IMK
Macroeconomic Policy Institute

The IMK is an institute of the Hans-Böckler-Stiftung

WORKING PAPER

Nr. 185 · August 2017 · Hans-Böckler-Stiftung

WHY HAVE THE RECENT OIL PRICE DECLINES NOT STIMULATED GLOBAL ECONOMIC GROWTH ?

Thomas Theobald, Peter Hohlfeld[1]

ABSTRACT

We analyze the global relationship between oil prices, commodity-specific financial market shocks and economic activity by means of Structural Vector Autoregressive (SVAR) models for the period 1996 - 2015. For the financial market variables in our model, we use a breakdown of G-20 countries into net commodity exporting and importing countries to compute the real exchange rate between the country groups as well as the corresponding interest rate spread. Regarding the discussion about the missing expansionary effects of the recent oil price declines at the global level, our empirical framework tests the following transmission: A downgrading of financial conditions for commodity exporting countries can lead to a more serious decline of their domestic demand as should be expected from the pure income effect of lower export revenues due to lower oil prices. Therefore, missing expansionary effects of the recent oil price declines should not only be traced back to the absence of expansionary monetary policy effects at the zero lower bound in many commodity importing countries, but also to a high dependency of commodity exporting countries on international financial markets.

Keywords: oil price, interest rate spread, real exchange rate, economic growth, sign restriction

JEL: C30, E37, Q43

---

[1] We would like to thank Ayoze Alfageme, Sebastian Gechert and participants at the 13th International Conference of the Western Economic Association for their many helpful comments as well as Sebastian Watzka for sharing his code. Any remaining errors are ours. Contact details: Email: Peter-Hohlfeld@boeckler.de; Thomas-Theobald@boeckler.de, Macroeconomic Policy Institute (IMK), 40476 Düsseldorf. Phone: +492117778215.

Why have the recent oil price declines not stimulated global economic growth ?

Thomas Theobald [*] Peter Hohlfeld

August 24, 2017

Abstract

We analyse the global relationship between oil prices, commodity-specific financial market shocks and economic activity by means of Structural Vector Autoregressive (SVAR) models for the period 1996 - 2015. For the financial market variables in our model, we use a breakdown of G-20 countries into net commodity exporting and importing countries to compute the real exchange rate between the country groups as well as the corresponding interest rate spread. Regarding the discussion about the missing expansionary effects of the recent oil price declines at the global level, our empirical framework tests the following transmission: A downgrading of financial conditions for commodity exporting countries can lead to a more serious decline of their domestic demand as should be expected from the pure income effect of lower export revenues due to lower oil prices. Therefore, missing expansionary effects of the recent oil price declines should not only be traced back to the absence of expansionary monetary policy effects at the zero lower bound in many commodity importing countries, but also to a high dependency of commodity exporting countries on international financial markets.

Keywords: oil price, interest rate spread, real exchange rate, economic growth, sign restriction

JEL Classifications: C30, E37, Q43

[*]We would like to thank Ayoze Alfageme, Sebastian Gechert and participants at the 13th International Conference of the Western Economic Association for their many helpful comments as well as Sebastian Watzka for sharing his code. Any remaining errors are ours. **Contact details:**: Email: Peter-Hohlfeld@boeckler.de; Thomas-Theobald@boeckler.de, Macroeconomic Policy Institute (IMK), 40476 Düsseldorf. Phone: +492117778215.

1 Introduction

The Brent oil price was falling from a level of 110 USD per barrel in summer 2014 to 50 USD at the end of 2015. The only other similar drop in oil prices since the 1990s, one of more than 50% of the initial value, occured during the Great Recession of 2008. But the price declines starting in 2014 were not initialized by a massive global economic downturn. Only part of it was probably caused by the slow down of Chinese aggregate demand. As oil importing regions on average show a higher marginal propensity to consume than oil exporters, many business cycle forecasts at this time predicted an acceleration of global economic growth due to the oil price slump. In fact, such effects have not materialized. For instance, IMF growth predictions in the World Economic Outlook for 2015 had to be revised down by -0.7 pp in total. And growth of global economic activity finally decelerated from 3.4% in 2014 to 3.1% in 2015. Bundesbank (2015*a*,*b*) fully assigns this slowdown to commodity exporting regions apart from China. In contrast, growth in commodity importing regions broadly remained stable.

For the assessment of macroeconomic effects of commodity price changes on economic growth, it is crucial whether those are caused by an expansion (contraction) of demand or by a contraction (expansion) of supply. With respect to the recent price declines, there seems to be evidence for both. While some studies emphasize the increase in US shale oil production, a lack of co-operation within the Organisation of the Petroleum Exporting Countries (OPEC) and the lifting of international sanctions against Iran (Bundesbank, 2016; Manescu and Nuno, 2015), others see demand-side aspects to be at the root of the price declines (IfW, 2016; Kirby and Meaning, 2015; Obstfeld et al., 2016). Indeed, a demand-side line of argument might partly explain why the decline has not positively affected economic growth, as the oil price itself dropped because of lower aggregated demand which continued to be muted (Cerdeiro and Plotnikov, 2017). However, taking weak demand as the only explanation seems not convincing why it was mainly commodity exporting countries that contributed to the downturn in global economic growth. The same applies to missing expansionary monetary policy effects at the zero lower bound in mainly commodity importing countries (Obstfeld et al., 2016).

Given the difference in marginal propensities to consume, the literature offers at least three lines of thought as to why global expansionary effects fail to materialize following oil price declines. The first is based on an asymmetry between the effect of an oil price increase and a decline (Hamilton, 2003). In general, linear regressions of economic activity on lagged oil prices appear to be unstable over time, while non-linear specifications using only positive oil price changes - at least when adjusted for local corrections - show a slightly higher forecast performance. Intuitively, negative oil price shocks may create a need for reallocation among economic agents similar as positve ones do. Hence, uncertainty about the persistence of a negative oil price shock and therefore about the necessary extent of reallocation might, on balance, lead to negative short-term consequences for economic growth, although, at the same time, there should be some counterbalancing effect from higher real disposable income for most households. However, as Kilian and Vigfusson (2011*b*) correctly point out, a functional nonlinear prediction equation does not necessarily shed light on the transmissions that are at work. This is why expansionary effects of oil price declines should not be ruled out by assumption.

A second explanation could be higher energy efficiency (Blanchard and Riggi, 2013). As the importance of fossil fuels for the production process and also for private consumption has declined since the 1980s, the macroeconomic effects can be expected to be weaker as in former times. But simulations by IMF (2016) only indicate minor effects from increased energy efficiency and even these are mostly limited to developed economies. A third and more regime-dependent explanation is given by Obstfeld et al. (2016). The authors stress that expansionary effects of oil price declines should not be ruled in principle. But they conclude that the 2014 regime was different, because inflation and nominal interest rates in many developed countries were already low before the oil price decreased. Instead of inducing expansionary effects from a subsequent cut in interest rates[1], lower commodity prices actually exacerbated the challenges of monetary policy to tackle a real interest rate that was still too high, disinflationary tendencies and poorly anchored inflation expectations.

Each of these approaches might help to explain the absence of expansionary effects in the wake of the recent oil price declines. However, it is striking that they focus primarily on showing why the developed economies have failed to attain a faster growth path. Instead, our focus is on the commodity exporting countries where economic growth slowed more than expected. Going beyond the pure income effect from lower export revenues[2], the present paper therefore examines whether additional contractionary effects result from a worsening of their financial market conditions. In doing so, we consider the financial market channel to complement other explanations (IMF, 2016).

The present paper employs various identification schemes in Structural Vector Autoregressive (SVAR) models for the period between 1996 and 2015 based on the quarterly database of the global macro-econometric model NiGEM (NIESR, 2016). Additionally, we robustify our

[1]Many observers conjecture that only a few economies like India benefited from this transmission channel in the recent commodity price regime.

[2]The income effect refers to lower revenues for oil producers and to lower fuel, heating and other costs for consumers.

results using monthly World Bank data. For the financial market variables in our model, we use a breakdown of the G-20 countries[3] into net commodity exporting and importing countries. These variables are the real exchange rate between the country groups as well as the corresponding interest rate spread. Our results provide evidence for the following transmission mechanism: A downgrading of financial conditions for commodity exporting countries can lead to a more serious decline of their domestic demand as can be expected from the pure income effect of lower export revenues due to lower oil prices. In particular, capital outflows, as reported by ECB (2016), reflect a depreciation of commodity exporting countries relative to importing ones, which can result in a slowdown of real investment activity. On the global level, this could have overcompensated the otherwise positive effect of an income transfer from countries with lower marginal propensity to consume towards those with a higher one. As usual, this result is strongly dependent on the method of identification. In our case, this concerns the identification of commodity-specific financial market shocks.

The remainder of this paper is as follows: Section 2 discusses selected references on the macroeconomic effects of oil price shocks. Section 3 introduces the commoditiy-specific financial market shock in a global accounting structure. Besides, we show some consequences of neglecting this shock in a typical structural model simulation. We then turn to an empirical analysis with Cholesky-type identification schemes. Section 4 briefly discusses the drawbacks of the previous design. We then robustify the results by using monthly instead of quarterly data which allows us to extend the variable set and to identify impulse responses with the aid of sign restrictions. Section 5 summarizes.

2 Related Literature

The macroeconomic consequences of an oil price shock will depend on whether the shock is caused by a change of demand or supply. Kilian (2009) emphasizes the oil price endogeneity, especially in the case of demand-side shocks. In general, this implies that models with exogenous oil price assumption turn out to be misspecified. Kilian (2009) proposes a structural breakdown of real oil prices into i. oil supply shocks, ii. aggregated demand shocks and iii. oil-specific demand shocks. The latter is designed to capture precautionary oil demand which results from a sudden change in expectations about the availability of future supply. Similarly, we deal with commodity-specific financial market shocks designed to capture a worsening of commod-

[3]This is not exactly the same as the political G-20, but refers to the almost identical group of the 20 largest countries in terms of their purchasing power adjusted gross domestic product in 2015. See Table 4 for details.

ity exporters' financial market conditions which can result from a sudden change in expectations about the recoverability of energy sector related investment. Regarding a VAR analysis, Kilian (2009) concludes that impulse responses, which just place the price of oil at the beginning of a transmission mechanism, might at most approximate the sample-dependent average effect of all oil price innovations on macroeconomic variables but are misleading with respect to the effects of a single oil price shock. In principle, this drawback also applies to our analysis in Section 3.4 but not to the one in Section 4.3. The latter requires to add an oil quantity to the system in order to separate between oil supply and demand shocks. As this further reduces the degree of freedom and as it is not meaningful to extend the dataset because of major structural breaks, we resort to a higher data frequency, *i.e.* from quarterly data in Section 3.4 to monthly data in Section 4.3. We can then confirm the result from the above-mentioned literature, which attributes recent oil price drops to both demand and supply side shocks. The approximation by an average shock as used in Section 3.4 may therefore form also a feasible approach.

