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Do heterogeneous countries respond differently to oil price shocks?

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Abstract: The article studies the macroeconomic impact of oil price changes in 17 highly heterogeneous countries classified in six groups: advanced, emerging, oil producer, non-oil producers, with energy price controls and without energy price controls. The results show that despite analyzed countries differ in several dimensions, most differences regarding oil price shocks impacts can be captured comparing two groups: advanced vs. emerging. Moreover, most of the differences in the way countries react to oil price shocks come from the source of the shock rather than by the group which the countries belong to. Remarkably, there are no significant differences in the response of industrial production between oil and non-oil producer countries. We posit, as potential explanations of the later finding the decline in the energy intensity of the global economy and the degree of trade openness.
Keywords: Oil Price Shocks, Macroeconomic Impacts, Oil Market
JEL Classification: E31, Q31, Q43

Resumen: El artículo estudia el impacto macroeconómico de los cambios en los precios del petróleo en 17 países heterogéneos clasificados en seis grupos: avanzados, emergentes, productores de petróleo, no productores, con controles de precios de energía y sin controles de precios. Los resultados muestran que la mayoría de las diferencias con respecto a los choques del precio del petróleo son capturadas comparando dos grupos: avanzados versus emergentes. Además, la mayoría de las diferencias en la forma en que los países reaccionan a los choques del precio del petróleo provienen del tipo de choque y no del grupo al que pertenecen los países. Sorprendentemente, no hay diferencias significativas en la respuesta de la producción industrial entre países productores y no son productores de petróleo. Postulamos, como posibles explicaciones de dicho hallazgo, la disminución de la intensidad energética en la economía global y el grado de apertura comercial.
Palabras Clave: Choques de Precio del Petróleo, Impacto Macroeconómico, Mercado de Petróleo

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1 Introduction

The analysis of the macroeconomic effects of oil price shocks has received considerable attention in the literature (for recent surveys see Kilian (2008b) and Hamilton (2008)). Most of it focuses on industrialized countries, particularly on the US. This bias is even more noticeable in cross-country studies (Cologni and Manera (2008); Kilian (2008a); Peersman and Van Robays (2012)) with some notable exceptions such as Abeysinghe (2001), Cuñado and Pérez de Gracia (2005) and Cuñado et al. (2015) who have looked at the impacts of oil price shocks in the Asian region.

In this paper, we contribute to the literature of macroeconomic impacts of oil shocks in several fronts. First, we conduct a cross-country analysis for 17 countries which are highly heterogeneous, not only in terms of their development stage but also in terms of whether they are oil importers or exporters or have gasoline price controls. Second, we focus our analysis in the period 2000-2015, where analyzed countries have experienced drastic reductions in terms of their net oil imports and energy intensities. Third, we perform statistical tests on the differences in responses across groups of countries after 5, 15 and 24 months of the occurrence of the shock. Moreover, we do so in the context of the literature that distinguishes oil price shocks by its source, whether it is oil supply, oil-specific demand or global demand driven by economic activity, as in Kilian (2009) and Peersman and Van Robays (2012).

Our results show that, since the 2000s, responses of economic activity to oil shocks are less differentiated across countries than what the literature has reported in the past. First, while oil supply shocks tend to have contractionary impacts on advanced economies, these are less intense and tend to decrease over time in comparison to past findings. Similarly, interest rates for those countries tend to decrease after an oil supply shock, contrary to what occurred in the 80's and the 90's (Barsky and Kilian (2002), Bernanke et al. (1997)). Interestingly, emerging economies seem to react in a similar way. Moreover, differences across country groups in the way oil shocks affect industrial activity tend to disappear over time and are not statistically different after 2 years of the shock. Second, except for Brazil, economic activity in oil producer countries does not increase after an oil supply shock. This result contrasts sharply with what other studies have found for oil producer countries (i.e. Peersman and Van Robays (2012)). One possible explanation may be that overall trade and particularly exports excluding oil have increased substantially for those countries. In particular, during the analyzed period exports excluding oil for oil producers are four times larger than oil exports. Hence, while oil exports may increase after the occurrence of an oil supply shock, other exports may suffer, especially if directed to advanced economies. In comparison to the rest of oil producer countries, Brazil exhibits low levels of trade openness, which may make it more dependent (and vulnerable) to oil price shocks. Third, despite countries can be classified according to different criteria (oil producers, advanced, with energy price controls, etc.), most differences regarding oil price shocks impacts can be captured comparing two groups: advanced vs. emerging. That is, we do not find significant differences across IRFs between oil producers, emerging and with price controls countries. Similarly we do not find statistically significant differences across IRFs between non-oil producers, advanced and without price controls countries. The main implication of such findings is that it is more relevant the development stage of the country to explain main differences regarding oil price shocks impacts, rather than whether the country is oil producer or has energy price controls in place.

The paper is organized as follows. Section 2 reviews the literature on the subject; Section 3 summarizes the data and the methodology. Section 4 presents results and Section 5 concludes.

2 Literature Review

How a rise in oil prices affects economic variables, particularly output, has been a topic of major interest in the literature. A generally accepted result is that an increase in oil prices has an adverse effect on output, increases prices and consequently monetary policy tightens. Hamilton (1983) seminal paper shows that since WWII and up to the late 70s, most of US recessions episodes were preceded by an increase in oil prices (excluding the one in 1960).

While such relationship proved to be weaker after the collapse of oil prices in the early 1980s (Hooker (1996)), the literature that followed mostly focused on testing nonlinear specifications of the oil price on economic activity (Mork (1989); Lee et al. (1995); Hamilton (1996), Hamilton (2003), among others) and on testing for endogenous monetary policies as the main source of economic downturns (Bernanke et al. (1997), Hamilton and Herrera (2004)). The rationale for testing nonlinear specifications is that oil prices are endogenous to economic activity, at least when analyzing impacts on the US economy, hence transformations aimed at either differentiating between positive an negative changes in the price of oil or at transforming oil price data were proposed to more properly reflect oil price shocks (Kilian (2008b)).

More recently, several papers suggested that such nonlinear transformations were either misspecified when testing for asymmetric responses to oil shocks (Kilian and Vigfusson (2011); Herrera et al. (2015)), or not enough to avoid the endogeneity of oil prices (Barsky and Kilian (2004)). Kilian and Vigfusson (2011) and Herrera et al. (2015) show no consistent evidence of asymmetries in the responses of economic activity to oil price shocks. Similarly, the role of endogenous monetary policy as the main source of the oil price shocks impacts on economic activity proposed by Bernanke et al. (1997) has been shown to be less relevant (Hamilton and Herrera (2004)).

In an influential paper, Kilian (2009) shows that for the U.S. economy the impacts of oil price shocks may be different depending on their source. Accordingly, he distinguishes oil price shocks from three main sources: 1) driven by oil-specific demand, aimed at identifying oil price shocks that emerge from concerns about future oil supplies; 2) coming from an increase in global demand and 3) arising from oil supply disruptions. Before this paper, most oil shocks were assumed to result from oil supply disruptions. Kilian (2009) shows that, on the contrary, most oil price increases since 1970s are driven by an increase in global economic activity. Such shocks, he shows, have completely different impacts on economic activity than those coming from oil-specific demand or oil supply. Specifically, using a SVAR he shows that oil supply shocks tend to temporarily increase the price of oil and decrease economic activity. When the source of a shock is oil-specific demand, mostly attributable to precautionary behavior, oil prices increase in a persistent way and real activity even tends to increase in the very short term. Finally, when increases in the price of oil are driven by a step up in global demand, this gradually leads to a raise in the price of oil, while economic activity increases sharply and more permanently.

More recently, several authors have used similar empirical specifications to test such results looking at more countries. Kilian et al. (2009) estimate the impact of oil shocks on changes in net foreign assets, oil and non-oil trade balances, current account and capital gains, for oil exporters and importers. According to their results, oil supply shocks have a limited impact on trade balances for oil-exporting economies and a short lived effect on capital loss. On the contrary, trade balances of oil exporters register a surplus that declines slowly over time as a consequence of an oil-specific demand driven shock; such shocks also produce capital losses due to exchange rate appreciation. The trade balance surplus is driven by an oil trade balance surplus, while non-oil trade balances tend to not suffer significant declines. When oil shocks are driven by an expansion in the aggregate demand, oil exporters experience a trade surplus, mainly caused by an oil trade surplus. Oil-exporting economies experience capital losses but they appear to not be statistically significant.

Also, considering a range of oil-exporting and oil-importing developed economies using data from 1986 up to 2010, Peersman and Van Robays (2012) show that oil supply shocks tend to lower GDP in oil importer countries, while oil exporters tend to benefit from them. Such shocks have, in general, inflationary pressures, except for some oil exporters countries. When the source of the oil shock is an increase in global demand, GDP and prices rise for most countries in their sample. On the contrary, when the source is oil-specific demand, economic activity falls while prices increase for most countries, except for some oil exporters.

Aastveit et al. (2015) is, to our knowledge, the first paper to include developing economies in their analysis of oil price shocks. The authors first estimate how much demand shocks coming from 18 developed and 15 developing economies contribute to changes in the price of oil for the period 1991-2009. They find that more than 50% of the fluctuations in the price of oil are driven by demand shocks from the analyzed economies. More importantly, demand shocks from developing countries are more important than those from developed countries. Additionally, using a Factor augmented VAR (FVAR), the authors also estimate impulse response functions of oil price shocks, differentiated by source as in Kilian (2009) and Peersman and Van Robays (2012). They find that the U.S. and euro area economies experience stronger declines in their economic activity as a result of oil-specific demand and oil supply shocks, compared to economies in South America (Brazil and Peru) and Asia, where activity actually seems to increase.

