a large sample of oil exporting and oil importing countries, including economies in the MENA region. The literature has argued that, for macroeconomic performance, oil price increases are more important than decreases. However, the oil price- trade balance literature has largely ignored these asymmetries. Studies that consider asymmetric impacts on the trade balance do not account for the sources of oil price changes. This paper fills the gap in the literature by examining the effects of both increases and decreases in oil supply and demand shocks on external balances.

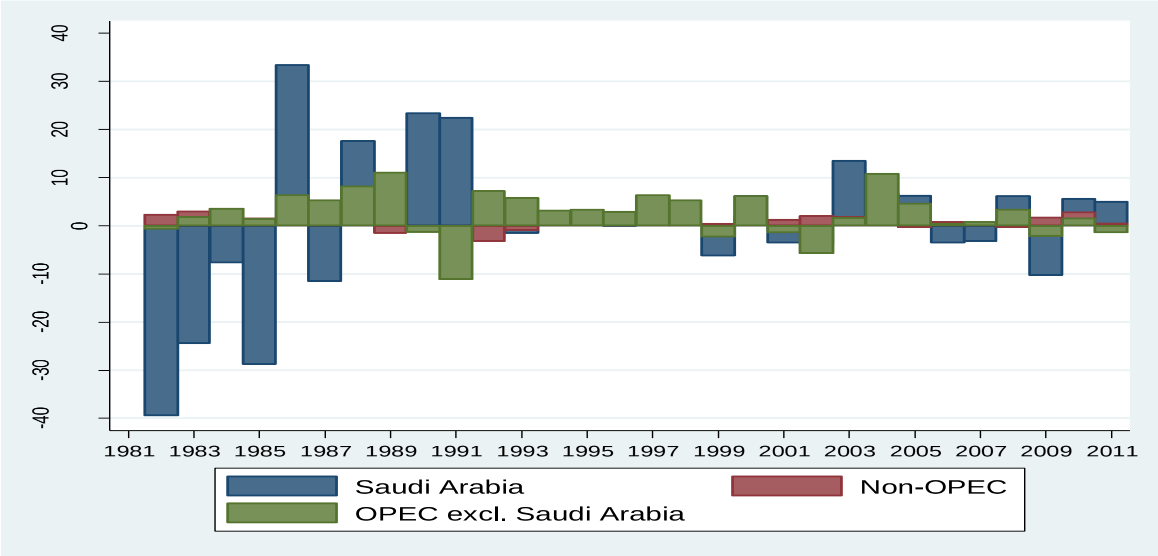
This paper disentangles oil shocks using the SVAR methodology proposed by Kilian (2009), and estimates asymmetric impacts within a variety of panel data methods. We account for endogenous oil prices, parameter heterogeneity, nonstationarity, and error cross section dependence. We find asymmetries in the effects of oil supply shocks, which can be attributed to the role of Saudi Arabia in regulating supply. In particular, oil price increases driven by oil supply disruptions have little impact on trade balances because counter supply shocks in the crude oil market, often from Saudi Arabia, can make up for supply disruptions. On the other hand, given the challenges in achieving co-ordinated supply cuts across all oil exporters, oil supply expansions significantly affect trade balances. We find that, as expected, oil price increases driven by higher global real economic activity improves the trade balance for oil exporters and deteriorate it for oil importers. However, oil price declines arising from lower global real economic activity deteriorate oil importers' trade balances, reflecting the fact that some countries maintain strong demand for commodities despite recessions in other parts of the world.

Together, our findings imply that not all asymmetric impacts of oil prices are the same, and that the source of the oil shock matters for the type of asymmetry observed. Our results encompass the asymmetries identified by Rafiq et. al., (2016) as a special case: lower oil prices deteriorate the oil trade balance for oil importers only if those lower prices are driven by demand side shocks.

Our results also have important policy implications for MENA oil exporters and oil importers. For oil importers, oil price increases should only be a concern if they result from demand side shocks. On the other hand, not all oil price declines improve trade balances for oil importers; lower oil prices are good news only if they are driven by supply expansions. For MENA oil exporters, the results suggest that policy makers should be more concerned about decreases in oil specific demand, such as precautionary oil demand or speculative oil demand, as these have a robust negative impact for oil and overall balances.

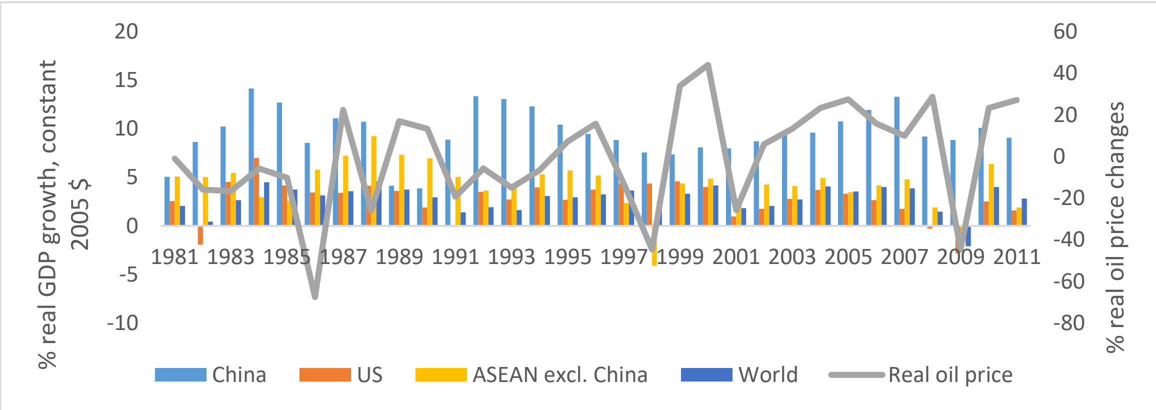
Figures and Tables:

Figure 1: Percentage Changes in Saudi Arabia, OPEC and Non-OPEC supply- 1982-2011



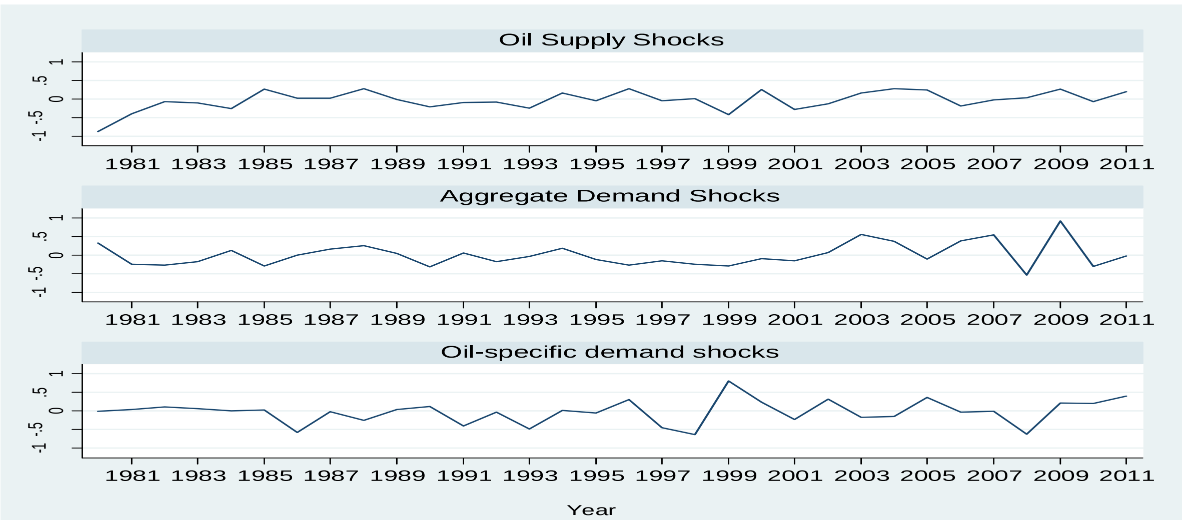
Source: Authors' calculations using data from US Energy Information Administration.

Figure 2: Oil Prices and US, China and Global Real GDP Growth Rates



Source: Authors calculations using data from World Bank's Word Development Indicators (WDI) and US Energy Information Administration (EIA).

Figure 3: Structural oil shocks- 1980-2011



Notes: Shocks are annual averages of the monthly structural residuals implied by the SVAR model in (1)

Table 1: Pesaran (2015) Cross-Section Dependence Tests and Bailey et. al., (2016) Exponents of Cross-Section Dependence

	Oil exporters					High and Middle-Income Oil importers					Full Sample Oil importers					Oil Shocks					
Variable	*CD*	$\hat{\alpha}^*_{0.05}$	$\hat{\alpha}$	$\hat{\alpha}^*_{0.95}$	*N*	*CD*	$\hat{\alpha}^*_{0.05}$	$\hat{\alpha}$	$\hat{\alpha}^*_{0.95}$	*N*	*CD*	$\hat{\alpha}^*_{0.05}$	$\hat{\alpha}$	$\hat{\alpha}^*_{0.95}$	*N*	Variable	*CD*	$\hat{\alpha}^*_{0.05}$	$\hat{\alpha}$	$\hat{\alpha}^*_{0.95}$	*N*
ΔOTB	12.178	0.731	0.808	0.885	660	18.495	0.759	0.846	0.934	1218	35.255	0.796	0.853	0.910	2205	$\hat{\xi}^{os}$	94.790	0.940	1.005	1.070	775
ΔNTB	1.687	0.481	0.552	0.623	660	1.807	0.410	0.478	0.545	1218	1.933	0.428	0.483	0.538	2205	$\hat{\xi}^{agd}$	94.790	0.917	1.005	1.093	775
ΔTTB	7.680	0.713	0.800	0.886	757	14.758	0.759	0.840	0.921	1333	25.079	0.769	0.845	0.922	2306	$\hat{\xi}^{od}$	94.790	0.923	1.005	1.087	775
$\Delta\ln(RER$	3.838	0.497	0.574	0.651	728	18.666	0.225	0.365	0.505	1168	22.044	0.213	0.303	0.394	2177						
$\Delta\ln(RGDP)$	4.715	0.746	0.824	0.901	734	18.414	0.854	0.947	1.041	1294	17.554	0.868	0.927	0.987	2272						

Notes: * represent 90% level confidence bands. $\hat{\alpha}$ is the bias-corrected exponent of cross section dependence in Bailey et. al., (2016). CD is Pesaran (2015) Cross-section dependence test. N is the number of observations.