Cashin et al. (2014) provide an interesting contribution using a Global VAR (GVAR) with sign restrictions. Their results for the period between 1979 and 2011 point to adverse economic implications for oil exporting and importing countries in the face of a supply shock. Oil exporting countries (especially with large reserves) show a positive GDP response to a supply-driven surge in oil prices and a tendency towards a real effective currency appreciation. In contrast, oil importing countries[4] show a medium- to long-term GDP decline with no clear pattern for the exchange rate. In the case of an expansionary demand-side shock, positive GDP effects can be observed for almost all countries, either because they are already in an upturn or because they benefit from the upturn of their trade partners. In the latter case, therefore, the classification as an oil exporting or importing country may be of secondary importance relative to country-specific characteristics. However, as already argued, if the recent oil price declines have both supply-side and demand-side causes, the country classification should retain its importance.

When assessing the macroeconomic effects of oil price changes, another question that arises is whether it is appropriate to use a linear specification, which implies a symmetric impulse response. There is no consensus on this in the literature. Several studies, such as Hamilton (1996, 2003, 2011), highlight non-linearities suggesting that oil price increases are more important for macroeconomic outcomes than oil price decreases. In particular, this applies to the causes of economic recessions. On the one hand, the arguments presented by Hamilton (1996)[5]

[4]China and Japan are a notable exception here. Cashin et al. (2014) attribute this to China's strong dependence on coal and the fact that both countries benefit disproportionately from higher exports to oil exporting trade partners.

[5]The author constructs a time series of so-called net oil price increases by comparing current oil prices to the

with regard to the US recession of 1990 are based on disrupton of supply from Middle East due to political unrest. On the other hand, Hamilton (2009) mainly identifies demand-side causes for oil price increases before 2008. Surprisingly, he then assumes similar economic consequences and therefore a significant contribution of oil price dynamics to the recession of 2008. Moreover, Hamilton (2003) criticizes the majority of theoretical models, whether Keynesian or neoclassical in nature, for assuming a more or less linear production process. Frequently used Cobb-Douglas-type production functions such as in Estrada and de Cos (2012) usually employ logarithmic output depending linearly on logarithmic energy consumption. This design implies that a reduction of oil supply (an oil price increase) affects productivity as much as an expansion (an oil price decrease), only with the opposite sign. Section 3.2 presents simulations based on a model with a similar mechanism, while it also tries to depict the international trade effects. Economically, Hamilton (2003) stresses the need for reallocation which hampers economic activity during the adjustment process regardless of whether the oil price shock is positive or negative[6].

Kilian and Vigfusson (2011*a*,*b*) confirm some degree of non-linearity in the presence of very large oil price shocks. At the same time, however, they defend the use of linear models. According to their analysis, linear models represent a feasible approximation for the majority of the observed shocks when the endogeneity of oil price changes is appropriately addressed. This line of argument is based on the results of Kilian (2009); Kilian and Hicks (2013); Baumeister and Kilian (2016), according to which demand, unlike to Hamilton's analysis, played a more important role in oil price changes since the end of the 1980s. As a general rule, oil price increases induced by a demand shock do not cause recessions, while supply shocks do. Kilian and Vigfusson (2011*b*) also criticize Hamilton (2011) for employing local projections in order to link structural impulse responses to conditional forecasts plotted as a function of the forecast horizon. According to their critique, the results of structural impulse responses can not be consistently estimated with this econometric design. Consequently, the slope-based test result in Hamilton (2011), which rejects a linear specification, also proves misleading. Summarizing, we follow Kilian and Vigfusson (2011*b*) by running a linear VAR specification.

Our results are based on a breakdown of the G-20 countries into commodity importers and exporters. As far as this refers to countries, for which such a categorization is straightforward,

maximum of the four previous quarters. If the difference is positive, the value is accepted, otherwise a zero entry occurs. The increase in oil price volatility in the 1980s meant that older asymmetric constructions based on single-period changes no longer delivered Granger causality with respect to US GDP in the period between 1948 and 1994. Using the modification, Hamilton (1996) obtains such a result on the overall sample, but not if the sample is reduced by starting after the first oil crisis in 1973. This raises doubts whether the selected asymmetric design - still assuming oil prices to be exogenous - is really helpful for an analysis of recent macroeconomic consequences.

[6]For instance, spending on energy savings, such as heat insulation, may be reduced in times of oil price declines.

we therefore also touch upon studies that deal with country-specific macroeconomic effects of oil price changes. This includes Saudi Arabia, which Nakov and Nuno (2013) describe as playing a dominant role among oil-exporting countries.[7] But even if Saudi Arabia is less exposed to international financial market pressures due to its privileged position among oil producers, this does not rule out such pressure for the commodity exporting countries as a whole. Hakro and Omezzline (2016) conducted a VAR analysis for Oman. They found an inverse relation between the oil price and the real effective exchange rate. Our analysis confirms their results for the majority of commodity exporting countries. Gupta and Goyal (2015) investigate how oil price fluctuations affect a number of macroeconomic variables in the case of India, where oil imports account for more than one third of total imports. From the perspective of a commodity importing country, like us, the authors find the following directions of causes and effects: i. a positive relationship between the oil price and real GDP indicating demand-side dominance in the sample, ii. a negative relationship between the oil price and the exchange rate which corresponds to a depreciation after a positive oil price shock, and iii. a positive relationship between oil prices and interest rates which corresponds to a rise in interest rates after a positive oil price shock. However, their Granger causality results do not show significance for the influence of lagged oil prices on exchange and interest rates. In contrast, we find these correlations to be significant at the aggregated level of a comparison between commodity exporting and importing countries.

A change in financial market conditions is at the heart of the proposed transmission mechanism. As proxies, we use the interest rate spread and the exchange rate between commodity exporting and importing countries. Previous studies have explored the relationship between the country-specific variables and the oil price. Wu (2010), for instance, finds a significant impact of oil prices on US interest rates. Theoretically, he assumes that an oil price increase generates international savings flowing into the US from oil-exporting countries. This leads to a reduction in the interest rate there. In contrast, we emphasize capital outflows from commodity exporting countries as reported by ECB (2016). Sotoudeh and Worthington (2015) analyse whether oil price changes have non-linear, asymmetric interest effects. Apart from hints of reverse causality, the authors find such interest effects for a number of net oil-producing countries, while there is no evidence for net oil-consuming countries. Chen and Chen (2007) detect a dominant role of oil

[7] The authors emphasize Saudi Arabia's technological progress which allows a flexible production process compared to its competitors. At the same time, Saudi Arabia has high spare capacity and a very volatile production over time. This enables Saudi Arabia to make monopoly profits that, according to Nakov and Nuno (2013), are almost exclusively gained at the expense of its competitors and not at the expense of consumers. Another country-specific feature of Saudi Arabia is the high savings rate which is often mentioned as an example of why the average marginal propensity to consume of oil-importing countries is above that of oil exporting countries.

prices in changes of the real exchange rate based on a panel of G-7 countries, while Ferraro et al. (2015) do not confirm a stable out-of-sample relationship of oil prices for the CAD/USD nominal exchange rate. Using data from the Philippines, Chen et al. (2013) identify a co-integration relation between oil prices and the real exchange rate with asymmetrical adjustment of the exchange rate. Summarizing, many references point towards significant financial market reactions as measured by changes in the interest and exchange rate in the wake of oil price shocks.

3 Oil Price, Financial Markets and Global Economic Activity

3.1 Accounting Structure

Let PO denote the oil price, CED the consumer price (expenditure deflator), RIR and RFX parts of the real interest rate and the real exchange rate which are not country-specific, but linked to the classification of a country as a net commodity exporter or importer. While abstracting from government expenditure, we can easily link the GDP identity to widely acknowledged behavioral assumptions about the direction of possible (lagged) influences, *i.e.* from the perspective of a commodity exporting country with RFX in direct quotation[8]:

$$\begin{aligned} Y\left(\downarrow \overset{\downarrow}{PO}, \uparrow \overset{\downarrow}{RIR}, \downarrow \overset{\uparrow}{CED}, \dots\right) &= C\left(\downarrow \overset{\uparrow}{PO}, \uparrow \overset{\downarrow}{RIR}, \downarrow \overset{\uparrow}{CED}, \dots\right) + I\left(\downarrow \overset{\downarrow}{PO}, \uparrow \overset{\uparrow}{RIR}, \downarrow \overset{\uparrow}{CED}, \dots\right) \\ &\quad + X\left(\downarrow \overset{\downarrow}{PO}, \uparrow \overset{\uparrow}{RFX}, \downarrow \overset{\uparrow}{CED}, \dots\right) - M\left(\uparrow \overset{\uparrow}{RFX}, \downarrow \overset{\uparrow}{CED} \dots\right). \end{aligned}$$

The arrows beside the input variables of a function show the direction of the change in the variable and the arrows above it the response of the function. Note that at this stage, we just assume the direction of the initial changes and the corresponding responses. Those are supposed to be in line with typical textbook results[9], although specific dynamics can be far more complex. In particular, we assume here that lower oil prices, like in commodity importing countries, have a positive net effect on consumption, while negative GDP effects arise from the financial variables and from lower oil prices in the investment[10] and export functions. Overall the negative effects of lower oil prices are supposed to exceed the positive one in consumption.

Next, we turn to unanticipated, uncorrelated shocks as impulses. Those represent the entries

[8] Domestic currency per unit of the foreign one. This means a higher value is equivalent to a currency depreciation.

[9] For instance, lower interest rates as a result of lower inflation should have a positive effect on investment. Lower domestic inflation might stimulate exports in consequence of lower export prices and imports are treated as if they behave proportionally to consumption.

[10] An expample for the negative effect of lower oil prices on investment is the US investment reaction after oil prices in 2015 fell below the break-even point of many shale oil explorations.

in the contemporaneous error term of structural VAR equations. Here, we assume similar RIR and RFX impulse responses so that we can easily introduce the commodity-specific financial market (CFM) shock. Furthermore, we summarize consumption and investment to domestic demand:

$$
\begin{aligned}
Y\left(\downarrow \overset{\downarrow}{u}^{PO}, \uparrow \overset{\downarrow}{u}^{CFM}, \downarrow \overset{\uparrow}{u}^{CED}, \dots\right) = DD\left(\downarrow \overset{\downarrow}{u}^{PO}, \uparrow \overset{\downarrow}{u}^{CFM}, \downarrow \overset{\uparrow}{u}^{CED}, \dots\right) \\
+ X\left(\downarrow \overset{\downarrow}{u}^{PO}, \uparrow \overset{\uparrow}{u}^{CFM}, \downarrow \overset{\uparrow}{u}^{CED}, \dots\right) - M\left(\uparrow \overset{\uparrow}{u}^{CFM}, \downarrow \overset{\uparrow}{u}^{CED}, \dots\right).
\end{aligned}
$$

Note that it is difficult to summarize the net export reaction as we cannot know whether the expansionary effect from lower priced exports or the contractionary effect from higher priced imports will be stronger.[11] Again, negative GDP effects can arise from an oil price shock, the commodity-specific financial marktet shock or both. Accordingly, when turning to the global level, we write world GDP (WDY) as a function of shocks to the global oil price, the commodity-specific financial market shock and other shocks:

$$
H_0 : WDY = f\left(\downarrow \overset{\downarrow}{u}^{WDPO}, \uparrow \overset{\downarrow}{u}^{CFM}, \dots\right) \tag{1}
$$

Throughout the paper, we will primarily test the hypothesis of whether the commodity-specific financial market shock has negative consequences on global economic growth in addition to contractionary oil price shocks. By construction, RFX and RIR depend on oil and other commodities, while the structurally-identified shock u^{CFM} should be independent from an oil price shock u^{WDPO}. Hence, if we find positive commodity-specific financial market shocks in 2014, those should not just be triggered by oil price shocks[12], but rather by a change in financial market sentiments.[13] However, a proper identification scheme for the research question at hand should at least simultaneously identify the commodity-specific financial market shock and the oil price shock as a negligence of the latter is likely to influence the results. Compare Uhlig(2005, p.388) for the consequences of not explicitly identified shocks related to the research question.