Finally, Cuñado et al. (2015) examine the impact of oil shocks for a more recent period 1997-2014. Their study focuses on Asian countries: Japan, Korea, India and Indonesia. Interestingly, they find that these economies do not respond to oil supply disruptions during the analyzed period. When the shock is global demand driven, GDP of the four countries responds positively. Finally, in response to an oil-specific demand shock, most countries react negatively, except for Indonesia which for much of the period considered in the study, was an oil exporter. They also find that Japan and Korea's monetary policy is effective at controlling oil supply shocks, in contrast to India and Indonesia whose policies are less effective possibly due to domestic energy price regulations.

3 Data and Methodology

To disentangle the impact of oil market shocks across countries, we use an structural VAR (SVAR) framework since it can better reflect the structure of the oil market (Bernanke et al. (1997); Kilian (2009); Peersman and Van Robays (2012); Cuñado et al. (2015)). In order to identify the model, we use a set of sign restrictions as proposed by Peersman and Van Robays (2012).

We gather three types of data representing oil market conditions, world economic activity and country-specific macroeconomic variables. Oil market variables include the "Total World Oil Supply" in millions of barrels per day (Q_t^{oil}); Following Kilian (2009) we use "US Crude Oil Imported Acquisition Cost by Refiners" in dollars per barrel as proxy for oil price (P_t^{oil}). Both variables are obtained from the US Energy Information Administration (EIA). As a proxy for world economic activity, we use OECD Total Industry Production Index seasonally adjusted (Y_t^W).

Our sample includes 17 countries (Brazil, Canada, Chile, Czech Rep., France, Germany, Ireland, Israel, Italy, Japan, Mexico, Norway, Poland, Russia Spain, UK, and US). For each country, we use seasonally adjusted industrial production index $(IP_{i,t})$ and consumer prices indices $(CPI_{i,t})$ as proxies for economic activity and price levels respectively; nominal short-term interest rates

$(i_{i,t})$ and nominal effective exchange rate indexes $(E_{i,t})$ (see A for details on all variables used).

Consumer prices and industrial production indices were obtained from Haver Analytics for all countries except for Brazil, whose source is Bloomberg due to data availability. Short-term interest rates data come mostly from OECD Monetary and Financial Statistics and from Haver Analytics in the case of Japan, Brazil and Israel. Exchange rate data was obtained from the IMF. The period of study goes from January 2000 to September 2015 and all data is at monthly frequency. As in Peersman and Van Robays (2012) all variables, but interest rates, are transformed into their first log-difference.

3.1 Methodology

Since we have 17 countries we decided to sort them into groups that reflect some common characteristics. In this fashion we define the following country groups: Advanced Economies (AE), Emerging Market Economies (EMEs), Oil Producers (OP), Non-Oil Producers (NOP), with energy price controls (CP), without energy price controls (NCP) and a general group that contains all countries (All). Table 1 shows the classification of countries according to each group.

The objective of this work is two fold: first, analyze how each group responds to oil price shocks. Second, identify if these responses are heterogeneous across groups. In order to perform this analysis we make use of a panel VAR (PVAR) approach adopting Pesaran and Smith (1995) Mean Group estimator (MG). The estimation procedure is as follows: First, keeping the sign restrictions for 3 periods we model the Impulse-Response Functions (IRF) for each country using a VAR of the form:[1]

$$Y_t = B_0 + B_1 Y_{t-1} + B_2 Y_{t-2} + B_3 Y_{t-3} + \varepsilon_t \tag{1}$$

Where the ordering of the variables is $Y_t = \begin{bmatrix} Q_t^{oil} & P_t^{oil} & Y_t^W & IP_{i,t} & CPI_{i,t} & i_{i,t} & E_{i,t} \end{bmatrix}'$ and ε_t captures the structural noise in the oil market and country-specific variables.[2]

Second, let $\hat{\Phi}_{i,j,k,t}^{irf}$ be the IRF of variable i for country j in group k at time t obtained from equation 1 to a one standard deviation shock and let $\omega_{j,k}$ represent the average participation of country j's GDP in the aggregate group's GDP over the whole sample period. The identification strategy used to estimate individual countries IRFs is the one designed by Uhlig (2005) who proposes a Bayesian approach to estimate VARs with sign restrictions consisting on selecting from

[1] We kept the sign restrictions for 2 and up to 6 periods after the shock; the results do not differ significantly.

[2] The number of lags included in the VAR was obtained from the Akaike information criterion.

a set of models the one that minimizes a penalty function that assigns less weight to the models that violate the restrictions and favors those which not only satisfy them, but also provide larger responses.[3] Then, variable i's IRF for group k is given by:

$$\bar{\Phi}^{irf}_{i,k,t} = \sum_{j=1}^{J} \omega_{j,k} \hat{\Phi}^{irf}_{i,j,k,t} \tag{2}$$

Where $\hat{\Phi}^{irf}_{i,j,k,t}$ is country j's IRF and $\omega_{j,k} = \frac{1}{T}\sum_{t=1}^{T} \frac{GDP_{j,k,t}}{\sum_{j=1}^{J} GDP_{k,t}}$

Note that $\bar{\Phi}^{irf}_{i,k,t}$ is a weighted average in contrast to Pesaran and Smith (1995) that use a simple average. This is so, in order to better measure the aggregate response of each variable for each group. The 16th and 84th percentile error bands for the MG estimator are computed using the variance-covariance matrix given by (see Pesaran and Smith (1995)):

$$\hat{\Gamma}_{i,k,t} = \frac{J}{J-1} \sum_{j=1}^{J} \left(\hat{\Phi}^{irf}_{i,j,k,t} - \bar{\Phi}^{irf}_{i,k,t} \right)' \left(\hat{\Phi}^{irf}_{i,j,k,t} - \bar{\Phi}^{irf}_{i,k,t} \right) \tag{3}$$

Kilian (2009) identifies the primary supply and demand shocks responsible for real oil price fluctuations by decomposing them into three main sources: oil supply shock, demand shock resulting of changes in global economic activity, and oil-specific demand shock originated from market expectations about future oil supply. The model is identified via the sign restrictions shown in Table 2. Considering that an oil supply shock represents an exogenous disruption of the supply curve (generally caused by geopolitical turmoil), oil production decreases driving prices up, while global economic activity could either slow down or suffer not change. When the source of the shock is demand driven by global economic growth, oil production rises to keep up with higher demand, while prices tend to increase as supply adjusts at a slower pace than demand. Finally, a third source is an increase in the demand for oil mostly due to heightened concern regarding the availability of oil in the future. In this case, supply increases to satisfy unmet demand, but supply adjustment is slower, hence prices also increase. Global economic conditions in this scenario tend to not change or decrease.

Before estimating the model, we first validate the categorization proposed in Table 1 via the following statistical analysis: (1) we compute the overall mean and standard deviation within

[3] In the estimation we draw one thousand joint draws from a flat Normal Inverted-Wihsart posterior and a uniform distribution for the orthogonal impulse vector. For a detailed explanation of the estimation method see appendices A and B in Uhlig (2005).

group, for each variable analyzed. (2) Each IRF for every country is standardized with the mean and variance of each of the groups. (3) We find the maximum standardized value (within group) for each of the 12 IRFs, of every country. The latter is done to quantify how unlikely (or likely) the response of each country is with respect to the overall response of the group. (4) We add up the 12 values obtained from the IRFs of each country for every group. This exercise defines a metric or a test statistic. That is, small values provide statistical evidence that each country responses are in accordance with the average response of its corresponding group. (5) We report, in ascending order, the statistic described in the previous steps (see Table 3). For instance, Brazil had its best fit with Oil Producer, next with Controlled Energy Prices, etc. Interestingly, all but one of the countries (UK) that are oil producers have a best fit with the group of oil producers. In general, most countries best three fits match with the classification in Table 1, except for some exceptions. Norway and Canada's second best fit is with the Emerging Economies group, while Chile's third best match is with the Non-Controlled Energy Prices Group and for the UK is Non-Oil Producer.

4 Results

Before describing the results, it is important to assess how one expect each type of shock to affect macroeconomic variables. For instance, a raise in oil prices due to a negative supply shock would not have the same effect as an increase in oil prices due to improved economic conditions. Hence, to facilitate the comparison and interpretation of the results it would be convenient to keep in mind that supply and oil-specific demand shocks leading to higher oil prices could be thought of as having contractionary effects, especially for non-oil producer countries, whilst by definition a raise in oil prices resulting from an increase in economic activity should have expansionary impacts across all countries. For countries with controlled energy prices, price impacts may be stickier and respond in less magnitude to oil shocks compared to prices in non-controlled energy prices countries.

Following the above, Figures 1 to 7 show for each group and each macroeconomic variable, the average IRF (blue line) and the corresponding confidence intervals at the 10 percent of significance (dotted green lines). Also, individual IRFs for each country within the specific group are also shown (dotted red lines).

For advanced economies (Figure 1), industrial activity responds negatively to an increase in oil prices derived from oil supply shocks and to oil-specific demand shocks, while it expands as a result of oil demand driven by economic activity shocks. Price responses to oil supply and oil-specific demand are faint compared to the ones observed when the shock is driven by global economic activity. In contrast to the impacts of oil shocks on interest rates in the 80's and early 90's found by the literature (Barsky and Kilian (2002), Bernanke et al. (1997)), our results show that interest rates tend to decrease as a result of oil supply and oil-specific demand shocks. Exchange rates in this group do not seem to experience statistically significant changes.

It may look counter-intuitive to see interest rates fall after an oil supply shock. However, as noticed, the impact of an oil price shock on inflation is rather faint. If we compare the response of inflation and interest rates after an oil supply shock and a world economic activity shock we see that the latest has a bigger effect on inflation than the former one. Hence, central banks react accordingly by rising interest rates. In turn, inflation is affected less by an oil supply shock but economic activity weakens. In such scenario, it is quite probable that by decreasing interest rates, countries signal their preference to bust economic activity over inflation control, which seems not highly affected by oil price shocks.