Table 2: Linear effects of oil price shocks on oil exporters' trade balances

	Linear Oil Exporters								
	Oil Trade Balance			Nonoil Trade Balance			Overall Trade Balance		
	POLS	MG	AMG	POLS	MG	AMG	POLS	MG	AMG
$\hat{\xi}^{os}_{t-1}$	-0.021	-0.032**	-0.058***	-0.003	-0.004	-0.021	-0.024	-0.032***	-0.198***
	[0.013]	[0.013]	[0.014]	[0.015]	[0.013]	[0.013]	[0.019]	[0.009]	[0.031]
$\hat{\xi}^{ogd}_{t-1}$	0.036***	0.033***	0.036***	0.001	-0.007	-0.002	0.041***	0.034***	0.104***
	[0.008]	[0.009]	[0.008]	[0.008]	[0.008]	[0.006]	[0.011]	[0.011]	[0.018]
$\hat{\xi}^{od}_{t-1}$	0.030***	0.031***	0.084***	0.009	0.016**	0.003	0.033***	0.033***	0.052***
	[0.009]	[0.008]	[0.011]	[0.008]	[0.006]	[0.004]	[0.012]	[0.010]	[0.011]
$\Delta\ln(rer_{t-1})$	0.010	-0.012	-0.007	0.010	-0.002	-0.015	0.020	0.005	0.012
	[0.016]	[0.030]	[0.013]	[0.018]	[0.022]	[0.022]	[0.019]	[0.033]	[0.027]
$\Delta\ln(rgdp_{t-1})$	0.086	-0.056	-0.024	0.054	-0.028	0.017	0.117	-0.060	0.001
	[0.059]	[0.055]	[0.039]	[0.073]	[0.049]	[0.055]	[0.100]	[0.088]	[0.059]
CDP			0.967***			0.413***			0.991***
			[0.144]			[0.107]			[0.138]
CD	12.71	9.70	1.75	2.17	1.89	1.71	11.37	10.80	2.42
α	0.83	0.80	0.17	-0.36	0.48	0.16	0.81	0.81	0.09
RMSE	0.06	0.06	0.04	0.07	0.07	0.05	0.09	0.08	0.07
N	611	611	611	611	611	611	689	689	689

* $p<0.1$; ** $p<0.05$; *** $p<0.01$ Standard errors in parenthesis. POLS is the Polled Ordinary Least Squares model, MG is Pesaran and Smith (1995) Mean Group model, AMG is Eberhardt and Teal (2008, 2010) and Bond and Eberhardt (2013) model. CDP is the Common Dynamic Process, CD is Pesaran (2015) Cross section Dependence test, α is Bailey et. al., (2016) bias adjusted exponent of Cross Section Dependence. RMSE is the Root Mean Square Error. N is the number of observations. All the variables are as defined in equation (5).

Table 3: Linear effects of oil price shocks on high and middle-income oil importers' trade balances

	Oil Trade Balance			Nonoil Trade Balance			Overall Trade Balance		
	POLS	MG	AMG	POLS	MG	AMG	POLS	MG	AMG
$\hat{\xi}^{os}_{t-1}$	0.003	0.005***	0.011***	0.004	0.005	0.003	0.005	0.008**	0.012***
	[0.003]	[0.001]	[0.001]	[0.007]	[0.003]	[0.004]	[0.006]	[0.004]	[0.003]
$\hat{\xi}^{ogd}_{t-1}$	-0.009***	-0.009***	-0.004***	-0.021***	-0.009**	-0.004	-0.029***	-0.019***	-0.007**
	[0.002]	[0.002]	[0.001]	[0.004]	[0.004]	[0.003]	[0.005]	[0.004]	[0.003]
$\hat{\xi}^{od}_{t-1}$	-0.007***	-0.006***	-0.009***	0.001	-0.001	-0.002	-0.006	-0.006*	-0.010***
	[0.001]	[0.001]	[0.001]	[0.004]	[0.003]	[0.003]	[0.004]	[0.003]	[0.004]
$\Delta\ln(rer_{t-1})$	0.008	0.004	-0.005*	-0.012	0.004	0.007	-0.005	0.015**	-0.012
	[0.005]	[0.004]	[0.003]	[0.012]	[0.011]	[0.011]	[0.012]	[0.007]	[0.012]
$\Delta\ln(rgdp_{t-1})$	0.017	0.014	0.011	-0.068	-0.093***	-0.069	-0.016	-0.072**	-0.080**
	[0.019]	[0.012]	[0.010]	[0.045]	[0.032]	[0.044]	[0.045]	[0.031]	[0.040]
CDP			0.726***			0.477***			0.596***
			[0.078]			[0.176]			[0.143]
CD	3.25	9.75	-0.58	0.53	-0.70	-2.47	10.68	2.52	-1.90
α	0.54	0.74	0.38	-0.44	0.33	0.04	0.80	0.50	0.18
RMSE	0.02	0.01	0.01	0.04	0.03	0.03	0.04	0.03	0.03
N	1,020	1,017	1,010	1,020	1,017	1,010	1,098	1,098	1,098

* $p<0.1$; ** $p<0.05$; *** $p<0.01$. Standard errors in parenthesis. See notes under Table 2.

Table 4: Linear effects of oil price shocks on the full sample of oil importers' trade balance