In order to illustrate the importance of both the oil price and financial market sentiments for global dynamics in 2014, it is also worth to look at the correlation between oil and equity prices.

[11] In a former version of the paper, we conjectured a stronger import than export effect. On a global level, however, it is difficult to derive a contractionary effect from such dynamics, as the contractionary effect in commodity exporting countries should be counterbalanced by higher export growth in commodity importing countries.

[12] Such a chain reaction, where global economic growth responds to the exchange rate, after the exchange rate responds to an oil price shock implies $cov\,(CFM_{t-i}, WDY_t) \neq 0$, which should be captured by the influence of CFM lags in the WDY response. Also compare Granger causality results in Table 5.

[13] Of course, the correlation between non-structural shocks is likely to be nonzero, i.e. $cov\left(\epsilon_t^{WDPO}, \epsilon_t^{CFM}\right) \neq 0$.

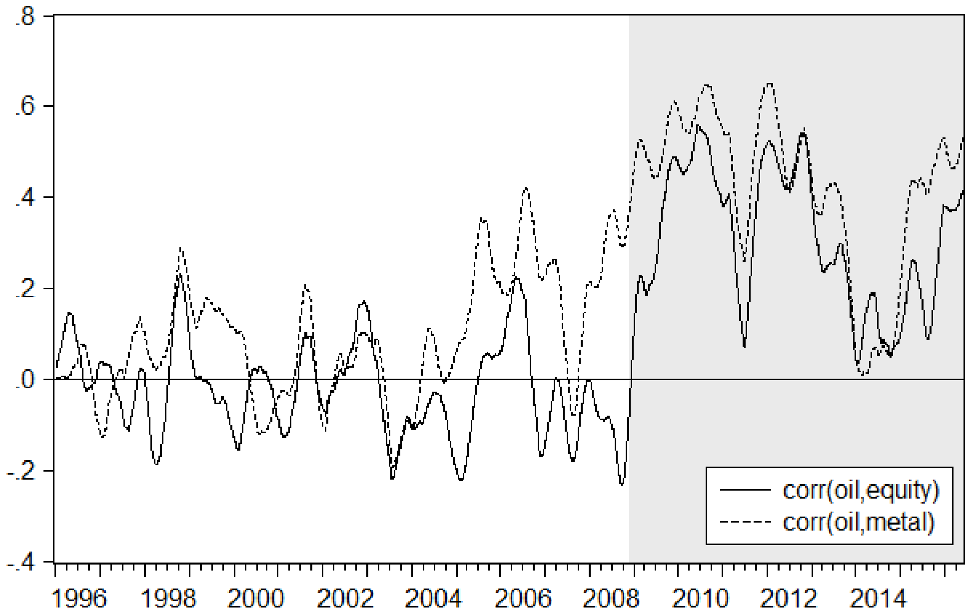

Figure 1: Correlation between oil (Brent Spot Price, USD per barrel, EIA), equity (US Equity Index, MSCI, IMI) and metal prices (Global Base Metal Index, Euromoney). Calculation is based on a rolling window of 90-days and smoothing by a moving average of order 2. Most of the time, the correlation between oil and metal prices has been positive. This is one example why we refer to a separation of commodity exporting and importing countries instead of focusing exclusively on the net oil position.

Figure 1 shows that this correlation has frequently been negative before financial crisis. Since then, it continued to be positive (gray area), while the most recent increase coincides with the drop of commodity prices in 2014. Some literature, Obstfeld et al. (2016) among others, suspect that this increase indicates that markets were right to no longer expect expansionary effects from oil price declines.

Part of our analysis will confirm significant financial market reactions by means of the commodity-specific exchange and interest rate responses to an oil price shock. However, this does not mean that the GDP response to an oil price shock will be the same. As Mohaddes and Pesaran (2017) correctly point out, there is no stable relationship between oil and equity prices over a longer time period. But certainly, an unanticipated shock to financial market sentiments can trigger its own real economic consequences. If such shocks additionally occur, a change in financial market expectations can act more or less self-fulfilling.

3.2 Structural Model Simulation

Table 1 shows simulated growth effects of commodity price shocks for the G-20 countries. For the simulations, we use the global macro-econometric model NiGEM, which is a widely used tool for business cycle forecasts at several institutions (IfW, 2016; IMK, 2016; NIESR, 2016). Conceptually, the model relies on error correction equations. However, the type of modelling is in many respects more theory driven than the VAR model, which we discuss in the following sections. The purpose of this section is to show that the transmission mechanism proposed in this paper is not well-established in conventional structural economic models.[14] We consider the model used to be a representative example in this regard. In addition to the oil price, we also shock metal prices considering the aforementioned correlation in Figure 1.

For the results in Column 1 of Table 1, we assume a drop in the oil price of 20 US Dollars per barrel and a drop in metal prices of 20% against the baseline scenario. Column 2 shows the results for corresponding price increases in order to illustrate the symmetry. The size of the oil price shock is close to the one-period shock that we will use later in the impulse response functions of the VAR analysis. The latter corresponds to one standard deviation of the real oil price during the observation period. In Column 3, the financial risk premium for commodity exporting countries is additionally raised by 30 basis points in order to simulate a currency depreciation. Column 4 shows the corresponding result for a decrease in the risk premium. A noticeable endogenous reaction of monetary policy is deliberately ruled out with respect to the line of argument proposed by Obstfeld et al. (2016).

The model results in the first two columns illustrate the positive income effect - for commodity importing countries in the event of price declines and for commodity exporting ones in the event of price rises. With respect to the results of Columns 3 and 4, the use of the nominal interest parity hypothesis in the model[15] requires that a rise in the risk premium and thus in the nominal interest rate leads to a nominal currency depreciation. Of course, this depreciation does not necessarily translate into a real one, if inflation dynamics outweigh the exchange rate effect. In the model, however, it does translate into a real depreciation for all countries except Russia.

[14]In a sense, we are more concerned with the mechanism that produces the differences between Columns 1 (2) and 3 (4) than with finding accurate effects. For instance, the effects clearly depend on the type of shock. Here, we assume transitory shocks that last for two years. Kirby and Meaning (2015) use the model to show that permanent shocks lead to stronger results.

[15]

$$\begin{aligned} &\text{Interest parity using quantity quotation:} && i_t^* - i_t = \ln\left(e_{t+1}^{e,n}/e_t^n\right) \\ &\text{Real exchange rate using quantity quotation:} && e_t^r = e_t^n p_t/p_t^* \end{aligned} \tag{2}$$

Shock Country	OIL, METAL (-20USD,-20%) 2016 / 2017	OIL, METAL (+20USD,+20%) 2016 / 2017	OIL, METAL, FX (-20USD,-20%,+0,3pp) 2016 / 2017	OIL, METAL, FX (+20USD,+20%0,-0,3pp) 2016 / 2017
China	-0,2 / ± 0	+0,2 / +0,1	-0,2 / -0,1	+0,2 / +0,1
USA	+0,1 / +0,4	-0,1 / -0,3	+0,1 / +0,4	-0,1 / -0,3
India	-0,3 / ±0	+0,3 / -0,1	-0,4 / ±0	+0,3 / ±0
Japan	+0,2 / +0,5	-0,2 / -0,4	+0,2 / +0,5	-0,2 / -0,4
Germany	+0,2 / +0,3	-0,2 / -0,2	+0,2 / +0,2	-0,2 / -0,2
Russia*	-3,5 / -2,3	+2,9 / +1,9	-3,4 / -2,2	+2,8 / +1,7
Brazil*	-0,1 / ±0	+0,1 / +0,1	-0,1 / ±0	+0,1 / ±0
Indonesia*	-1,1 / -1,5	+1,0 / +1,4	-1,1 / -1,3	+1,0 / +1,2
United Kingdom	-0,1 / -0,1	+0,1 / +0,2	-0,1 / -0,1	+0,1 / +0,2
France	+0,1 / +0,2	-0,1 / -0,1	+0,1 / +0,2	-0,1 / -0,1
Mexico*	-0,1 / ±0	+0,1 / +0,1	-0,1 / ±0	+0,1 / ±0
Italy	-0,1 / ±0	+0,1 / ±0	-0,2 / ±0	+0,2 / ±0
South Korea	-0,1 / ±0	+0,1 / ±0	-0,2 / ±0	+0,2 / ±0
Middle East*	-0,7 / -0,2	+0,5 / +0,1	-0,6 / -0,2	+0,5 / +0,1
Spain	-0,1 /+0,1	+0,1 / -0,1	-0,2 / +0,1	+0,2 / -0,1
Canada*	±0 / +0,2	±0 / -0,1	+0,1 / +0,4	-0,1 / -0,2
Turkey	-0,2 / -0,4	+0,2 / +0,4	-0,3 / -0,6	+0,2 / +0,6
Australia*	±0 / +0,2	±0 / -0,1	±0 / +0,3	±0 / -0,2
Taiwan	+0,1 / +0,4	-0,1 / -0,5	+0,1 / +0,4	-0,1 / -0,5

Table 1: Structural model simulations. Values refer to the (percentage point) change of real GDP growth against baseline. Simulations are carried out using the global macro-econometric model NiGEM v1.16c (NIESR, 2016). Column heads refer to transitory commodity price and exchange rate shocks lasting for two years. The spring forecast of the IMK (IMK, 2016) serves as a baseline. After the shocks expire, oil and metal prices and the relevant risk premium for the exchange rates return to the baseline. The first column shows the change in economic growth as a result of a decline in commodity prices, the second column the consequences of a corresponding price increase. In the remaining columns, the risk premium of commodity exporting countries (*) is additionally shocked. In the model, a higher risk premium implies a currency depreciation. According to the interest parity theory, the assumption of identical returns makes the exchange rate, here in indirect quotation, decrease due to an increase in domestic yields.

When comparing the growth effects in Columns 1 and 3, it is evident that most commodity exporting countries show slightly higher growth in the case of an additional currency depreciation. A detailed analysis of the expansionary effect reveals a noticeable decline in real imports. In the case of lower financial risk premia for commodity exporting countries (Column 2 vs. 4), reversed dynamics can be observed. So far, those results are clearly at odds with a negative financial market influence on commodity exporting countries and global economic growth as stated in the hypothesis H_0. If we find evidence for H_0 in the following empirical analysis, this means at least that a revision of the shock setting will be necessary to study the macroeconomic effects of declining oil prices as thoroughly as possible in a structural model such as NiGEM. This is why IMF (2016) simulates additional financial market spill-overs on the real economy in oil exporting countries. However, our empirical analysis will indicate that even those ex post scenarios tend to underestimate the role of financial market stress.