Compared to advanced economies, the impacts of oil shocks on industrial activity in emerging economies are less intense (Figure 2); industrial activity barely decreases in the very short term as a result of an oil supply shock, and it falls for a shorter period after an oil-specific demand shock. The interest rate decreases momentarily immediately after an oil demand driven by economic activity shock occurs and tends to rise in the long term, also much later than in advanced economies and with less intensity. In contrast, exchange rates in emerging market economies are more responsive to oil shocks than in advanced economies and tend to appreciate. The impacts of oil-specific demand shocks on prices tend to be stronger when compared against those observed in advanced economies.

Interestingly, for most oil producing countries (Figure 3), economic activity does not increase as a result of oil supply or specific demand shocks. The exception is Brazil, whose industrial activity increases as a result of an oil supply shock. Industrial activity increases for all oil producer countries after oil demand driven by economic activity shocks, similar to what non-oil producer countries experience. Most of the impacts are reflected via exchange rates, which tend to appreciate when an oil-specific demand or oil demand driven by economic activity shock occurs, mainly due to capital influx. Interest rates do not seem to change as a result of oil price shocks, possibly due to the fact that prices do not change, except for when oil prices are driven by oil specific-demand shocks.

For non-oil producers (Figure 4), economic activity decreases when oil supply or oil-specific demand shocks hit and the impact is persistent over time. It starts recovering 10 months after the shock. The lasting of the effect may be related to the capacity of such economies to adjust to high oil import prices, i.e. the earlier industries adjust to higher oil prices, the least persistent are the impacts of oil price shocks. When shocks are driven by economic activity, industrial activity, prices and interest rates tend to increase. Remarkably, interest rates do not tend to increase when shocks are supply or demand oil-specific. Oil shocks do not have statistically significant impacts on exchange rates for this group of countries.

When looking at the responses for the group of controlled energy prices (Figure 5), we can observe that prices tend to increase more in countries with price controls than in countries with no controls (Figure 6), particularly when oil shocks are demand specific, mainly reflecting that gasoline price controls do not seem to affect overall price behavior in the context of oil price shocks. This is more notorious given price responses of this group are similar to those of oil producer and emerging countries. Exchange rates in countries with energy price controls behave in a similar fashion than in oil producers: in general, they tend to appreciate possibly as a result of capital influx due to economic growth expectations in those countries. They do not change in the case of oil demand-specific shocks. One explanation for such non-response may be that, because oil demand-specific shocks are usually driven by future expectations of supply shortages, investors tend to be more cautious and capital movements are put to a halt.

In the aggregate (Figure 7), oil shocks impacts are driven by advanced countries: economic activity tends to decrease as a result of oil-specific demand or supply shocks, while it increases as a result of an increase in global economic activity. Prices, interest rates and exchange rates do not seem to react to oil-specific demand or supply shocks. These results are similar to other findings in the literature that show that in recent decades oil shocks have rather moderate impacts in the global economy (Blanchard and Gali (2007); Segal (2011)).

4.1 Testing differences across groups

In this subsection we formally test if there are statistically significant differences in the IRFs across groups and time. In particular, we conduct mean differences of the IRFs at 5, 15 and 24 months, see Tables 4 to 6. The first column in the tables show the reference group and the labels of the groups for which the reference IRFs are compared against. Coefficients are expressed in absolute values and statistically significant differences are denoted by asterisks.

The first thing to notice is that some groups respond in a homogeneous way to oil shocks: there seems to not be statistically significant differences between emerging (EME), controlled prices (CP) and oil producers (OP). Also, advanced (AE), non-controlled prices (NCP) and non-oil producers (NOP) countries tend to behave in a similar way.

Hence, most of the differences that we observe in Tables 4 to 6 emerge from the differences between these two main broad groups: EME, CP and OP vs. AE, NCP and NOP. By variables, differences in the impacts on prices and interest rates arise mainly from oil-specific demand shocks across those two main groups and they tend to be persistent over time. Differences in the response of exchange rates arise mainly from oil supply or oil demand driven by economic activity shocks; while those observed for industrial activity originate mostly exclusively from oil supply shocks. Remarkably: 1) impacts of oil shocks on industrial activity are not statistically different between emerging and advanced countries and 2) most differences across groups in terms of the impacts of oil shocks on industrial activity tend to disappear over time, even across groups of countries that have traditionally been reported as reacting differently to oil shocks, such as OP and NOP.

While formally testing why there are rather small differences in the way oil and non-oil producer countries react to oil supply shocks is beyond the scope of this paper, we advance some hypotheses that may help to shed light on the possible causes of this finding. One of the hypothesis is that exports excluding oil, have increased for both oil and non-oil producers in recent decades. Figure 8 shows the evolution of exports excluding oil for both oil and non-oil producers since 1996 as percentage of GDP. Since 2000s those exports have increased for both groups of countries, although the rate of growth in oil producers has been slower than in non-oil producers. Figure 9 shows oil exports as percentage of GDP. Oil exports have sharply decreased since 2014 due to the oil price collapse and they are nearly 4 times lower than other exports for oil producer countries. Related to this point, trade openness may also be playing a role in explaining why oil supply shocks do not seem to have a positive impact on industrial activity. Figure 10 shows the evolution of trade openness measured as the sum of imports and exports to GDP for oil producer countries. Interestingly, Brazil, the least open economy from the countries in the OP group, is also the the only country within such group that reacts positively to oil supply shocks. Finally, the energy intensity of analyzed economies has been decreasing over time. Figure 11 shows the evolution of energy intensities since 2000. Not only energy intensity has constantly decreased in the analyzed period but some of the largest decreases occurred in the mid 2000s.

5 Conclusions and Policy Implications

This study shows that since 2000s the way countries react to oil shocks is less differentiated than previously found. The literature has emphasized that oil producer countries tend to benefit from oil shocks compared to non-oil producers. Our work shows that in recent decades oil shocks seem not to boost economic activity in oil producer countries as used to be the case in decades before 2000s. We document that most of the differences on how countries react to oil shocks arise from the source of the oil shock, rather than from country differences. These new findings may be explained by the recent developments in global markets. First, countries are more integrated and even for oil export economies, exports excluding oil have grown at a constant pace, while oil exports have decreased in recent years. Second, worldwide energy consumption ratios to GDP have also been constantly falling since 2000. These two facts coupled with the findings of the paper highlight the need of conducting research on how oil exporting economies are transforming and adapting to new oil market conditions.

Considering our results suggest that the differences in the impacts of oil prices are mainly due to the source of the oil price shocks, it becomes more relevant for policymakers to identify the source of the shock. Also, opening up to trade may make oil producers less vulnerable to oil price fluctuations, consequently, it may also downplay the potential gains from oil price increases. Our findings are relevant in the current context, considering oil prices may remain low in the medium term and that even if these begin to increase, the benefits may not be as high as they were in the years previous to the 2000s. In addition, the emergence of the U.S. as an important oil producer in the last couple of years may also bring about significant changes in the dynamics of the oil market reducing gains from future increases in oil prices for all participants due to higher competition. This new environment will deliver important challenges for policymakers, particularly for those in oil producers countries. Strengthening trade openness and export diversification may be sound strategies to cope with such challenges.

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6 Tables and Figures

Table 1: Country Grouping According to Economic and Oil Market Characteristics

Groups	Countries Included
1. All	Canada, France, Germany, Italy, Japan, Norway, Spain, UK, US, Brazil, Chile, Czech Rep., Ireland, Israel, Mexico, Poland, Russia
2. AE	Canada, France, Germany, Italy, Japan, Norway, Spain, UK, US
3. EMEs	Brazil, Chile, Czech Rep., Ireland, Israel, Mexico, Poland, Russia
4. OP	Brazil, Canada, Mexico, Norway, Russia
5. NOP	Chile, Czech Rep., France, Germany, Ireland, Israel, Italy, Japan, Poland, Spain, UK, US
6. CP	Brazil, Chile, Mexico, Russia
7. NCP	Canada, Czech Rep., France, Germany, Ireland, Israel, Italy, Japan, Norway, Poland, Spain, UK, US

Table 2: Sign Restrictions of Structural Shocks

Structural Shocks	Q_t^{oil}	P_t^{oil}	Y_t^W
Oil Supply	< 0	> 0	≤ 0
Oil Demand Driven by Economic Activity	> 0	> 0	> 0
oil-specific Demand	> 0	> 0	≤ 0

Table 3: Best Fit of Country Per Group

Countries	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Brazil	Pr	CP	EMEs	Adv	NCP	Non-Pr
Canada	Pr	EMEs	NCP	Adv	Non-Pr	CP
Chile	CP	EMEs	NCP	Adv	Non-Pr	Pr
Czech Republic	EMEs	NCP	Non-Pr	Adv	CP	Pr
France	Adv	NCP	Non-Pr	EMEs	Pr	CP
Germany	Adv	NCP	Non-Pr	EMEs	Pr	CP
Ireland	NCP	EMEs	Non-Pr	Adv	Pr	Non-Pr
Israel	NCP	Non-Pr	EMEs	Adv	Pr	CP
Italy	Adv	Non-Pr	NCP	EMEs	Pr	CP
Japan	Adv	NCP	Non-Pr	EMEs	Pr	CP
Mexico	Pr	CP	EMEs	NCP	Adv	Non-Pr
Norway	Pr	EMEs	Adv	NCP	CP	Non-Pr
Poland	NCP	EMEs	Non-Pr	Adv	Pr	CP
Russia	EMEs	CP	Pr	NCP	Adv	Non-Pr
Spain	Adv	NCP	Non-Pr	EMEs	Pr	CP
UK	NCP	Adv	Non-Pr	EMEs	Pr	CP
US	Adv	NCP	Non-Pr	EMEs	Pr	CP

Adv = Advanced economies; EMEs = Emerging market economies; Pr = Producers; Non-Pr = Non-producers; CP = Controlled energy prices; NCP = Non-controlled energy prices.