	Oil Trade Balance			Nonoil Trade Balance			Overall Trade Balance		
	POLS	MG	AMG	POLS	MG	AMG	POLS	MG	AMG
$\hat{\xi}^{os}_{t-1}$	0.005**	0.006***	0.011***	0.008*	0.009**	0.005	0.012**	0.011***	0.014***
	[0.002]	[0.001]	[0.001]	[0.005]	[0.004]	[0.004]	[0.005]	[0.004]	[0.004]
$\hat{\xi}^{ogd}_{t-1}$	-0.010***	-0.008***	-0.006***	-0.018***	-0.008***	-0.003	-0.028***	-0.017***	-0.006**
	[0.001]	[0.001]	[0.001]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
$\hat{\xi}^{od}_{t-1}$	-0.008***	-0.007***	-0.011***	0.002	0.000	0.003	-0.007**	-0.007***	-0.007***
	[0.001]	[0.001]	[0.001]	[0.003]	[0.002]	[0.002]	[0.003]	[0.002]	[0.003]
$\Delta\ln(rer_{t-1})$	0.000	0.003	-0.005**	-0.000	0.003	0.005	-0.000	0.010	0.001
	[0.001]	[0.003]	[0.002]	[0.004]	[0.008]	[0.007]	[0.005]	[0.007]	[0.007]
$\Delta\ln(rgdp_{t-1})$	0.003	0.017*	0.011	-0.021	-0.062***	-0.056*	-0.009	-0.045*	-0.058*
	[0.007]	[0.009]	[0.008]	[0.022]	[0.024]	[0.030]	[0.022]	[0.025]	[0.030]
CDP			0.769***			0.764***			0.839***
			[0.064]			[0.169]			[0.131]
CD	6.00	18.64	-1.56	0.78	0.46	-1.83	21.53	4.41	1.62
α	0.58	0.76	-0.27	-0.32	0.43	0.23	0.79	0.55	0.26
RMSE	0.02	0.01	0.01	0.04	0.04	0.03	0.04	0.04	0.03
N	1,946	1,943	1,936	1,946	1,943	1,936	2,040	2,040	2,040

* $p<0.1$; ** $p<0.05$; *** $p<0.01$. Standard errors in parenthesis. See notes under Table 2.

Table 5: Asymmetric effects of oil price shocks on oil exporters' trade balances

	Oil Trade Balance			Nonoil Trade Balance			Overall Trade Balance		
	POLS	MG	AMG	POLS	MG	AMG	POLS	MG	AMG
$\hat{\xi}^{os+}_{t-1}$	-0.096***	-0.077***	0.001	0.012	0.007	0.020	-0.094**	-0.100***	0.006
	[0.029]	[0.027]	[0.020]	[0.035]	[0.031]	[0.035]	[0.039]	[0.025]	[0.020]
$\hat{\xi}^{os-}_{t-1}$	0.063**	0.016	-0.014	-0.014	0.031**	0.025	0.054	0.042**	-0.018
	[0.028]	[0.023]	[0.020]	[0.030]	[0.015]	[0.020]	[0.034]	[0.020]	[0.016]
$\hat{\xi}^{ogd+}_{t-1}$	0.032***	0.049***	0.074***	0.016	-0.001	0.006	0.041***	0.076***	0.097***
	[0.012]	[0.019]	[0.016]	[0.012]	[0.008]	[0.009]	[0.015]	[0.021]	[0.025]
$\hat{\xi}^{ogd-}_{t-1}$	0.090***	0.041	-0.010	0.007	-0.009	-0.007	0.109***	0.058*	-0.005
	[0.022]	[0.026]	[0.026]	[0.023]	[0.012]	[0.014]	[0.032]	[0.031]	[0.027]
$\hat{\xi}^{od+}_{t-1}$	0.111***	0.089***	-0.009	0.056***	0.039*	0.033	0.165***	0.178***	-0.019
	[0.018]	[0.019]	[0.024]	[0.019]	[0.022]	[0.021]	[0.023]	[0.031]	[0.027]
$\hat{\xi}^{od-}_{t-1}$	-0.009	-0.015	-0.116***	-0.035**	-0.012	-0.039**	-0.043**	-0.044***	-0.174***
	[0.013]	[0.012]	[0.023]	[0.017]	[0.016]	[0.018]	[0.018]	[0.015]	[0.032]
$\Delta\ln(rer_{t-1})$	0.010	-0.013	-0.021	0.008	-0.024	-0.044*	0.016	0.005	-0.017
	[0.016]	[0.027]	[0.020]	[0.018]	[0.024]	[0.023]	[0.018]	[0.030]	[0.041]
$\Delta\ln(rgdp_{t-1})$	0.104*	-0.005	0.007	0.062	-0.053	0.008	0.134	0.002	0.022
	[0.060]	[0.056]	[0.057]	[0.074]	[0.076]	[0.075]	[0.102]	[0.104]	[0.073]
CDP			0.911***			0.374***			0.961***
			[0.145]			[0.098]			[0.148]
CD	10.72	9.55	1.26	2.55	2.26	1.33	8.45	8.63	-2.37
α	0.78	0.79	0.24	0.38	0.49	0.23	0.65	0.79	0.02
RMSE	0.06	0.05	0.04	0.07	0.06	0.05	0.09	0.08	0.06
N	611	611	611	611	611	611	689	689	689

* p<0.1; ** p<0.05; *** p<0.01 Standard errors in parenthesis. POLS is the Polled Ordinary Least Squares model, MG is Pesaran and Smith (1995) Mean Group model, AMG is Eberhardt and Teal (2008, 2010) and Bond and Eberhardt (2013) model. CDP is the Common Dynamic Process, CD is Pesaran (2015) Cross section Dependence test, α is Bailey et. al., (2016) bias adjusted exponent of Cross Section Dependence. RMSE is the Root Mean Square Error. N is the number of observations. All the variables are as defined in equation (7).