3.3 Empirical Analysis

3.3.1 Variable Selection and Data Transformation

Figures 7 and 8 show the variables of our empirical investigation for the period spanning 1999M1 to 2015M12. They are the Brent oil price (WDPO), the real exchange rate between commodity exporting and importing countries (RFX_PROD_CONS), the nominal interest rate spread (IRS_PROD_CONS) between the country groups, real world GDP (WDY), global consumer prices (WDCED) and global oil supply[16]. For all the analyses apart from Section 4.3, quarterly data from 1996 to 2015 are taken from the historical database of the aforementioned NiGEM model. Simulations discussed in the previous section are based on the first model release in 2016. This ensures that the data up to 2015 are observed and not the outcome of the model. Nevertheless, we also use a second source to verify this data.[17] For Section 4.3, monthly data from 1999 to 2015 are taken from the Global Economic Monitor of the World Bank.

Using NiGEM data for the econometric analysis allows us to take advantage of data consistency: If we find evidence for a transmission mechanism, which seems to be neglected in the model, we can therefore be sure that the evidence is not simply a consequence of employing a different data source. However, this approach suffers from the drawback that the quarterly data frequency limits the number of observations. This is why we resort to monthly data for the robustification in Section 4.3.

It is hard to justify starting the sample before 1996 due to major structural breaks in com-

[16]This is measured in million barrels per day. Data stems from the US Energy Information Administration.

[17]The correlation between NiGEM oil prices and those from the US Energy Information Administration, NiGEM exchange rates and those from the IMF Exchange Rate Archives, NiGEM 10-year government bond yields and those from Eurostat as well as NiGEM global economic growth and OECD Economic Outlook Estimates are all above 98%. Only in the case of Chinese government bond yields (compared against China Bond data) and global inflation (compared against Ifo Economic Situation Surveys), do we obtain lower values (71% and 31% respectively). In part, the relatively low correlation in the case of inflation can be attributed to the fact that NiGEM takes the consumer expenditure deflator as a reference measurement instead of the price changes of a basket of goods.

modity exporting countries. These include the transformation process in Russia after the end of Communism[18], the end of hyperinflation and the introduction of a new currency in Brazil in 1994 and the end of the tequila crisis and of the fixed exchange rate regime in Mexico in 1995. As we want to avoid a further reduction of the degree of freedom, we chose to estimate the quarterly data models using either the commodity-specific exchange rate (Sections 3.4 - 4.1) or the interest rate spread (Section 4.2). Each of the systems contains the real oil price and real world GDP in order to study both the GDP and the financial responses to an oil price shock as well as the GDP response to a commodity-specific financial market shock. As a further control variable, we also include global consumer prices to ensure that the strongest macroeffect of oil price changes, namely that of total price changes, is properly taken into account (Galesi and Lombadi, 2013).

Our results are sensitive to the breakdown of G-20 countries into commodity exporters and importers. We therefore need to derive plausible decision rules for the classification. Column 1 in Table 4 contains the selected G-20 countries. The countries initially account for about three-quarters of global economic activity. Column 2 displays each country's share of world GDP for 2015 computed by means of purchasing power parities. As we are particularly interested in the dynamics that started in the second half of 2014, this share represents the relevant time-constant weight used for each country when calculating the exchange rate and the interest rate spread between commodity exporters and importers. There are three countries, which have been excluded from the sample. First, the US, as the US Dollar is partly used as an numeraire for the exchange rate computations. Furthermore, the US has switched from being a net oil importer to an exporter in recent years (Mohaddes and Pesaran, 2017), which makes it hard to find an unique classification. A similar uncertainty with regard to the classification only arises for the United Kingdom and Turkey[19], which have some oil exploration, but also play a prominent role as major refinery places. After omitting these three countries, coverage of global economic activity is still above 50% of global GDP in 2015. As already mentioned, we consider metal prices and hence the role of a country as a net ore exporter in addition to its role as a net oil exporter.[20]

Columns 3 and 4 in Table 4 show the classification results based on two different methods. Column 3 refers to the results of the model simulations from Section 3.2.[21] In fact, this pro-

[18]The Russian inflation rate in 1994, for example, was above 300% without any policy rate adjustment.

[19]In the case of Turkey, there are also some data concerns, in particular for 1996.

[20]Strictly speaking, we would have to use the term 'oil and ore exporting countries' instead of 'commodity exporting countries' throughout the paper. The additional consideration of ore exports is an important factor in the classification of Australia and Brazil. With the exception of these two countries, our classification is ultimately the same as that of Cashin et al. (2014), who only take oil exports into account.

[21]Implicitly, we use a threshold of more than 0.3 percentage points as a significant growth effect for the entire

cedure does not provide a clear-cut result in several cases. We therefore also use export and import information from the Fischer Weltalmanach (Column 4).[22] Of course, other procedures are conceivable. However, the selected method generates a classification which is highly in line with the current literature (Cashin et al., 2014; Sotoudeh and Worthington, 2015): Russia, Brazil, Indonesia, Mexico, Saudi Arabia, Iran, Canada and Australia are classified as commodity exporters and all other G-20 countries as commodity importers.

Let us look at the financial time series constructed in this way. As a first result, the positive correlation between the commodity-specific real exchange rate (Figure7, middle left) and the commodity-specific nominal interest rate spread (Figure7, bottom left) is striking. In both series, one can also identify peaks during times of declining oil prices (2008, 2014). As both foreign exchange and interest-bearing bonds are tradable financial market goods, the positive correlation indicates that both series are subject to joint financial market shocks. This finding provides the starting point for our econometric analysis.

All variables are seasonally adjusted and transformed to log-levels.[23] Next, we conduct Augmented Dickey Fuller tests. All variables show an unit root similar to results of other studies (Gupta and Goyal, 2015, among others). Sims et al. (1990) argue that the OLS estimator in the VAR is consistent and asymptotically normal, even if individual variables are integrated or possibly co-integrated. Indeed for our data, a Johansen test indicates one co-integration relationship so that taking benefits from better small sample properties of a model in differences does not represent the preferred approach.[24] Rather, like other studies before (Khan and Ahmend, 2014), we decide in favor of a level estimation including a linear trend[25], although long-term impulse responses can be subject to inconsistencies under these circumstances (Phillips, 1998).

3.3.2 Specification and Identification

In this study, we estimate the following VAR (p) model

$$y_t = c_1 + c_2 t + \sum_{i=1}^{p} \Phi_i y_{t-i} + \epsilon_t, \tag{3}$$

simulation period. A country is classified as a commodity exporter if it benefits from an increase in commodity prices. Conversely, the income effect should be negative for commodity importers (see Table 1).

[22]Accordingly, a country is classified as a commodity exporter if the export volumes of fossil fuels and ores exceed the import volumes among the five most important export and import products.

[23]In the case of the interest spread, we first use the sample minimum as an add-on so that all values are positive.

[24]Using quarterly data, we also check impulse responses of a model in differences. Results are roughly the same.

[25]Figures 7 and 8 show detrended logs, which are used for the Bayesian estimation in Section 4.3

where $y_t = (y_{1t}, \ldots, y_{nt})'$ is the $(n \times 1)$ vector of endogenous variables, y_{t-i} are the corresponding lags for $i = 1, 2, \ldots$, $c_j = (c_{1t}, \ldots, c_{nt})'$ are the multidimensional intercept and trend coefficient, Φ_i is the i^{th} $(n \times n)$ matrix of autoregressive coefficients and $\epsilon_t = (\epsilon_{1t}, \ldots, \epsilon_{nt})'$ is the $(n \times 1)$ realization of a white noise process.

First of all, the number of lags, p, has to be determined. For this purpose, we follow the Schwarz and the Hannan-Quinn information criteria, which indicate to include two lags in the case of the quarterly data model. In the case of the monthly data model, we correspondingly include six lags. Proposition 3.1 in Lütkepohl (2005) states that coefficients of the above-mentioned VAR model can consistently be estimated by OLS and that the estimators will be asymptotically normally distributed, if the VAR additionally fulfils the following stability condition

$$det\left(I - \Phi_1 z - \ldots - \Phi_p z^p\right) \neq 0, \qquad |z| < 1 \tag{4}$$

where z are the eigenvalues of the extended coefficient matrix. We find all models being sufficiently stable.[26] For the sake of brevity, we do not discuss the unrestricted VAR estimation output in detail, but show Granger causality results in the next section. Those are very much in line with the significance of single coefficients in the estimation output.

Most of our analysis deals with impulse responses and variance decompositions which require a structural identification. Structural error terms u_t can be identified by

$$u_t = B^{-1}\epsilon. \tag{5}$$

For the results of the Sections 3.4.2, 4.1 and 4.2, VAR coefficients are obtained from OLS estimation and the Cholesky factor B depends on the ordering of the variables. Apart from generalized impulses (Pesaran and Shin, 1998), we select the following ordering

$$WDPO \rightarrow CFM \rightarrow WDCED \rightarrow WDY. \tag{6}$$

Here, we allow all variables to respond to an oil price shock and economic activity to respond to a commodity-specific financial market shock, while a contemporaneous oil price response to

[26]All test results, e.g. the stability test result, are available upon request. Apart from the stability test, we also check the assumption of ϵ_t as a white noise process step-by-step, in order to assess the consistency of the estimator. In particular, this will be true, if the residuals show no autocorrelation and if they are normally distributed. Portmanteau and Lagrange Multiplier (LM) tests show that the null hypothesis of no autocorrelation cannot be rejected for most lags. As usual, a higher number of lags must be traded off against a lower degree of freedom. Next, we also check the result of a multidimensional Jarque-Bera test. Here, only when applying a one percent level of significance, the null of joint normality cannot be rejected. Finally, we also test for homoscedasticity. The overall test result speaks in favor of heteroscedasticity. In fact, this may indicate a loss of efficiency, but not necessarily one of consistency.

a commodity-specific financial market shock, to an inflation shock or to an aggregated demand shock is ruled out by construction. In particular the last assumption is hard to defend. This is why we robustify our results by a different type of identification.

In Section 4.3, sign restrictions are used for identification as for instance in Canova and De Nicolo (2002); Uhlig (2005); Schenkelberg and Watzka (2013). This approach requires to draw VAR coefficients from the Normal-Wishart posterior[27] and to calculate for each draw impulses responses over the specified horizon by

$$B = W\Sigma^{1/2}Q, \tag{7}$$

where $W\Sigma^{1/2}$ denotes the Bayesian-inherent Cholesky factor and Q an orthogonal matrix obtained from QR decomposition. For further details see Appendix B in Schenkelberg and Watzka (2013). Beside the Bayesian mean over all responses that fulfill the sign restriction condition, their implementation also incorporates the computation of the close-to-median model following Fry and Pagan (2007).