Table 4: Test of differences in IRFs' means across country groups after 5 months

	Industrial Activity			Prices			Interest Rate			Exchange Rate		
Reference = All	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.
AE	0.351	1.400	0.584	0.512	2.254**	1.496	1.042	2.164**	0.869	3.076***	0.799	2.975**
EME	1.232	0.361	0.169	0.387	2.387**	0.966	0.525	2.810**	1.289	2.256**	1.039	2.831**
OP	2.411**	0.832	0.322	0.955	2.128**	0.728	0.547	1.678	0.997	1.222	0.374	4.350***
NOP	0.509	1.643	0.718	0.437	2.278**	1.615	1.152	2.120**	0.897	3.192***	0.774	3.704***
CP	2.271**	0.044	0.209	0.700	3.265***	1.159	0.449	2.531**	1.273	2.201**	0.622	4.368***
NCP	0.430	1.373	0.645	0.488	2.162**	1.627	1.032	2.022**	0.886	3.128***	0.790	3.224***
Reference = AE												
EME	1.303	1.887*	0.431	0.004	4.395***	2.008**	0.949	5.076***	1.778*	4.593***	1.566	5.366***
OP	2.118**	2.135**	0.790	0.564	4.101***	1.655	0.907	3.224***	1.379	2.859**	0.883	6.704***
NOP	0.101	0.150	0.061	0.099	0.085	0.017	0.192	0.061	0.064	0.028	0.067	0.181
CP	2.065**	1.502	0.309	0.394	5.647***	1.962**	0.707	4.186***	1.579	3.925***	1.031	6.716***
NCP	0.026	0.107	0.015	0.061	0.128	0.010	0.064	0.208	0.022	0.122	0.077	0.080
Reference = EME												
OP	0.905	0.543	0.453	0.450	0.228	0.104	0.074	0.572	0.091	0.414	0.463	1.109
NOP	1.550	2.200**	0.542	0.076	4.406***	2.085**	0.984	5.038***	1.790*	4.679***	1.563	6.603***
CP	0.890	0.443	0.072	0.341	0.620	0.368	0.095	0.204	0.321	0.418	0.104	1.143
NCP	1.503	1.889*	0.466	0.047	4.322***	2.090**	0.941	4.956***	1.785*	4.634***	1.582	5.940***
Reference = OP												
NOP	2.512**	2.379**	0.920	0.655	4.114***	1.707*	0.936	3.197***	1.388	2.880**	0.859	8.614***
CP	0.065	0.928	0.448	0.030	0.859	0.435	0.033	0.686	0.377	0.718	0.273	0.053
NCP	2.503**	2.131**	0.858	0.635	4.030***	1.705*	0.899	3.134***	1.384	2.844**	0.864	7.664***
Reference = NOP												
CP	2.420**	1.800*	0.390	0.456	5.650***	2.008**	0.728	4.157***	1.586	3.961***	1.010	8.616***
NCP	0.084	0.282	0.084	0.044	0.206	0.030	0.286	0.146	0.046	0.101	0.009	0.293
Reference = CP												
NCP	2.403**	1.486	0.322	0.437	5.558***	2.007**	0.701	4.094***	1.582	3.925***	1.014	7.670***

***,**,* denote statistically significant mean differences at the 1, 5 and 10 percent levels.
Coefficients represent absolute values of mean differences.

Table 5: Test of differences in IRFs' means across country groups after 15 months

	Industrial Activity			Prices			Interest Rate			Exchange Rate		
Reference = All	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.
AE	0.156	0.427	1.436	0.729	2.285**	0.302	0.782	1.922*	0.485	3.085***	0.048	2.228**
EME	1.583	0.077	1.177	0.160	2.319**	0.565	0.595	2.003**	0.084	2.181**	0.484	1.406
OP	2.033**	0.458	0.819	0.937	1.765*	0.902	0.636	1.143	0.315	1.779*	0.319	1.350
NOP	0.046	0.553	1.504	0.641	2.215**	0.383	0.891	1.803*	0.487	3.389***	0.204	2.569**
CP	2.680**	0.276	1.478	0.632	2.779**	0.903	0.452	1.566	0.134	2.176**	0.097	1.121
NCP	0.062	0.427	1.528	0.685	2.130**	0.341	0.764	1.735*	0.516	3.176***	0.117	2.392**
Reference = AE												
EME	1.547	0.353	2.523**	0.422	4.220***	0.827	0.972	3.487***	0.276	4.437***	0.419	2.960**
OP	2.019**	0.843	2.145**	0.286	3.409***	1.235	0.959	2.283**	0.025	3.699***	0.333	2.790**
NOP	0.129	0.096	0.007	0.113	0.003	0.100	0.127	0.121	0.032	0.094	0.134	0.077
CP	2.687**	0.150	2.715**	0.095	4.644***	1.153	0.681	2.564**	0.124	3.864***	0.068	2.310**
NCP	0.115	0.033	0.032	0.084	0.201	0.041	0.067	0.242	0.023	0.108	0.055	0.083
Reference = EME												
OP	0.252	0.529	0.317	0.616	0.356	0.232	0.092	0.518	0.201	0.102	0.624	0.077
NOP	1.637	0.474	2.637**	0.347	4.163***	0.886	1.013	3.404***	0.261	4.641***	0.331	3.210***
CP	0.853	0.201	0.384	0.420	0.462	0.341	0.054	0.028	0.068	0.442	0.220	0.134
NCP	1.641	0.347	2.691**	0.375	4.106***	0.859	0.959	3.361***	0.274	4.498***	0.397	3.079***
Reference = OP												
NOP	2.126**	0.975	2.236**	0.395	3.370***	1.305	0.994	2.227**	0.002	3.838***	0.437	2.993
CP	0.641	0.707	0.670	0.118	0.791	0.146	0.020	0.465	0.092	0.499	0.295	0.068
NCP	2.137**	0.865	2.276**	0.375	3.317***	1.279	0.947	2.189**	0.010	3.721***	0.385	2.874**
Reference = NOP												
CP	2.794**	0.256	2.818**	0.174	4.587***	1.206	0.705	2.516**	0.108	3.978***	0.006	2.432**
NCP	0.018	0.141	0.026	0.034	0.176	0.063	0.212	0.113	0.011	0.221	0.087	0.175
Reference = CP												
NCP	2.808**	0.128	2.866**	0.155	4.533***	1.183	0.671	2.484**	0.114	3.877***	0.039	2.336**

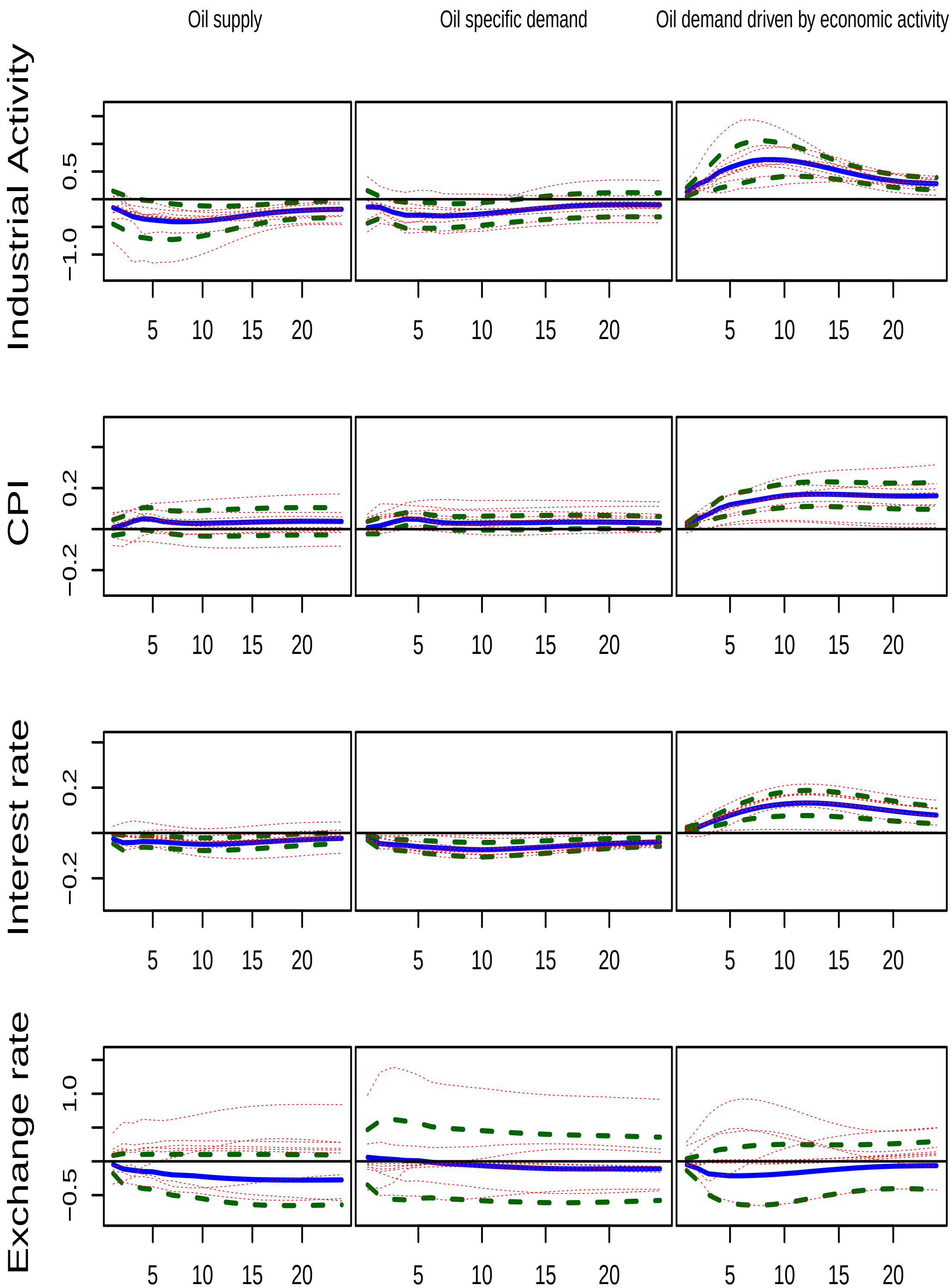
***,**,* denote statistically significant mean differences at the 1, 5 and 10 percent levels.
Coefficients represent absolute values of mean differences.