Table 6: Asymmetric effects of oil price shocks on high and middle-income oil importers' trade balances

	Oil Trade Balance			Nonoil Trade Balance			Overall Trade Balance		
	POLS	MG	AMG	POLS	MG	AMG	POLS	MG	AMG
$\hat{\xi}^{os+}_{t-1}$	0.015**	0.017***	0.008***	0.031**	0.015	0.012	0.043***	0.025**	0.006
	[0.007]	[0.003]	[0.003]	[0.015]	[0.012]	[0.012]	[0.015]	[0.011]	[0.012]
$\hat{\xi}^{os-}_{t-1}$	-0.011	-0.008***	0.002	-0.024	0.011	0.007	-0.035**	-0.005	0.010
	[0.006]	[0.003]	[0.003]	[0.015]	[0.008]	[0.010]	[0.015]	[0.009]	[0.011]
$\hat{\xi}^{ogd+}_{t-1}$	-0.010***	-0.005**	-0.017***	-0.013*	-0.005	-0.002	-0.021***	-0.009	-0.015**
	[0.003]	[0.002]	[0.003]	[0.007]	[0.009]	[0.008]	[0.008]	[0.008]	[0.006]
$\hat{\xi}^{ogd-}_{t-1}$	-0.016***	-0.020***	-0.004*	-0.031***	-0.011	-0.007	-0.049***	-0.028***	-0.025**
	[0.006]	[0.003]	[0.002]	[0.011]	[0.008]	[0.008]	[0.012]	[0.008]	[0.010]
$\hat{\xi}^{od+}_{t-1}$	-0.026***	-0.021***	-0.003	0.003	-0.014	-0.016*	-0.023**	-0.034***	-0.023***
	[0.004]	[0.004]	[0.003]	[0.010]	[0.010]	[0.009]	[0.010]	[0.009]	[0.008]
$\hat{\xi}^{od-}_{t-1}$	0.002	-0.002*	0.015***	-0.009	0.006	0.004	-0.007	0.002	0.013***
	[0.003]	[0.001]	[0.002]	[0.007]	[0.005]	[0.006]	[0.006]	[0.004]	[0.005]
$\Delta \ln(rer_{t-1})$	0.005	-0.001	-0.008***	-0.018	-0.008	0.001	-0.013	-0.004	-0.018
	[0.005]	[0.004]	[0.003]	[0.013]	[0.012]	[0.014]	[0.013]	[0.010]	[0.012]
$\Delta \ln(rgdp_{t-1})$	0.013	0.012	0.018	-0.059	-0.187***	-0.131**	-0.014	-0.157***	-0.170***
	[0.018]	[0.011]	[0.011]	[0.044]	[0.041]	[0.054]	[0.044]	[0.039]	[0.049]
CDP			0.686***			0.283*			0.529***
			[0.079]			[0.147]			[0.154]
CD	2.30	9.31	-1.02	-0.78	-1.02	2.12	9.41	2.14	-1.0
α	-0.39	0.76	0.30	-0.53	0.30	0.14	0.77	0.48	0.30
RMSE	0.02	0.01	0.01	0.04	0.03	0.03	0.04	0.03	0.03
N	1,020	1,010	1,010	1,020	1,010	1,010	1,098	1,098	1,098

* p<0.1; ** p<0.05; *** p<0.01. Standard errors in parenthesis. See notes under Table 5.

Table 7: Asymmetric effects of oil price shocks on oil importers' trade balance

	Oil Trade Balance			Nonoil Trade Balance			Overall Trade Balance		
	POLS	MG	AMG	POLS	MG	AMG	POLS	MG	AMG
$\hat{\xi}^{os+}_{t-1}$	0.018***	0.017***	0.005**	0.021*	0.014	0.007	0.037***	0.024***	0.010
	[0.004]	[0.003]	[0.002]	[0.011]	[0.010]	[0.011]	[0.011]	[0.009]	[0.010]
$\hat{\xi}^{os-}_{t-1}$	-0.009**	-0.008***	-0.001	-0.006	0.005	0.007	-0.017	-0.006	0.005
	[0.004]	[0.002]	[0.002]	[0.011]	[0.008]	[0.010]	[0.011]	[0.008]	[0.010]
$\hat{\xi}^{ogd+}_{t-1}$	-0.011***	-0.006***	-0.015***	-0.007	-0.002	0.001	-0.017***	-0.006	-0.008
	[0.002]	[0.002]	[0.002]	[0.006]	[0.007]	[0.006]	[0.006]	[0.007]	[0.006]
$\hat{\xi}^{ogd-}_{t-1}$	-0.018***	-0.018***	-0.001	-0.034***	-0.017***	-0.006	-0.053***	-0.039***	-0.014
	[0.004]	[0.002]	[0.002]	[0.009]	[0.006]	[0.011]	[0.009]	[0.007]	[0.009]
$\hat{\xi}^{od+}_{t-1}$	-0.027***	-0.021***	-0.001	0.003	-0.003	-0.008	-0.024***	-0.027***	-0.012*
	[0.002]	[0.003]	[0.002]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
$\hat{\xi}^{od-}_{t-1}$	0.001	-0.003***	-0.017***	-0.005	0.002	-0.016**	-0.004	-0.002	-0.032***
	[0.002]	[0.001]	[0.002]	[0.005]	[0.005]	[0.008]	[0.005]	[0.004]	[0.009]
$\Delta \ln (rer_{t-1})$	0.000	0.000	-0.006**	-0.001	-0.004	-0.002	-0.001	-0.002	-0.003
	[0.001]	[0.003]	[0.002]	[0.004]	[0.009]	[0.010]	[0.005]	[0.008]	[0.008]
$\Delta \ln (rgdp_{t-1})$	0.004	0.007	0.019**	-0.021	-0.123***	-0.091**	-0.009	-0.105***	-0.100***
	[0.007]	[0.009]	[0.009]	[0.022]	[0.031]	[0.037]	[0.022]	[0.031]	[0.037]
CDP			0.746***			0.610***			0.692***
			[0.067]			[0.181]			[0.145]
CD	4.23	15.05	-1.63	0.64	-0.31	-1.20	15.00	2.97	1.08
α	0.50	0.70	0.26	-0.32	0.38	0.34	0.75	0.51	0.32
RMSE	0.02	0.01	0.01	0.04	0.03	0.03	0.04	0.03	0.03
N	1,946	1,936	1,936	1,946	1,936	1,936	2,040	2,040	2,040