3.4 Empirical Results using Cholesky-type Identification

3.4.1 Granger - Causality

Table 5 contains the results of a Granger causality analysis for the quarterly data model using the commodity-specific exchange rate. For each of the endogenous variables, we test whether lags of the others significantly affect its fit. As is usual in the literature, if prior values of a variable, $y_{*,t-1}$, predict future values of another, $y_{**,t}$, we take the Granger causality as a first indication for a relevant economic influence.[28]

First, lagged oil price changes significantly affect inflation. There is also evidence for reverse causality, but the p-value for an erroneous rejection of a significant influence is slightly higher. We also find a significant impact of lagged global economic growth on inflation, while the p-value is higher than for the opposite Granger causality direction. All these results are largely compatible with standard economic theory (Galesi and Lombadi, 2013). Second, lagged oil price changes significantly affect global economic growth. In addition, they have a significant impact on changes of the commodity-specific real exchange rate. Third, lagged changes of the commodity-specific real exchange rate have a significant impact on global economic growth.

[27]Discussing results for priors other than the standard choice goes beyond the scope of this paper, although the choice of a prior is unquestionably central for a Bayesian approach.

[28]Of course, our analysis will not be based solely on the Granger causality results, as the underlying regression can be subject to confounding effects.

Summarizing these relations, we propose a direct and an indirect impact from commodity price changes on global economic activity. The latter operates through financial markets, where foreign exchange rates are determined. Finally, the Granger causality analysis also emphasizes the endogeneity of the oil price as a function of global demand, as lagged economic growth affects oil price changes.

3.4.2 Impulse Response and Variance Decomposition

Figures 2, 3, 9 and 10 show the impulse responses to an oil price shock, a commodity-specific exchange rate shock, a consumer price shock and a global output shock based on the Cholesky identification scheme in (6). In each case, we follow the response of the variables over 8 quarters (24 months in Section 4.3 respectively). The size of the shocks amounts to one standard deviation of the corresponding variable. Confidence bands comprise 95% (68% in Section 4.3 respectively) of all values as is usually the case in the literature (Uhlig, 2005, among others).

Figure 2 plots the response of the above-mentioned variables to a positive oil price shock. By construction, the oil price increases in the wake of such a shock (subfigure top left). This delivers an effect amounting to over 10% in the quarter where the shock occours. The effect remains significant for around one year and, although it becomes barely insignificant after that, it shows some persistency up to the end of the response plot. The commodity-specific exchange rate even shows a significant reaction for over two years (subfigure top right). The impulse response is negative which corresponds to a currency appreciation of commodity exporting countries relative to importing ones. If the reaction is symmetric, a negative oil price shock, as it occured in 2014, will lead to a currency depreciation of commodity exporting countries. Consumer prices and world GDP show only a significant response in the first quarter. Even during this period, the size of the response is rather weak (0.1%). Surprisingly, the GDP response is also positive which hints at a demand-side dominance in the causes of oil price shocks in our sample.

Figure 3 displays the response of the variables to a positive commodity-specific exchange rate shock. Note that by construction the oil price response must be zero in the first period. After that it is negative for all other horizons plotted in the response function (subfigure top right). While consumer prices show no significant reaction at the beginning, their response becomes significantly negative for longer horizons (subfigure bottom left). The response of real GDP to the commodity-specific exchange rate shock is significantly negative (subfigure bottom right). From the second quarter on, it amounts to -0.2% per quarter. This result confirms H_0 in Eq. (1).

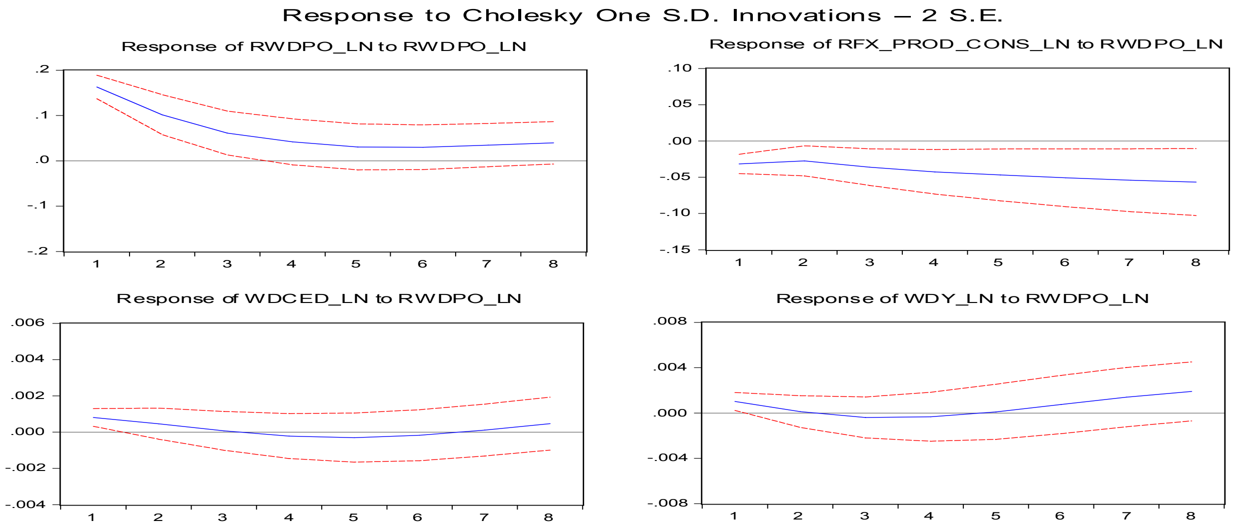

Figure 2: Impulse response to an oil price shock identified by the following Cholesky ordering: RWDPO_LN → RFX_PROD_CONS_LN → WDCED_LN → WDY_LN. Standard errors are analytic ones. In case of normality, error bands correspond to the 2,5% and 97,5% percentiles.

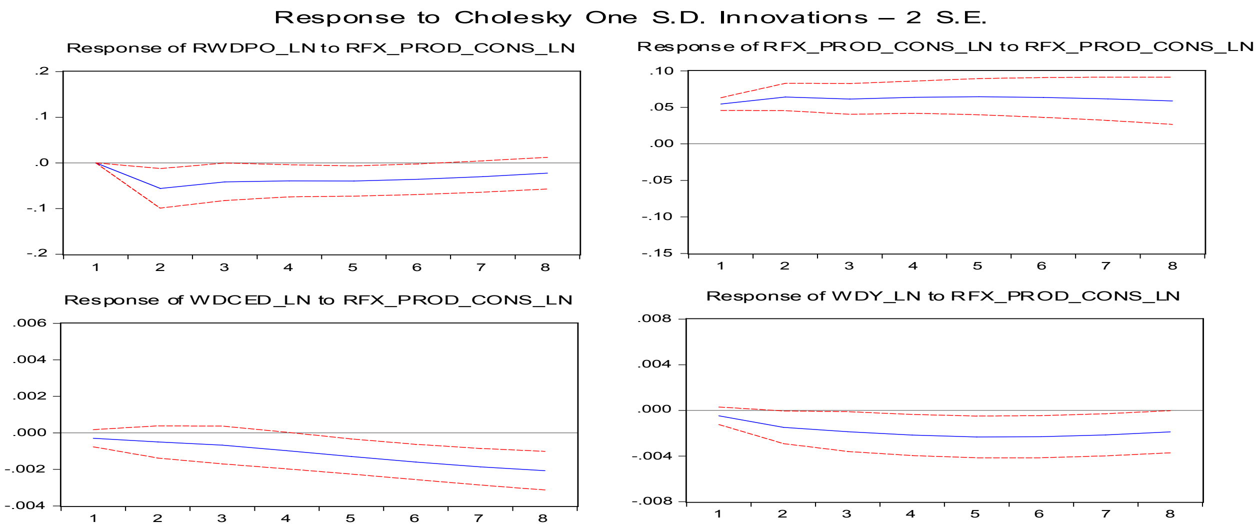

Figure 3: Impulse response to an exchange rate shock identified by the following Cholesky ordering: RWDPO_LN → RFX_PROD_CONS_LN → WDCED_LN → WDY_LN. Standard errors are analytic ones. In case of normality, error bands correspond to the 2,5% and 97,5% percentiles.

For completeness, Figures 9 and 10 present the remaining impulse responses of the fully identified system. The impulses correspond to positive consumer price and output shocks. There, the contemporaneous response of several variables is restricted to zero, as consumer prices and global GDP are positioned at the end of the Cholesky ordering in (6). Note again that especially the assumption to restrict the impact response of oil prices to a global output shock to zero is hard to defend (Kilian, 2009). However, all other reactions are widely consistent with the literature. This applies to the negative response of global GDP to a positive consumer price shock for longer horizons (Figure 9, bottom right) and to the positive response of consumer prices to a global output shock (Figure 10, bottom left).

Table 6 shows the results of the corresponding variance decomposition which measures the relative proportion of the variability for a dependent variable[29] due to all the above-mentioned shocks. We limit ourselves to discussing the outcomes greater than 10% in the fourth period which are triggered by cross variable shocks. Despite the impact restriction, output shocks account for about 19% of the variations in oil prices. The oil price shock by itself explains about 23% of the variations in the commodity-specific real exchange rate. Finally, shocks to the commodity-specific exchange rate account for 11% in the variation of global GDP. All in all, the results confirm that commodity-specific financial market shocks can play a prominent role for real economic dynamics at the global level.

As a first robustification, Figures 11 and 12 plot the generalized impulse responses to an oil price shock and to a commodity-specific exchange rate shock. On the one hand, the impulse responses are now invariant to the ordering of the variables using the approach developed by Pesaran and Shin (1998). On the other hand, the approach is based on the assumption that, depending on which of the innovations is shocked, it can affect all the variables in the system.[30] Under this identification scheme, however, results are very similar to those obtained under the Cholesky ordering in (6). Again, there is a negative effect of oil price shocks on the commodity-specific exchange rate (Figure 11, top right) and a negative effect of a commodity-specific exchange rate shock on global GDP (Figure 12, bottom right).

[29]In detail, the entries in the table denote the fraction of the variance of the forecast revision for a certain variable explained by shocks in the direction of the impulse vector.

[30]In other words, depending on the shock, the corresponding variable is standing first in the ordering. Again, this only represents one of many identification possibilities which, in a given situation, may produce contradictory results compared to standard theory. Thus, it cannot be generally considered as superior to other methods (Kim, 2013).

4 Robustification

In Sections 4.1 and 4.2, we robustify our results by employing variable sets other than in Sections 3.4. However, all our Cholesky-type identification schemes are subject to important drawbacks. We cannot distinguish oil supply from oil demand shocks. Furthermore, we have to impose zero restrictions for the impact of several shocks on those variables which appear in the ordering before. As already mentioned, this assumption is especially hard to defend in the case of the oil price response to an aggregated demand shock. This is why, Section 4.3 uses an extended variable set including an oil quantity to distinguish oil supply from oil demand shocks with the aid of sign restrictions. No restrictions are imposed on the response of real GDP to answer the question in the title of the paper. In this regard, we follow the agnostic approach by Uhlig (2005).

4.1 Different Effects in Commodity Exporting and Importing Countries

In order to put into perspective the effects of commodity-specific financial market shocks, we additionally estimate VAR models replacing global GDP by domestic demand either from commodity exporting regions (Figure 13) or from commodity importing regions (Figure 14). Following hypothesis H_0, the impulse response from the former model should confirm a significant response of commodity exporters' domestic demand to the commodity-specific exchange rate shock, while there should be a weaker insignificant response of commodity importers' domestic demand to the same shock. As can be seen in Figures 13 and 14 (subfigures bottom left), this is indeed the case.