Table 6: Test of differences in IRFs' means across country groups after 24 months

	Industrial Activity			Prices			Interest Rate			Exchange Rate		
Reference = All	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.	Oil Supply	Oil Specific Demand	Oil Demand by Econ. Act.
AE	0.519	0.111	0.929	0.775	2.398**	0.118	1.131	1.998**	0.194	3.114***	0.117	1.929*
EME	1.362	0.370	0.120	0.186	2.387**	0.521	0.937	2.043**	0.376	2.183**	0.193	1.515
OP	1.849*	0.289	0.098	0.999	1.766*	1.019	0.942	1.146	0.979	1.678	0.423	1.554
NOP	0.401	0.224	0.971	0.688	2.313**	0.211	1.273	1.849*	0.157	3.382***	0.257	2.253**
CP	2.284	0.524	0.111	0.715	2.762**	0.987	0.769	1.637	0.677	2.131**	0.146	1.275
NCP	0.414	0.107	0.992	0.727	2.218**	0.167	1.122	1.777*	0.196	3.188***	0.190	2.115**
Reference = AE												
EME	1.132	0.266	0.703	0.439	4.415***	0.654	1.551	3.641***	0.065	4.448***	0.105	2.856***
OP	1.637	0.383	0.950	0.284	3.474***	1.236	1.475	2.366**	0.506	3.549***	0.478	2.828***
NOP	0.157	0.104	0.019	0.113	0.012	0.108	0.132	0.148	0.045	0.077	0.118	0.073
CP	2.107**	0.423	0.902	0.127	4.681***	1.147	1.154	2.750**	0.314	3.798***	0.200	2.391**
NCP	0.153	0.013	0.008	0.090	0.238	0.053	0.071	0.277	0.019	0.115	0.054	0.064
Reference = EME												
OP	0.301	0.594	0.044	0.637	0.389	0.351	0.090	0.559	0.737	0.156	0.489	0.145
NOP	1.213	0.184	0.734	0.362	4.344***	0.730	1.612	3.534***	0.132	4.624***	0.023	3.162***
CP	0.782	0.156	0.209	0.466	0.429	0.420	0.121	0.014	0.391	0.418	0.248	0.193
NCP	1.215	0.294	0.743	0.387	4.280***	0.700	1.540	3.486***	0.102	4.495***	0.071	3.055***
Reference = OP												
NOP	1.729*	0.489	1.003	0.397	3.428***	1.337	1.525	2.296**	0.623	3.660***	0.569	3.097***
CP	0.520	0.726	0.202	0.087	0.783	0.119	0.045	0.496	0.260	0.518	0.153	0.072
NCP	1.735*	0.393	1.034	0.384	3.370***	1.310	1.463	2.256**	0.616	3.556***	0.531	2.994***
Reference = NOP												
CP	2.190**	0.352	0.933	0.209	4.616***	1.225	1.188	2.687**	0.402	3.892***	0.264	2.557**
NCP	0.009	0.127	0.012	0.027	0.191	0.060	0.221	0.117	0.028	0.210	0.071	0.151
Reference = CP												
NCP	2.197**	0.459	0.945	0.194	4.556***	1.200	1.143	2.651**	0.385	3.801***	0.232	2.467**

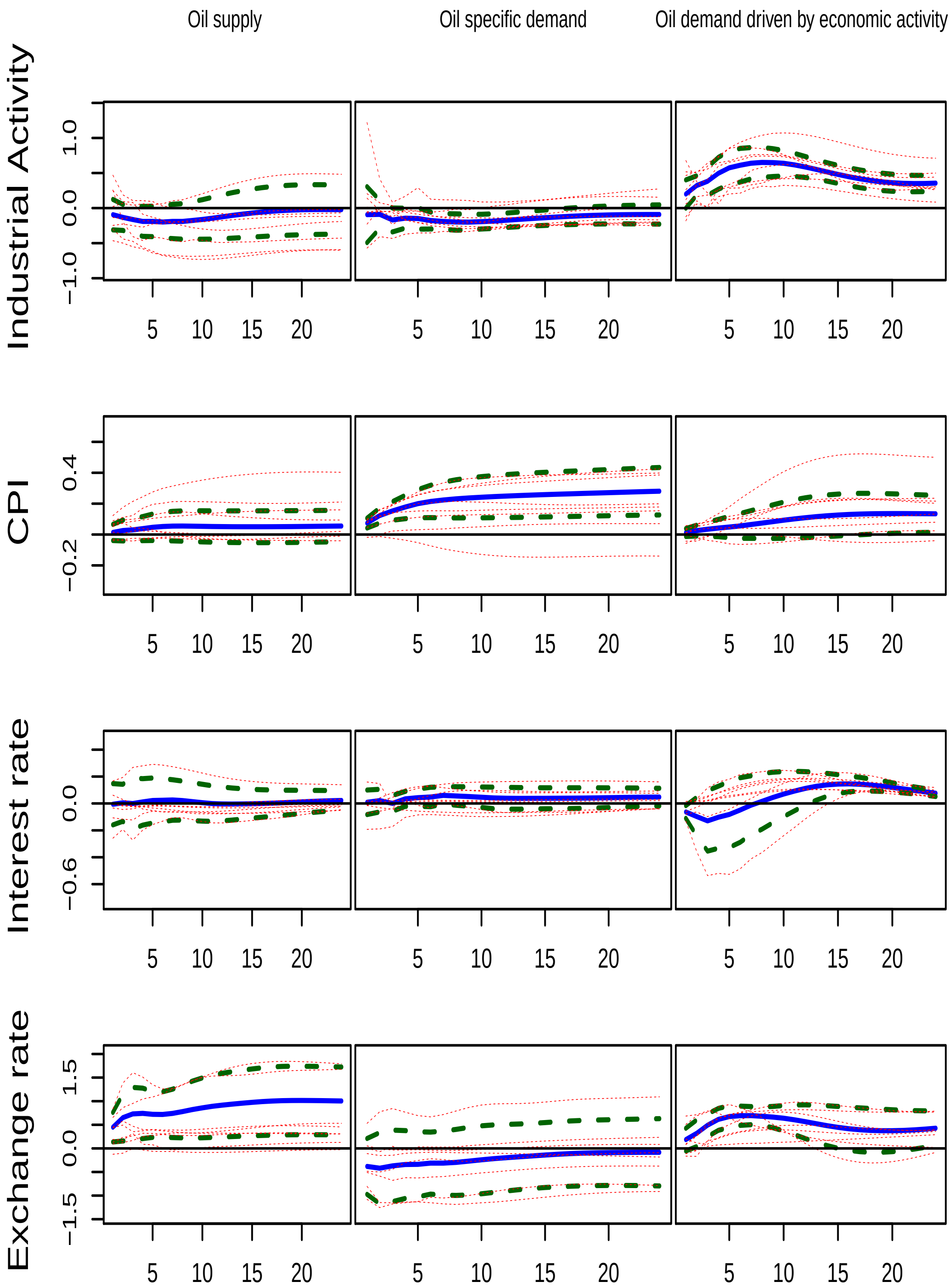
***,**,* denote statistically significant mean differences at the 1, 5 and 10 percent levels.
Coefficients represent absolute values of mean differences.

Figure 1: IRF for Oil Shocks



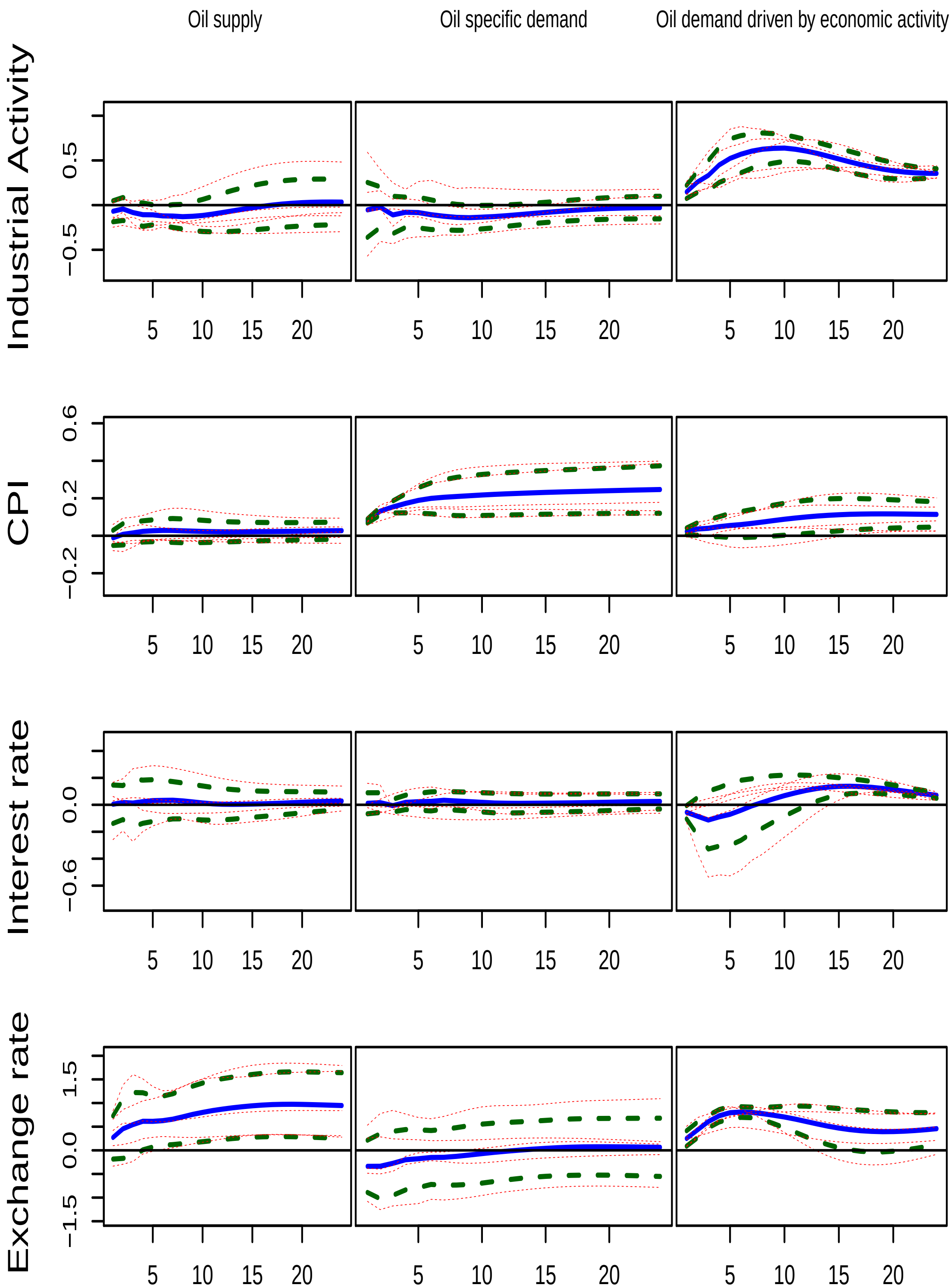
Average IRF (blue line) together with 10% confidence interval bands (green line) and individual IRFs for each country within the specific group (red dotted lines).