* *p*<0.1; ** *p*<0.05; *** *p*<0.01. Standard errors in parenthesis. See notes under Table 5

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Appendices:

Appendix A: Unit Root and Cointegration Tests

For each sub-sample, we test for unit roots using the Maddala and Wu (1999) tests and Pesaran (2007) tests, the latter valid in the presence of error Cross Section Dependence (CSD). Both tests allow for heterogenous parameters across panel members and test the null hypothesis of a unit root against the alternative that at least one panel member's series is stationary. Table A shows the results from the unit root tests. Generally, we cannot rule out nonstationarity in the oil trade balance, nonoil trade balance, overall trade balance, real exchange rates and real GDP for all three country groups. This is especially true when we consider the Pesaran (2007) test that accounts for CSD. We expect the three oil shocks in (4) to be stationary since they are averages of structural residuals implied by (1). To test for unit roots in these shocks, we employ the Maddala and Wu (1999) test and Im, Pesaran and Shin (2003) test, rather than the Pesaran (2007) test. This is because the shocks, identical across countries in each year, are equal to their cross-section averages. Since the Pesaran (2007) test augments standard ADF regressions with cross section averages of the series, it does not consistently estimate the test, and it produces perfect p-values of unity. Table A shows that, as expected, these series are stationary.

Given that we have a mix of stationary and nonstationary regressors, we expect no cointegration among the variables. Moreover, the monthly shocks implied by (1), from which the annual shocks are derived, are orthogonal by construction. Nevertheless, there is non-zero correlation between the annual shocks[9], so we test for cointegration using the Pedroni (1999) test and the Westerlund (2007) error correction tests, the latter valid under CSD. The results, presented in Table B and Table C, show that the variables do not cointegrate for all three groups of countries. Based on these results, and the results from our unit root tests, we focus on estimating short-run relationships using all variables in first difference except the oil shocks; these shocks are stationary and, in our context, their first differences have no straightforward interpretation. The first difference representation of the models also limit omitted variable bias through accounting for individual country-specific characteristics.

[9] Pairwise correlation coefficients between all variables are presented in Appendix E

Table A: Unit Root Tests

		Madalla and Wu (1999) Unit root tests			Pesaran (2007) Unit root tests			Madalla and Wu (1999) Unit root tests- Oil Shocks			Im, Pesaran and Shin (2003) Unit root test- Oil Shocks	
Variable	ADF-lags	Oil Exporters	High and Middle-Income Oil Importers	Full sample Oil Importers	Oil Exporters	High and Middle-Income Oil Importers	Full sample Oil Importers	Variable	lags			
TTB	0	150.88***	177.75***	306.49***	-3.70***	-3.56***	-5.37***	ξ^{os}	0	2402.34***	Variable	
	1	150.15***	145.88***	230.20***	-2.69***	-0.88	-1.57*		1	1417.26***	ξ^{os}	-42.48***
	2	81.78***	132.83***	186.68**	-1.05	1.28	1.31		2	722.15***	ξ^{agd}	-51.08***
	3	63.73*	109.27**	173.24	-0.6	3.15	2.95		3	482.34***	ξ^{od}	-28.38***
	4	56.33	107.92*	169.63	1.64	5.71	5.3		4	965.68***		
NTB	0	149.17***	131.59***	298.46***	-4.81***	-1.54*	-4.56***	ξ^{agd}	0	2764.22***		
	1	114.06***	113.39**	209.91***	-2.53***	-0.71	-2.18**		1	704.69***		
	2	61.82	102.46	163.85	-0.19	-0.25	-0.59		2	176.69*		
	3	51.89	84.92	149.26	0.74	2.95	1.37		3	196.51***		
	4	40.12	109.32**	173.64	3.62	4.01	4.86		4	179.64*		
OTB	0	91.40***	89.91	170.08	-0.79	-5.79***	-7.03***	ξ^{od}	0	2463.45***		
	1	101.20***	92.98	148.42	-0.95	-6.60***	-4.71***		1	1503.23***		
	2	51.15	144.37***	196.80***	-0.25	-1.93**	-0.66		2	812.37***		
	3	63.78*	102.59	143.52	-2.44***	0.11	2.32		3	603.99***		
	4	74.35**	230.07***	260.39***	2.46	1.18	3.94		4	261.46***		
$\Delta\ln$ (RER	0	28.73	116.27**	182.66**	-1.31*	2.00	2.70					
	1	55.97	109.17**	160.15	-3.56***	-4.70***	-1.82**					
	2	37.85	79.08	119.94	-2.12**	3.51	4.59					
	3	98.21***	95.47	151.7	-3.76***	4.73	4.49					
	4	97.52***	109.58**	141.95	0.03	4.38	5.22					
$\Delta\ln(RGDP)$	0	92.48***	65.15	117.64	1.17	4.65	4.46					
	1	69.49**	93.98	187.22**	1.14	2.49	1.64					
	2	74.99**	57.54	134.46	2.33	4.58	4.1					
	3	52.19	54.64	113.12	2.27	5.63	4.72					
	4	68.19**	50.86	95.83	2.22	5.51	6.26					