4.2 Results for the Commodity-specific Real Interest Rate Spread

We also estimate a VAR model, for which we replace the commodity-specific real exchange rate by the real interest rate spread between commodity exporting and commodity importing countries. Figures 15 and 16 show the corresponding responses to an oil price shock and to a commodity-specific real interest rate spread shock. Again, we obtain a significant response of the commodity-specific financial market variable to an oil price shock (Figure 15, top right). In contrast to the analysis using the commodity-specific exchange rate, we obtain a weaker response of global GDP to the corresponding interest rate spread shock (Figure 16, bottom right). Indeed, the response is insignificant after the second period. However, in the next section we will include both variables into the system to identify commodity-specific financial shocks.[31]

[31] Note that we include the nominal interest rate spread there, as this shows a higher correlation with the real exchange rate and sign restrictions for both are used to identify commodity-specific financial market shocks.

4.3 Empirical Results using Sign Restrictions

In this section, we use monthly data from the World Bank to add two variables to our system, oil supply as well as the nominal interest rate spread between commodity exporting and importing countries. This allows us to identify oil supply shocks, oil demand shocks and commodity-specific financial market shocks by means of sign restrictions. We always decide in favor of a relatively short restriction horizon of six months. For longer horizons, the response of all variables is not restricted.

4.3.1 Identification Strategy

With respect to the identification of oil supply and demand shocks, we follow Cashin et al. (2014): A (positive) oil supply shock is identified by restricting the oil quantity to increase and the oil price to decrease following the shock. Correspondingly, a (negative) oil demand shock is identified by restricting the oil quantity and the oil price to decrease following the shock (Tables 2 and 3). In the case of a first model including consumer prices, we furthermore restrict them to decrease following both oil supply and oil demand shocks (Tables 2). All these assumptions are widely accepted to identify supply and demand shocks (Schenkelberg and Watzka, 2013, among others).

The identification of a commodity specific financial market shock is more explorative. To the best of our knowledge, no other paper has tried to identify these shocks using sign restrictions. We justify our identification theoretically as follows: A commodity-specific financial market shock is based on unanticipated financial market reactions linked to significant commodity price changes. In our case, the latter characteristic corresponds to restricting the oil price to decrease (Tables 2 and 3). Furthermore, Figure 7 shows a worsening of commodity exporters' financial market conditions reflected by a currency depreciation and an increase in interest rates relative to commodity importing countries. Such a worsening can result from a sudden change in expectations about the recoverability in energy sector related investment. On the one hand, international investors may claim a higher risk premium. On the other hand, they may decide in favor of capital outflows from commodity exporting countries as reported by ECB (2016). Overall, beside the oil price restriction, we therefore identify a commodity-specific financial market shock by restricting both the interest rate spread as well as the exchange rate to increase following the shock (Tables 2 and 3).[32]

As one can see by studying the marginal differences between the impulse response functions

[32]Note that an increasing exchange rate is equivalent to a currency depreciation of commodity exporting countries.

1st identification scheme using sign restrictions

	Oil supply shock	Oil demand shock	Financial market shock	
Variable	Sign	Sign	Sign	Horizon
Oil price	<0	<0	<0	M=6
Oil supply	>0	<0		M=6
Exchange rate			>0	M=6
Interest rate spread			>0	M=6
Consumer price	≤ 0	≤ 0		M=6
Industrial production				

Table 2: The table displays sign restrictions on the responses of the variables in the model after an oil supply, oil demand and exchange rate shock. M = 6 indicates that the restriction horizon is six months.

2nd identification scheme using sign restrictions

	Oil supply shock	Oil demand shock	Financial market shock	
Variable	Sign	Sign	Sign	Horizon
Oil price	<0	<0	<0	M=6
Oil consumption	>0	<0		M=6
Exchange rate			>0	M=6
Interest rate spread			>0	M=6
Industrial production				

Table 3: The table displays sign restrictions on the responses of the variables in the model after an oil supply, oil demand and exchange rate shock. M = 6 indicates that the restriction horizon is six months.

in Figures 5, 6 and Figures 17, 18, consumer prices do not play an important role for our research question.[33] Moreover, the extended model including six lags of six variables limits the degree of freedom as well as the number of possible draws within the Bayesian approach. This is why we estimate a second model omitting consumer prices. Accordingly, we also skip the restrictions on consumer prices when identifying oil supply and demand shocks (Table 3). In the next section we will analyse the results of this model in more detail.

[33]A comparison of the variance decompositions in Tables 7 and 8 shows a difference which is worth mentioning: In the model that excludes consumer prices, the explanatory power of the commodity-specific financial market shock is slightly higher.

4.3.2 Impulse Response and Variance Decomposition

Figure 4 plots the monthly evolution of the smoothed structural shocks identified according to Table 3. The focus of our interest is on the dynamics from 2014 onwards. It becomes evident that all of the three structural shocks differ significantly from zero during that period. In detail, we find positive commodity-specific financial market shocks (corresponding to a worsening of the financial conditions for commodity exporting countries), negative oil demand shocks and positive oil supply shocks. The fact that both supply-side and demand-side shocks appear is consistent with the literature mentioned in the introduction. In contrast to the dynamics in 2014, it is striking that the oil price decline in 2008 can mainly be attributed to demand-side shocks.

Figures 5 and 6 show the impulse responses to an oil supply shock, an oil demand shock and a commodity-specific financial market shock based on the identification scheme in Table 3.

We start our analysis with the oil supply shock (Figure 5, top), where the oil price (oil supply) is restricted to be negative (positive) during the first six periods. The response of the commodity-specific real exchange rate to the oil supply shock is significantly positive (from the fourth month on) and persistent. This result is similar to the one obtained in Section 3.4.2. The effect amounts to around 0.7% per period and lasts for over two years (24 months). The response of the commodity-specific interest rate spread to the oil supply shock is insignificant such as the response of global GDP. Although the GDP increase after shock is not significant, note that the direction of the median response seems plausible, as, if at all, a positive oil supply shock should affect economic activity positively.

Next, we analyze the oil demand shock (Figure 5, bottom), where both the oil price and oil supply are restricted to be negative during the first six periods. The response of the commodity-specific real exchange rate to the oil demand shock is almost significant, strictly positive and again very persistent. The effect amounts to about 0.5% per period. Hence, the reaction is a little bit weaker than in the case of an oil supply shock. The response of the commodity-specific interest rate spread to the oil demand shock turns out to be insignificant as in the case of the oil supply shock. The response of global GDP to the oil demand shock is significantly negative for the first seven months. The effect reaches its peak in the fifth month at a value of -0.4%. The cumulative effect during the seven months adds up to a change larger than -1%. This result underlines the importance of demand-side effects also for the contractionary dynamics starting in 2014 (Cerdeiro and Plotnikov, 2017, among others).

Finally, we turn to the commodity-specific financial market shock (Figure 6), where the oil price is restricted to be negative and the commodity-specific exchange rate and interest rate

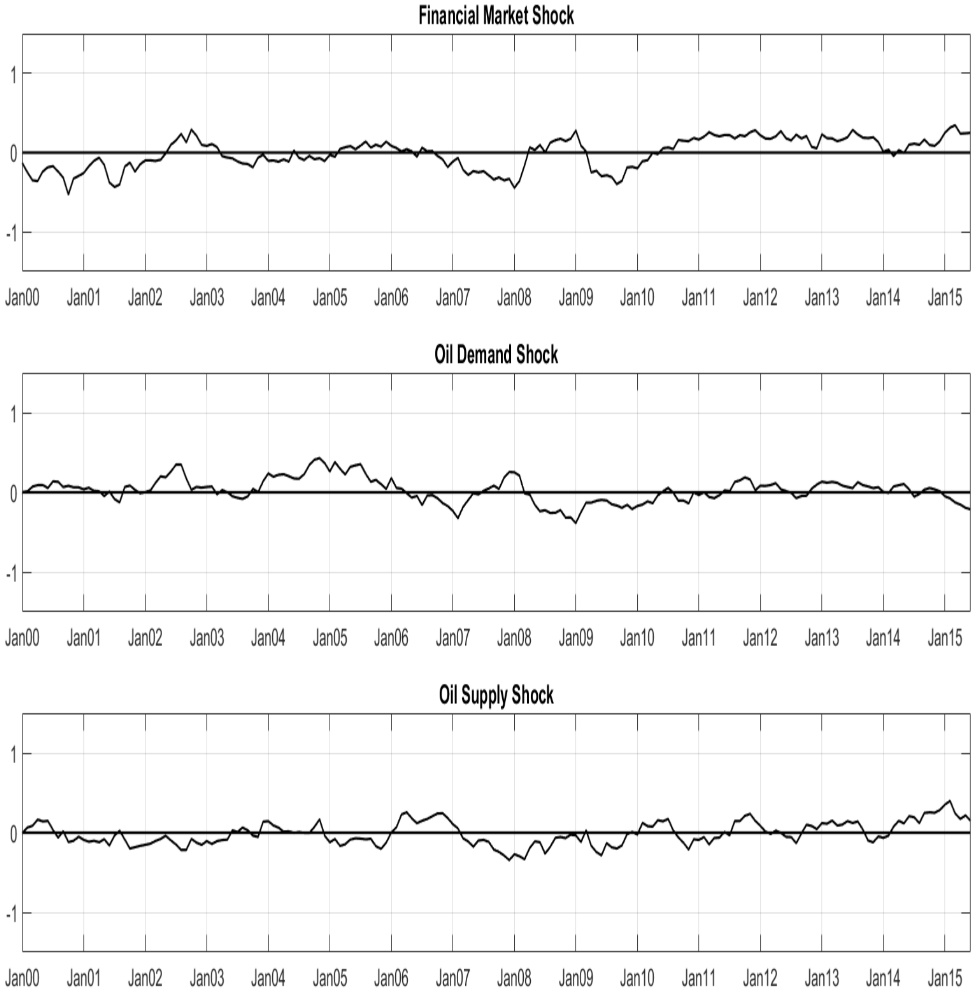

Figure 4: The figure displays the evolution of smoothed structural shocks. Note that without smoothing monthly oil supply, demand and exchange rate shock behave much more erratic so that it is difficult to detect certain events along the economic calender. Smoothing is carried out by a high order moving average (12 months).

spread are restricted to be positive during the first six months. The response of oil supply to the financial market shock is insignificant during the first year. Then it turns out be significantly positive, although the effect is rather weak (0.2% up to the end of the second year). Economically, a higher production may result from the attempt of single oil exporters to counterbalance lower revenues due to lower oil prices.

The most striking result is the significantly negative response of global GDP to the commodity-specific financial market shock. The size of the effect is comparable to the one triggered by the oil demand shock, although, technically speaking, the response is only significant for three months instead of six in the case of the oil demand shock. However, this result confirms the hypothesis H_0 and points to a second (financial market) transmission channel being responsible for contractionary effects at the global level from 2014 onwards.