Figure 2: IRF for Oil Shocks



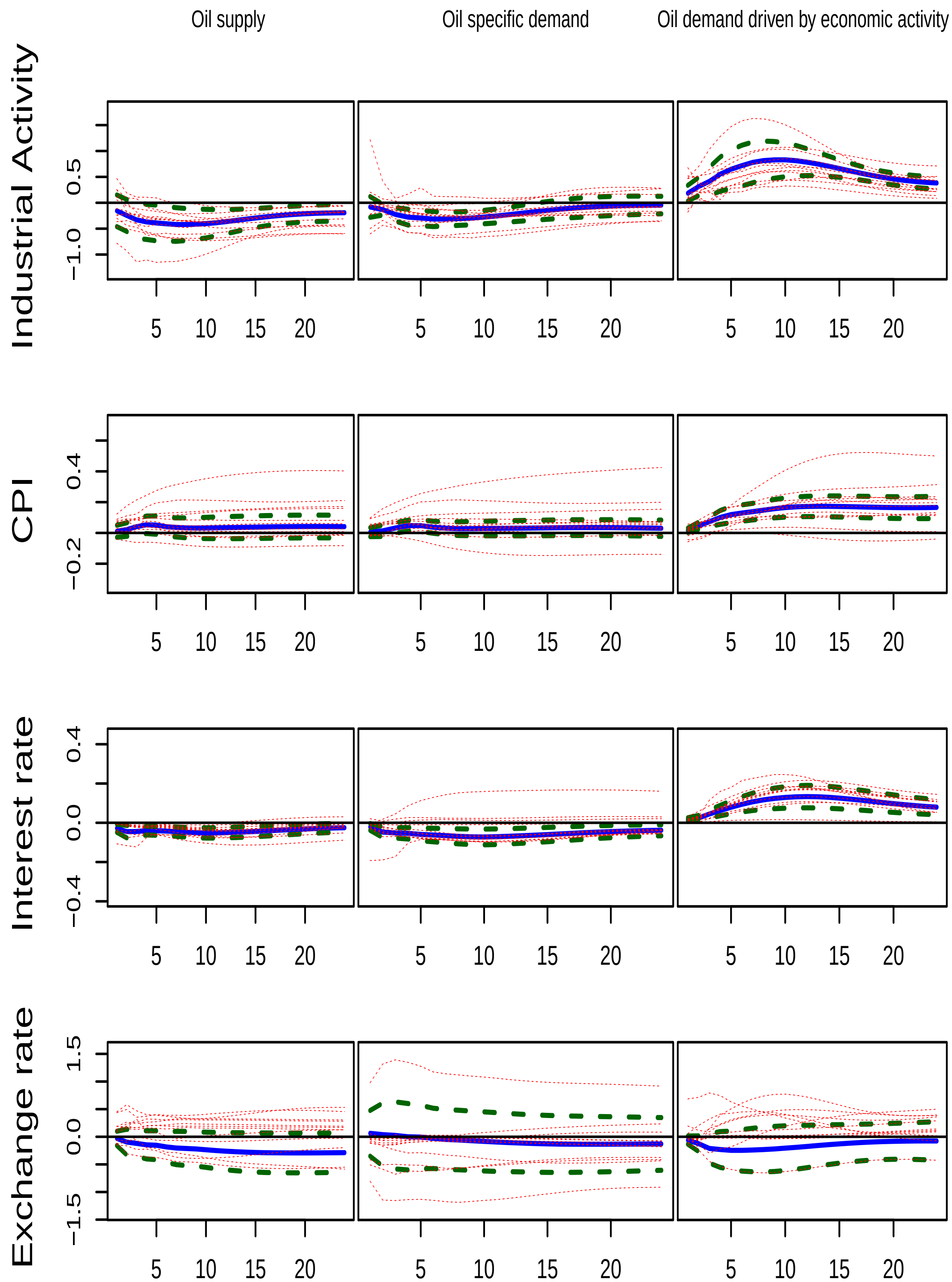
Average IRF (blue line) together with 10% confidence interval bands (green line) and individual IRFs for each country within the specific group (red dotted lines).

Figure 3: IRF for Oil Shocks



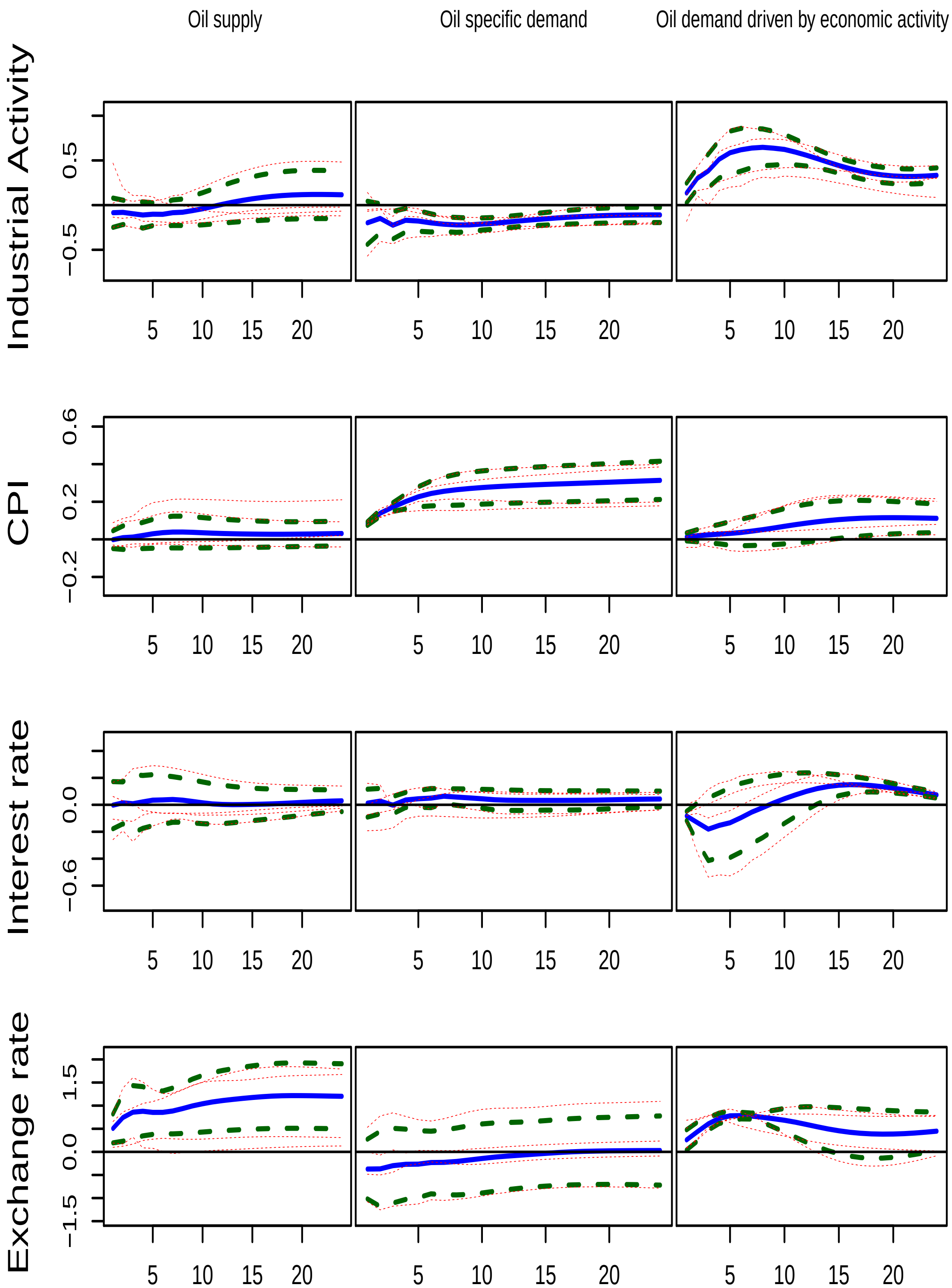
Average IRF (blue line) together with 10% confidence interval bands (green line) and individual IRFs for each country within the specific group (red dotted lines).