Notes: We include a constant term, a trend term, and up to four lagged differences in the ADF regressions for the MW tests and Pesaran (2007) tests. We do not include a trend term in the MW tests and IPS tests for the oil shocks because, as residuals from model (1), these shocks are randomly distributed around zero with no upward or downward trend, as shown in Figure 3

TABLE B: Pedroni (1999) Cointegration Tests

	Oil Exporters			High and Middle-Income Oil Importers			Full sample oil importers		
	OTB	NTB	TTB	OTB	NTB	TTB	OTB	NTB	TTB
Panel-v	-3.54	-4.14	-3.00	-5.81	-4.95	-4.34	-6.53	-5.16	-5.19
Panel-rho	4.13	2.67	3.14	7.15	5.93	5.31	7.71	6.13	6.41
Panel-t	-0.08	-2.55	-0.27	3.82	2.34	1.84	2.80	0.76	1.72
Panel-adf	4.20	-0.63	-0.09	7.64	4.00	3.43	9.79	4.37	4.68
Group-rho	5.97	4.97	5.14	9.07	8.57	7.86	9.99	9.65	9.60
Group-t	0.14	-1.41	0.79	3.78	3.52	2.96	2.82	2.49	3.11
Group-adf	3.14	1.57	1.64	8.62	5.51	4.76	11.11	6.69	6.12

Notes: H0: No cointegration. We include a constant and trend term. The number of lags is determined using the Akaike Information Criteria (AIC)

TABLE C: Westerlund (2007) CSD robust Cointegration Tests

	Oil Exporters						High and Middle-Income Oil Importers						Full sample oil importers					
	OTB		NTB		TTB		OTB		NTB		TTB		OTB		NTB		TTB	
Statistic	Value	p-value	Test	p-value	Test	p-value	Test	p-value	Test	p-value	Test	p-value	Test	p-value	Test	p-value	Test	p-value
Group-t	-2.48	0.65	-2.72	0.36	-3.203	0.14	-2.90	0.23	-2.65	0.51	-2.25	0.83	-2.79	0.30	-2.76	0.38	-2.31	0.84
Group-a	-6.166	0.91	-7.97	0.76	-8.823	0.67	-6.65	0.98	-5.52	1.00	-5.32	0.99	-7.19	0.97	-6.85	1.00	-6.43	0.99
Panel-t	-11.805	0.38	-14.74	0.10	-13.298	0.35	-15.12	0.41	-16.65	0.18	-14.64	0.55	-20.17	0.34	-22.36	0.13	-18.34	0.62
Panel-a	-7.196	0.62	-8.60	0.39	-8.204	0.65	-6.91	0.82	-7.03	0.69	-7.36	0.70	-7.33	0.83	-7.80	0.73	-7.45	0.76

Notes: H0: No cointegration. We include a constant and trend term. We use bootstrapped standard errors that are robust to CSD.

Appendix B: List of Sample Countries

Oil Exporters	Full Sample Oil Importers			High and Middle-Income Oil Importers	
Algeria	Australia	Guyana	Panama	Australia	Namibia
Angola	Austria	Haiti	Paraguay	Austria	Netherlands
Bahrain	Belgium	Honduras	Peru	Belgium	New Zealand
Brunei	Belize	Hungary	Philippines	Belize	Paraguay
Chad	Botswana	India	Poland	Botswana	Peru
Colombia	Brazil	Ireland	Portugal	Brazil	Poland
Congo, Republic of	Burkina Faso	Israel	Romania	Chile	Portugal
Ecuador	Cape Verde	Italy	Rwanda	Cyprus	Romania
Egypt	Central African Rep.	Jamaica	Senegal	Dominica	Seychelles
Equatorial Guinea	Chile	Japan	Seychelles	Dominican Republic	Spain
Gabon	China	Jordan	Sierra Leone	El Salvador	Swaziland
Indonesia	Comoros	Kenya	Spain	Finland	Sweden
Kazakhstan	Cyprus	Korea	Sri Lanka	France	Switzerland
Kuwait	Djibouti	Lebanon	Swaziland	Germany	Thailand
Mexico	Dominica	Malawi	Sweden	Greece	Tunisia
Nigeria	Dominican Republic	Mali	Switzerland	Hungary	Turkey
Norway	El Salvador	Mauritius	Tanzania	Ireland	United States
Oman	Ethiopia	Morocco	Thailand	Israel	Uruguay
Saudi Arabia	Finland	Mozambique	Tunisia	Italy	
Sudan	France	Namibia	Turkey	Jamaica	
Syrian Arab Republic	Germany	Nepal	Uganda	Japan	
Trinidad and Tobago	Ghana	Netherlands	United States	Jordan	
United Arab Emirates	Greece	New Zealand	Uruguay	Korea	
Venezuela, Rep. Bol.	Guinea	Niger	Vanuatu	Lebanon	
Yemen	Guinea-Bissau	Pakistan	Zambia	Mauritius	
			Zimbabwe		

Appendix C: Data Sources

Variable	**Source**
Global oil production	US Energy Information Administration (EIA), millions of barrels per day
Global real economic activity	Lutz Kilian's website
Exchange rate	IMF's World Economic Outlook (WEO), Local currency per unit of US $
Real GDP/ Real world GDP	World Bank's Word Development Indicators (WDI), constant 2005 US $
Nominal GDP	IMF's World Economic Outlook (WEO), current US $
Oil exports and oil imports	IMF's World Economic Outlook (WEO), current US $
Merchandise exports and imports	World Bank's Word Development Indicators (WDI), current US $
CPI	IMF's World Economic Outlook (WEO), index number