Figures 5 and 6 also display the results (red dotted lines) of the so-called "close-to-median model" (Fry and Pagan, 2007). The notion behind this approach is to check whether the median (black solid lines), which summarizes the information from the different draws within the Bayesian VAR approach, can be replicated by one single model. In most cases, the impulse responses generated by the close-to-median model are similar to those from the median overall models. In the interesting case of the negative GDP response to the commodity-specific financial market shock, however, we observe a noticeable deviation between the two approaches. But the impulse response of the close-to-median model even shows a stronger contractionary GDP reaction. The peak is here below -0.6%. Hence, both the impulse response generated by the close-to-median model and the one generated by the median overall models confirm H_0.

Table 8 reports the results of the variance decomposition based on the close-to-median model. Following Uhlig (2005), the variance shares of the three structural shocks do not sum up to one, as the system is not fully identified.[34] However, by referring to the results of the close-to-median model, we can ensure that the reported variance shares and those of two unidentified disturbances, capturing all other shocks, will add up to one (Schenkelberg and Watzka, 2013, p. 338). We limit ourselves to discussing the outcomes in the 12th (24th) period.

Oil supply shocks account for 16% (20%) of the variations in oil prices. While the shares of oil demand shocks are slightly lower, those of the financial market shocks are slightly higher. All shares are in the range of 10% to 20%. The same applies to to all shares measuring the variation in oil quantity. Oil supply and demand shocks explain about 10% of the variations in the commodity specific exchange rate and interest rate spread, while the corresponding shares explained by the financial market shocks are 25% and higher. Finally, the oil supply shocks only account for about 10% of the variations in global GDP[35], while oil demand shocks and the financial market shocks account for 15% to 20%.

[34] As can be seen in Table8, they sum up to roughly 50% of the variation in all variables.

[35] Note that we use industrial production from the Global Economic Monitor of the World Bank as a monthly proxy of global GDP throughout the paper.

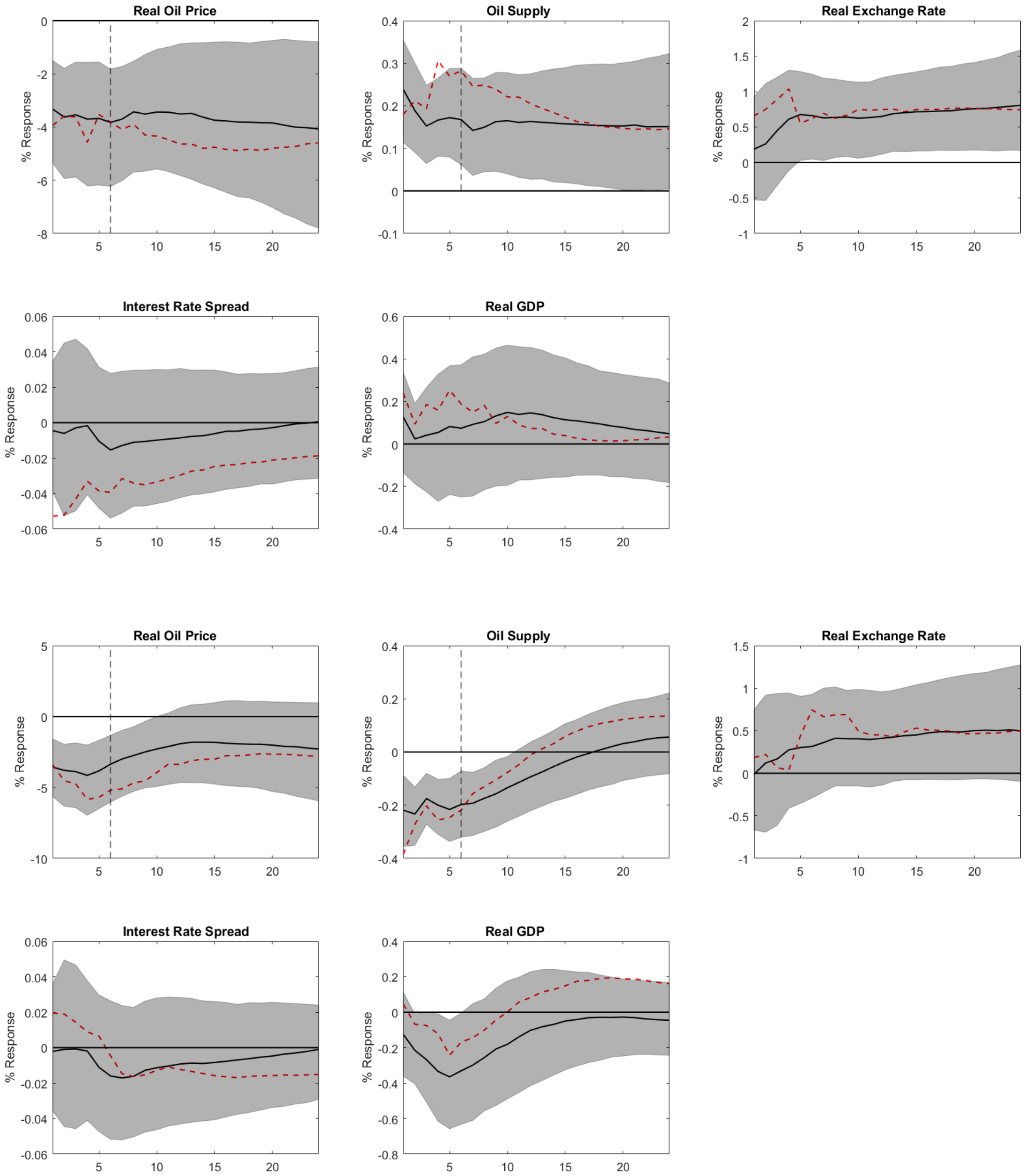

Figure 5: Impulse response to oil supply (top) and demand shocks (bottom) over a 24-month horizon. Identification as described in Table 3. Solid lines denote the median impulse responses from a BVAR (1000 draws), shaded areas indicate the 16% and 84% percentiles of the posterior distribution. Vertical lines indicate the restriction horizon. The red dotted line displays the response generated by the close-to-median model.

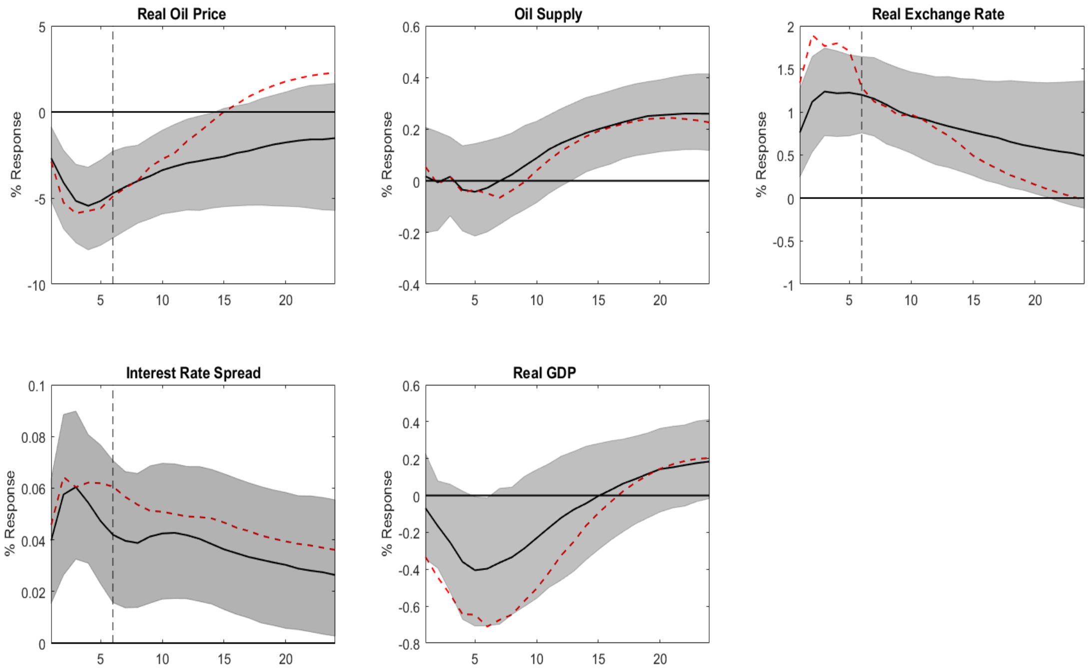

Figure 6: Impulse response to a real exchange rate shock over a 24-month horizon. Identification as described in Table 3. Solid lines denote the median impulse responses from a BVAR (1000 draws), shaded areas indicate the 16% and 84% percentiles of the posterior distribution. Vertical lines indicate the restriction horizon. The red dotted line displays the response generated by the close-to-median model.

Depending on our monthly data sample, 1999 - 2015, we find oil price changes more likely to be caused by demand-side than supply-side disturbances. Of course, this does not rule out stronger supply-side causes in earlier times. Indeed, many studies find a comparably strong demand-side dependency of oil price changes for several periods within the sample 1999-2015.[36] Our results are thus in line with these findings.

[36]These studies include Hamilton (2009); Kilian (2009); Kilian and Hicks (2013) referring to the strong oil price rise between 2003 and 2008 as a result of extra demand from Asian countries, Baumeister and Kilian (2016) regarding the sharp rise in the price of oil in 2009 after global demand recovered from the financial crisis, and Kirby and Meaning (2015); IfW (2016); Obstfeld et al. (2016) stressing the role of demand in the recent oil price declines.

5 Conclusion

At least since 2008, there has been greater awareness of the extent to which financial markets affect the real economy. This applies to business cycle fluctuations in particular. Based on a SVAR analysis, this paper suggests that commodity-specific financial market reactions represent one reason why the recent oil price declines have led to a stronger slowdown of the economic activity in commodity exporting countries as could be expected from the pure income effect. The corresponding transmission mechanism operates through a (real) currency depreciation and higher interest rate risk premia of these countries reflected by international capital movements (ECB, 2016). Overall, this results in a slowdown of their real investment activity.

In conjunction with other approaches, this transmission channel helps to explain why in net terms the recent oil price changes had no expansionary effects at the global level, contrary to the expectation in many business cycle forecasts. As a first conclusion, a recalibration of typical global macro-econometric models would appear to be necessary in order to take this transmission into account adequately.

As documented in IMF (2016), those commodity exporting countries which do not show any diversification of growth drivers were hit particularly hard by the oil price declines. In view of the income effect alone, this is not surprising. However, financial market conditions can exacerbate this problem underlining the urgent need for such economies to cope with the challenges of diversifying their growth model. From the perspective of a commodity exporting country, our results point to an adverse financial market influence. In contrast to other studies (Cerdeiro and Plotnikov, 2017, e.g.), our findings do therefore not rule out temporary capital controls as a means to go against the adverse effect of commodity-specific financial shocks.

References

Baumeister, C. and Kilian, L. (2016), ‘Forty years of oil price fluctuations: Why the price of oil may still surprise us’, *Journal of Economic Perspectives* **30**(1), 139–2160.

Blanchard, O. J. and Riggi, M. (2013), ‘Why are the 2000s so different from the 1970s - A structural interpretation in the macroeconomic effects of oil prices’, *Journal of the European Economic Association* **11**(5), 1032–1052.