Figure 4: IRF for Oil Shocks



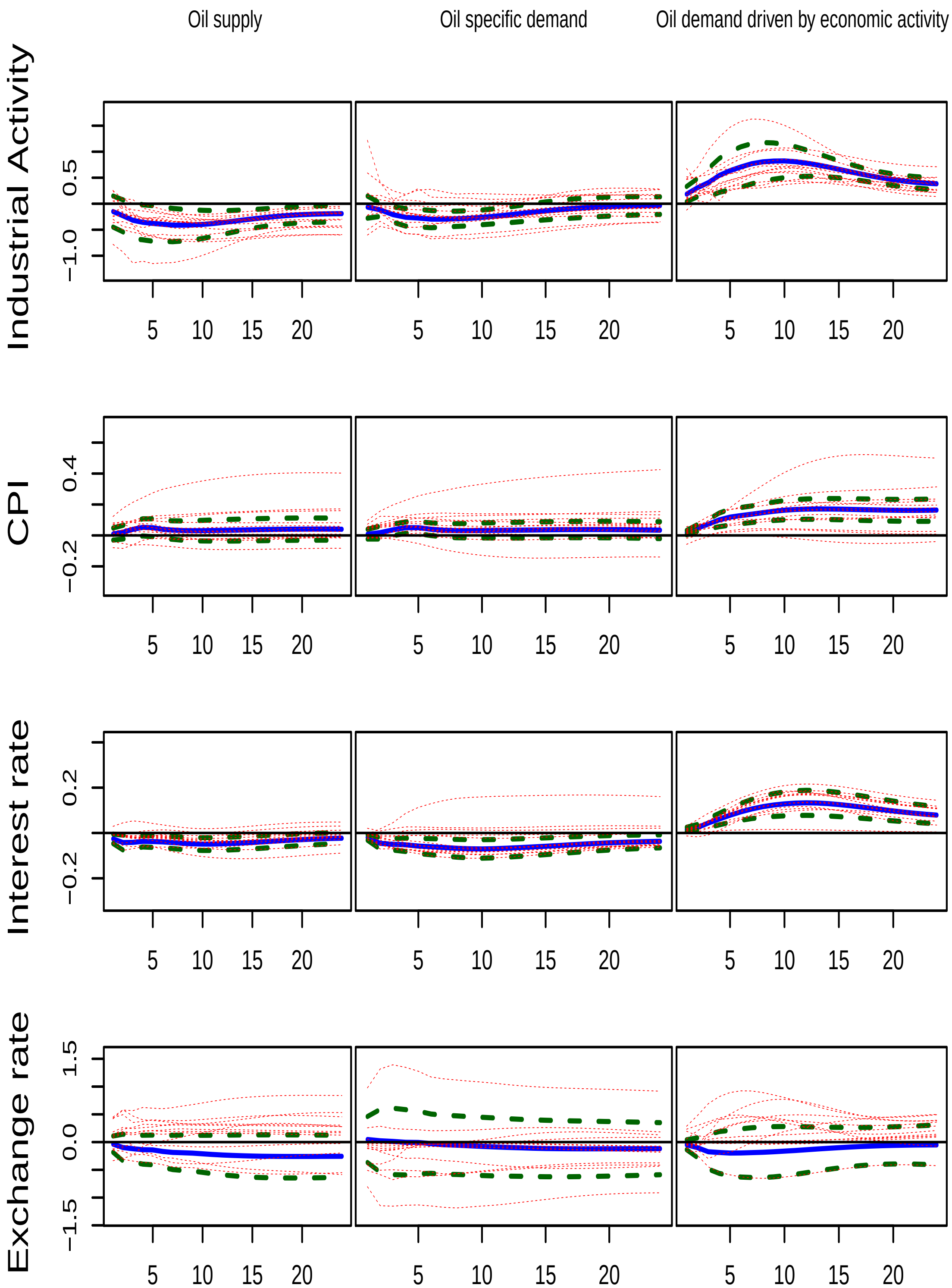
Average IRF (blue line) together with 10% confidence interval bands (green line) and individual IRFs for each country within the specific group (red dotted lines).

Figure 5: IRF for Oil Shocks



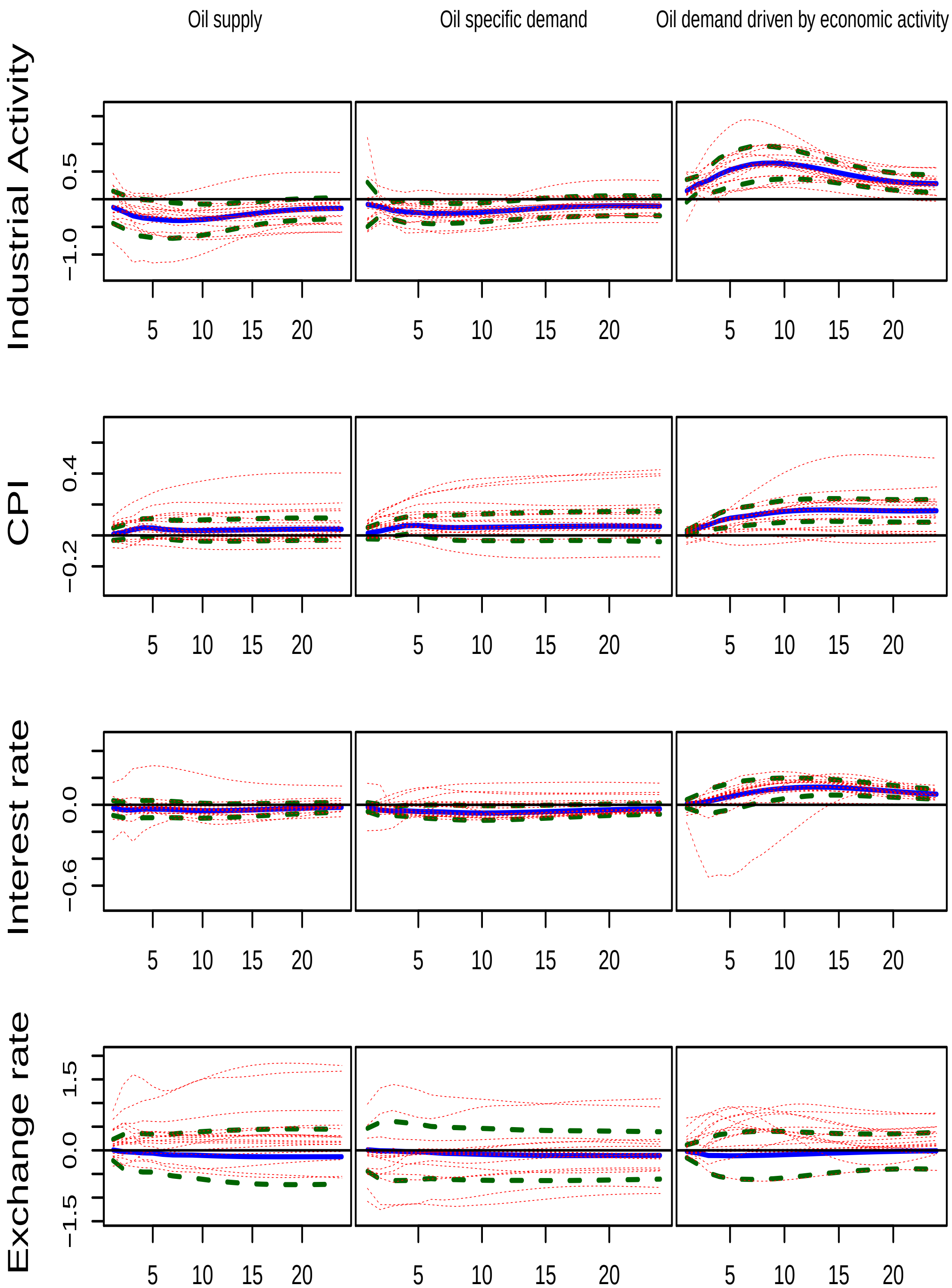
Average IRF (blue line) together with 10% confidence interval bands (green line) and individual IRFs for each country within the specific group (red dotted lines).

Figure 6: IRF for Oil Shocks



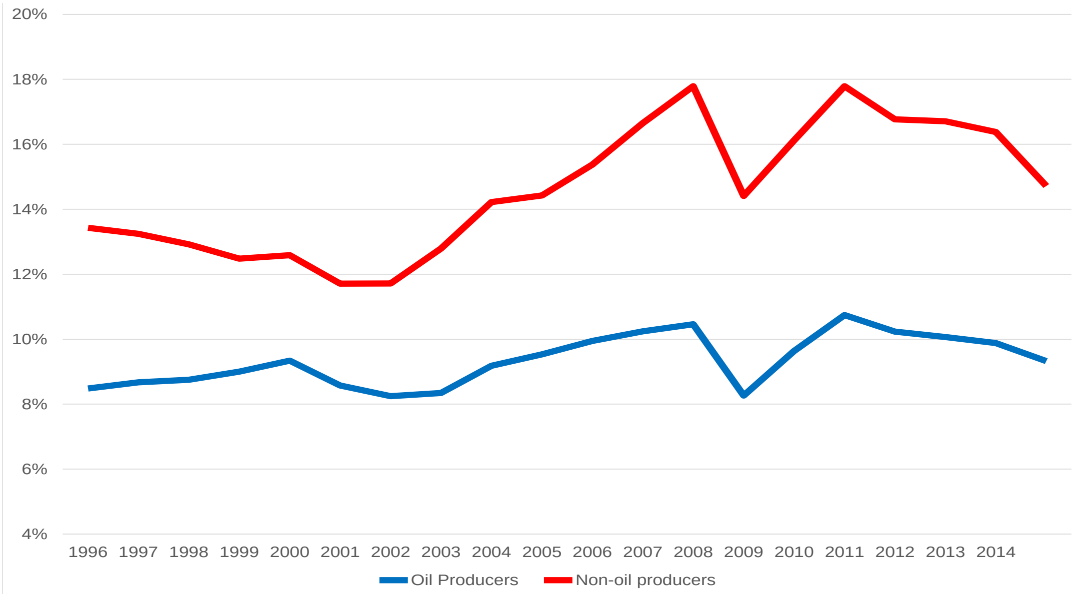
Average IRF (blue line) together with 10% confidence interval bands (green line) and individual IRFs for each country within the specific group (red dotted lines).