Appendix D: Variable measurements

Variable	Measurement
Overall goods trade balance	(Merchandise exports- Merchandise imports)/nominal GDP
Oil trade balance	(Oil exports-oil imports)/nominal GDP
Nonoil trade balance	Overall goods trade balance-oil trade balance
Real oil price	US refiner acquisition cost of imported oil/ US CPI
Real exchange rate	US dollar exchange rate *US CPI)/Country CPI

Appendix E: Descriptive Statistics

Descriptive statistics- Oil Exporters

Variable	N	Mean	S.D.	Min	Median	Max
ΔTTB	757	0.00	0.09	-0.51	0.00	0.64
ΔOTB	660	0.00	0.07	-0.42	0.00	0.54
ΔNTB	660	0.00	0.07	-0.67	0.00	0.48
$\hat{\xi}^{os}$	800	-0.03	0.25	-0.87	-0.04	0.28
ξ^{od}	800	-0.03	0.32	-0.64	0.00	0.81
$\hat{\xi}^{agd}$	800	0.00	0.31	-0.54	-0.07	0.92
$\Delta\ln(RER$	728	0.00	0.17	-0.58	-0.01	1.89
$\Delta\ln(RGDP)$	734	0.04	0.07	-0.28	0.04	0.92

Descriptive statistics- High and Middle-Income Oil Importers

Variable	N	Mean	S.D.	Min	Median	Max
ΔTTB	1333	0.00	0.04	-0.32	0.00	0.29
ΔOTB	1218	0.00	0.02	-0.12	0.00	0.25
ΔNTB	1218	0.00	0.04	-0.22	0.00	0.26
$\hat{\xi}^{os}$	1376	-0.03	0.25	-0.87	-0.04	0.28
ξ^{od}	1376	-0.03	0.32	-0.64	0.00	0.81
$\hat{\xi}^{agd}$	1376	0.00	0.31	-0.54	-0.07	0.92
$\Delta\ln(RER$	1168	0.00	0.11	-0.66	0.00	0.80
$\Delta\ln(RGDP)$	1294	0.03	0.04	-0.55	0.03	0.32

Descriptive statistics-Full Sample Oil Importers

Variable	N	Mean	S.D.	Min	Median	Max
ΔTTB	2356	0.00	0.04	-0.32	0.00	0.36
ΔOTB	2205	0.00	0.02	-0.12	0.00	0.25
ΔNTB	2205	0.00	0.04	-0.27	0.00	0.27
$\hat{\xi}^{os}$	2432	-0.03	0.25	-0.87	-0.04	0.28
ξ^{od}	2432	-0.03	0.32	-0.64	0.00	0.81
$\hat{\xi}^{agd}$	2432	0.00	0.31	-0.54	-0.07	0.92
$\Delta\ln(RER$	2177	0.02	0.33	-0.67	0.00	12.54
$\Delta\ln(RGDP)$	2272	0.03	0.05	-0.70	0.04	0.32

Appendix F: Pairwise Correlation Coefficients between all variables

Pairwise correlation coefficients- Oil Exporters								
	ΔTTB	ΔOTB	ΔNTB	$\Delta LNRER$	$\Delta LNRGDP$	ξ^{os}	ξ^{agd}	ξ^{ad}
ΔTTB	1.000							
ΔOTB	0.631	1.000						
ΔNTB	0.711	-0.097	1.000					
$\Delta \ln (RER$	0.118	0.162	0.055	1.000				
$\Delta \ln (RGDP)$	0.157	0.254	-0.009	-0.062	1.000			
ξ^{os}	-0.005	0.071	-0.061	-0.064	0.073	1.000		
ξ^{agd}	-0.125	-0.172	-0.014	-0.067	0.018	0.134	1.000	
ξ^{od}	0.193	0.211	0.040	0.091	-0.022	-0.006	0.021	1.000
Pairwise correlation coefficients- High and Middle-Income Oil Importers								
	ΔTTB	ΔOTB	ΔNTB	$\Delta LNRER$	$\Delta LNRGDP$	ξ^{os}	ξ^{agd}	ξ^{ad}
ΔTTB	1.000							
ΔOTB	0.268	1.000						
ΔNTB	0.907	-0.163	1.000					
$\Delta \ln (RER$	0.134	-0.067	0.133	1.000				
$\Delta \ln (RGDP)$	-0.117	0.037	-0.168	-0.126	1.000			
ξ^{os}	-0.020	-0.026	-0.015	-0.142	-0.008	1.000		
ξ^{agd}	0.094	0.116	0.055	-0.102	-0.050	0.134	1.000	
ξ^{od}	0.022	-0.089	0.059	0.057	-0.035	-0.006	0.021	1.000
Pairwise correlation coefficients- Full Sample Oil Importers								
	ΔTTB	ΔOTB	ΔNTB	$\Delta LNRER$	$\Delta LNRGDP$	ξ^{os}	ξ^{agd}	ξ^{ad}
ΔTTB	1.000							
ΔOTB	0.285	1.000						
ΔNTB	0.933	-0.078	1.000					
$\Delta \ln (RER$	-0.046	-0.077	-0.033	1.000				
$\Delta \ln (RGDP)$	-0.060	0.001	-0.068	-0.146	1.000			
ξ^{os}	-0.016	-0.020	-0.014	-0.045	0.025	1.000		
ξ^{agd}	0.090	0.139	0.049	-0.038	-0.011	0.134	1.000	
ξ^{od}	0.020	-0.098	0.057	-0.020	-0.001	-0.006	0.021	1.000