Figure 7: IRF for Oil Shocks



Average IRF (blue line) together with 10% confidence interval bands (green line) and individual IRFs for each country within the specific group (red dotted lines).

Figure 8: Exports excluding oil as percentage of GDP

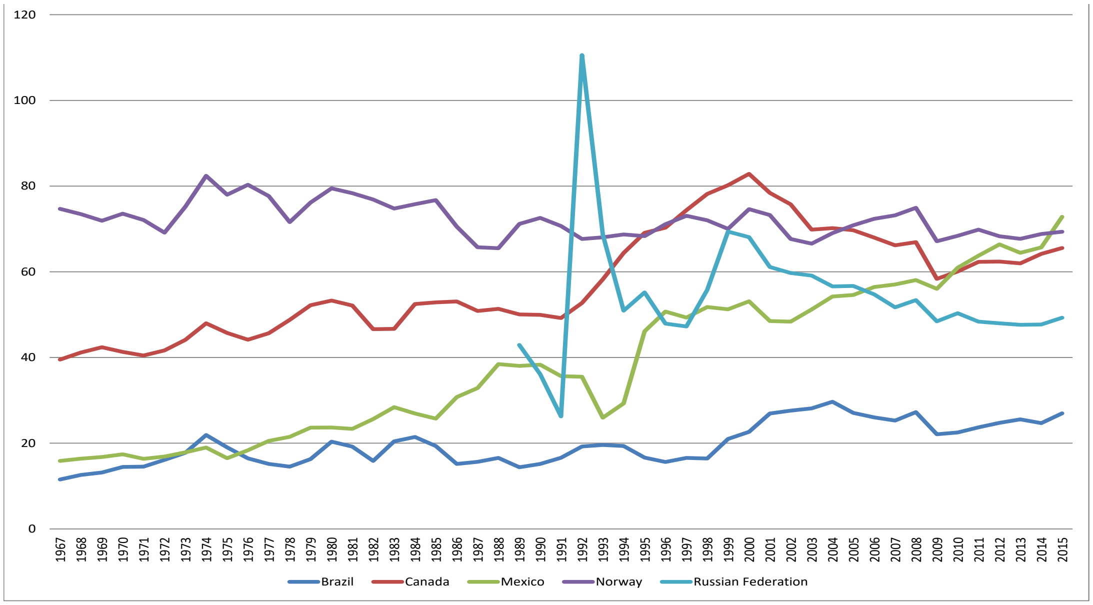


Exports excluding oil to GDP based on purchasing-power-parity (PPP) valuation of country GDP (Millions of US dollars).
Source: IMF and WB.

Figure 9: Oil exports as percentage of GDP

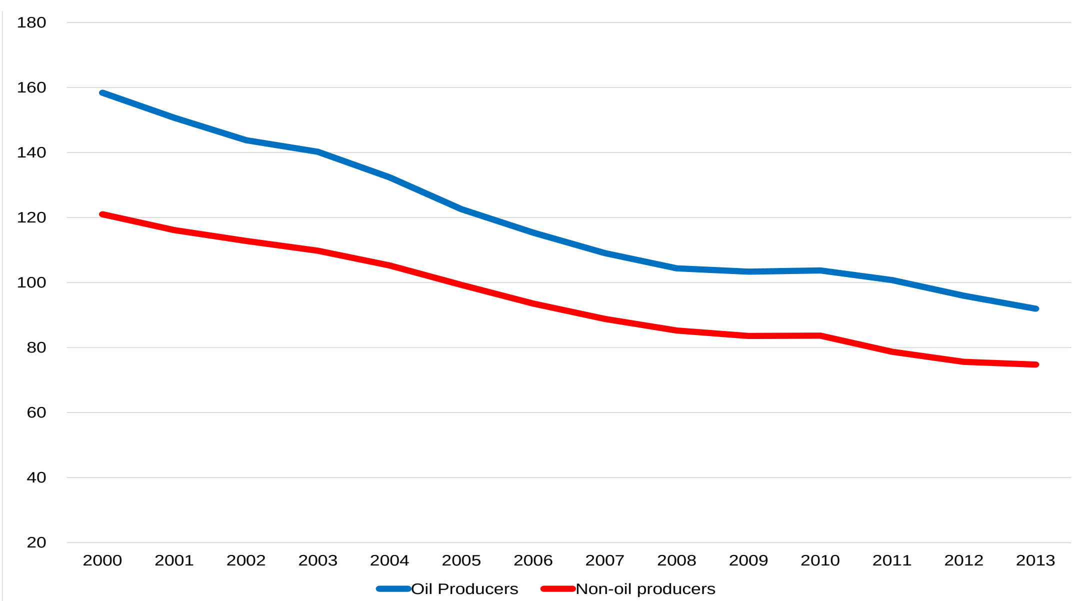
Crude, NGL and feedstocks-Net imports (Tonne of oil equivalent (toe)) to GDP based on purchasing-power-parity (PPP) valuation of country GDP (Millions of US dollars).
Source: IMF and IEA.

Figure 10: Trade openness



Sum of imports and exports to total GDP (%).
Source: WB.

Figure 11: Energy consumption to GDP



Total final consumption of total energy (Tonne of oil equivalent (toe)) to GDP based on purchasing-power-parity (PPP) valuation of country GDP (Millions of US dollars).
Source: IMF and IEA.

A Appendix

Table A.1: Advanced Economies Macroeconomic Variables

Country	Indicator	Source	Description	Unit
Canada	IP	Haver Analytics	Industrial Production (SA)	Index 2007=100
	CPI	Haver Analytics	Consumer Price Index (SA)	Index 2002=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
France	IP	Haver Analytics	Industrial Production excl. Construction (SWDA)	Index 2010=100
	CPI	Haver Analytics	Harmonized Index of Consumer Prices	Index 2005=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Germany	IP	Haver Analytics	Total Industry excl. Construction(SA/WDA)	Index 2010=100
	CPI	Haver Analytics	Harmonized Index of Consumer Prices (SA)	Index 2005=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Ireland	IP	Haver Analytics	Industrial Production excluding Construction (SWDA)	Index 2010=100
	CPI	Haver Analytics	Harmonized Index of Consumer Prices (SA)	Index 2005=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Italy	IP	Haver Analytics	Total Industry excl. Construction (SA)	Index 2010=100
	CPI	Haver Analytics	Harmonized Index of Consumer Prices (SA)	Index 2005=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Japan	IP	Haver Analytics	Industrial Production excluding Construction (SA)	Index 2010=100
	CPI	Haver Analytics	Consumer Price Index (NSA)	Index 2010=100
	i	Haver Analytics	Short-term Prime Lending Rate of Banks	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Norway	IP	Haver Analytics	Industrial Production excluding Construction (SWDA)	Index 2005=100
	CPI	Haver Analytics	Harmonized Index of Consumer Prices (SA)	Index 2005=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Spain	IP	Haver Analytics	Industrial Production excluding Construction (SWDA)	Index 2010=100
	CPI	Haver Analytics	Harmonized Index of Consumer Prices (SA)	Index 2005=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
U.K.	IP	Haver Analytics	Industrial Production excluding Construction (SA)	Index 2012=100
	CPI	Haver Analytics	Harmonized Index of Consumer Prices (SA)	Index 2005=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
U.S.	IP	Haver Analytics	Industrial Production excluding Construction (SA)	Index 2012=100
	CPI	Haver Analytics	Harmonized Index of Consumer Prices (SA)	Index Dec-97=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100

Table A.2: Emerging Economies Macroeconomic Variables

Country	Indicator	Source	Description	Unit
Brazil	IP	Bloomberg	Industrial Production (SA)	Index 2012=100
	CPI	Haver Analytics	National Consumer Price Index (SA)	Index 2010=100
	i	Haver Analytics	Interest Rate: Selic - Target Rate	Percent
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Chile	IP	Haver Analytics	Industrial Production: Manufacturing (SA)	Index 2009=100
	CPI	Haver Analytics	Consumer Price Index (SA)	Index 2013=100
	i	OECD	Monthly Monetary and Financial Statistics (OECD)	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Czech Rep.	IP	Haver Analytics	Industrial Production (SA)	Index 2010=100
	CPI	Haver Analytics	Consumer Price Index (SA)	Index 2005=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Israel	IP	Haver Analytics	Manufacturing Production at Constant Prices (SA)	Index 2011=100
	CPI	Haver Analytics	CPI: General Index including VAT (SA)	Index 2014=100
	i	Haver Analytics	3-Month LIBOR Interest Rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Mexico	IP	Haver Analytics	IP including Construction (SA)	Index 2008=100
	CPI	Haver Analytics	Consumer Price Index (SA)	Index 2010=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Poland	IP	Haver Analytics	IP excluding Construction (SA/WDA)	Index 2010=100
	CPI	Haver Analytics	Consumer Price Index (SA)	Index 1998=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100
Rusia	IP	Haver Analytics	IP excluding Construction (SA)	Index 2013=100
	CPI	Haver Analytics	Consumer Price Index (SA)	Index 2005=100
	i	OECD	Short-term interest rate	Percent per annum
	E	IMF-IFS	Nominal Effective Exchange Rate	Index 2010=100

Table A.3: Oil and World Economic Activity Variables

Indicator	Source	Description	Unit
Q^oil	U.S. EIA	Total World Supply	Million barrels per day
P^oil	U.S. EIA	U.S. Crude Oil Imported Acquisition Cost by Refiners	Dollars per barrel
Y^W	OECD STAT	All OECD Countries Production of Total Industry, s.a.	Index 2010=100