Bundesbank (2015*a*), Slowdown in growth in the emerging market economies, Monthly Report July 2015, Deutsche Bundesbank.

Bundesbank (2015*b*), The slowdown in global economic growth and the decline in commodity prices, Monthly Report November 2015, Deutsche Bundesbank.

Bundesbank (2016), The drop in oil prices: its causes and its consequences, Monthly Report February 2016, Deutsche Bundesbank.

Canova, F. and De Nicolo, G. (2002), 'Monetary disturbances matter for business fluctuations in the G7', *Journal of Monetary Economics* **49**(6), 1131–1159.

Cashin, P., Mohaddes, K., Raissi, M. and Raissi, M. (2014), 'The differential effects of oil demand and supply shocks on the global economy', *Energy Economics* **44**, 113–134.

Cerdeiro, D. A. and Plotnikov, D. (2017), Taking stock: Who benefited from the oil price shocks?, IMF WP 104, International Monetary Fund.

Chen, J.-E., Lee, C.-Y. and Goh, L.-T. (2013), 'Exchange rate and oil price: asymmetric adjustment', *Applied Economics Letters* **20**(10), 987–990.

Chen, S. S. and Chen, H. C. (2007), 'Oil prices and real exchange rates', *Energy Economics* **29**, 390–404.

ECB (2016), Recent developments in capital flows to emerging market economies, Economic Bulletin Issue 5, European Central Bank.

Estrada, A. and de Cos, P. H. (2012), 'Oil prices and their effect on potential output', *Applied Economics Letters* **19**, 207–214.

Ferraro, D., Rogoff, K. and Rossi, B. (2015), 'Can oil prices forecast exchange rates? An empirical analysis of the relationship between commodity prices and exchange rates', *Journal of International Money and Finance* **54**, 116–141.

Fry, R. and Pagan, A. (2007), 'Some issues in using sign restrictions for identifying structural vars', *National Centre for Econometric Research Working Paper* **14**.

Galesi, A. and Lombadi, M. (2013), External shocks and international inflation linkages, *in* F. di Mauri and M. H. Pesaran, eds, 'The GVAR Handbook: Structure and Applications of a Macro Model of the Global Economy for Policy Analysis', Vol. 70.

Gupta, P. and Goyal, A. (2015), 'Impact of oil price fluctuations on Indian economy', *OPEC Energy Review* **June 2015**, 141–161.

Hakro, A. N. and Omezzline, A. M. (2016), 'Oil prices and macroeconomic dynamics of the Oman economy', *Journal of Developing Areas* **50**, 1–27.

Hamilton, J. D. (1996), 'This is what happened to the oil price-macroeconomy relationship', *Journal of Monetary Economics* **38**, 215–220.

Hamilton, J. D. (2003), 'What is an oil shock ?', *Journal of Econometrics* **113**, 363–398.

Hamilton, J. D. (2009), Causes and Consequences of the Oil Shock of 2007-08, Brookings Papers on Economic Activity Spring 2009.

Hamilton, J. D. (2011), 'Nonlinearities and the macroeconomic effects of oil prices', *Macroeconomic Dynamics* **15**, 364–378.

IfW (2016), Oil price declines: Boon or bane ?, Business Cycle Report 15.

IMF (2016), Too slow for too long, WEO April, International Monetary Fund.

IMK (2016), German economy robust in harsh climate, Report 113, Macroeconomic Policy Institute.

Khan, M. A. and Ahmend, A. (2014), 'Revisiting the macroeconomic effects of oil and food price shocks to Pakistan economy - a SVAR analysis', *OPEC Energy Review* **June**, 184–215.

Kilian, L. (2009), 'Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market', *American Economic Review* **99**(3), 1053–1069.

Kilian, L. and Hicks, B. (2013), 'Did unexpectedly strong economic growth cause the oil price shock of 2003-2008?', *Journal of Forecasting* **32**, 385–394.

Kilian, L. and Vigfusson, R. J. (2011*a*), 'Are the responses of the US economy asymmetric in energy price increases and decreases?', *Quantitative Economics* **2**(3), 419–453.

Kilian, L. and Vigfusson, R. J. (2011*b*), 'Nonlinearities in the oil price - output relationship', *Macroeconomic Dynamics* **15**(S3), 337–363.

Kim, H. (2013), 'Generalized impulse response analysis: General or Extreme ?', *EconoQuantum* **10**(2), 136–141.

Kirby, S. and Meaning, J. (2015), 'Oil prices and economic activity', *National Institute Economic Review* **231**(February), F43–F48.

Lütkepohl, H. (2005), *New Introduction to Multiple Time Series Analysis*, Springer, Berlin.

Manescu, C. B. and Nuno, G. (2015), 'Quantitative effects of the shale oil revolution', *Energy Policy* **86**, 855–866.

Mohaddes, K. and Pesaran, M. H. (2017), 'Oil prices and the global economy: Is it different this time around?', *Energy Economics* **65**, 315–325.

Nakov, A. and Nuno, G. (2013), 'Saudi Arabia and the oil market', *The Economic Journal* **123**, 1333–1362.

NIESR (2016), Summary of key forecast assumptions, National Institute Economic Review 235, National Instiute of Economic and Social Research.

Obstfeld, M., Milesi-Ferretti, G. M. and Arezki, R. (2016), Oil prices and the global economy: It's complicated, IMFdirect March 2016, International Monetary Fund.

Pesaran, H. M. and Shin, Y. (1998), 'Impulse response analysis in linear multivariate models', *Economics Letters* **58**, 17–29.

Phillips, P. C. B. (1998), 'Impulse response and forecast error variance asymptotics in nonstationary VARs', *Journal of Econometrics* **83**, 21–56.

Schenkelberg, H. and Watzka, S. (2013), 'Real effects of quantitative easing at the zero lower bound: Structural VAR-based evidence from Japan', *Journal of International Money and Finance* **33**, 327–357.

Sims, C., Stock, J. and Watson, M. W. (1990), 'Inference in linear time series models with some unit roots', *Econometrica* **58**, 113–144.

Sotoudeh, M. A. and Worthington, A. C. (2015), 'Nonlinear interest rate effects of global oil price changes: the comparison of net oil-consuming and net oil-producing countries', *Applied Economics Letters* **22**(9), 693–669.

Uhlig, H. (2005), 'What are the effects of monetary policy on output? Results from an agnostic identification procedure', *Journal of Monetary Economics* **52**, 381–419.

Wu, M. (2010), 'Investigating the relationships among oil prices, bond index returns and interest rates', *International Research Journal of Finance and Economics* **38**, 147–164.

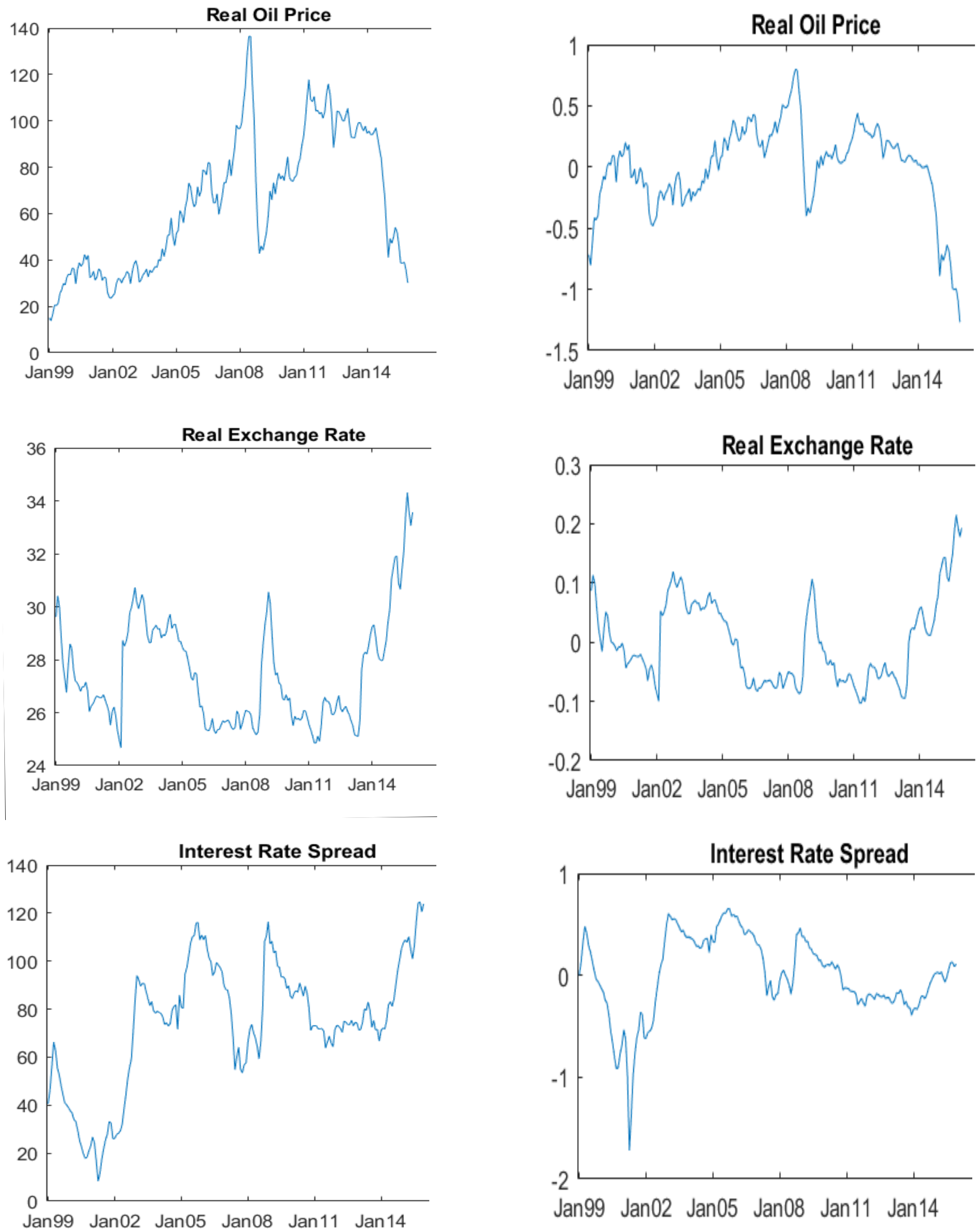

Figure 7: Real oil prices (in USD per barrel), the real exchange rate and the interest rate spread between commodity exporting and importing countries as well as the corresponding detrended logs. The latter series are constructed using the classification from Table 2 as well as GDP weights (PPP) from 2015.

Figure 8: Detrended logs of global GDP, consumer prices and oil supply.

Country	World GDP share 2015 PPP	Characteristics according to NiGEM Simulation	Characteristics according to Weltalmanach (2015)
China	17.2	indifferent	importing*
USA	15.9	(importing)	(importing)
India	7.1	indifferent	importing*
Japan	4.3	importing*	importing*
Germany	3.4	importing*	importing*
Russia	3.1	exporting*	exporting*
Brazil	2.8	indifferent	exporting*
Indonesia	2.5	exporting*	exporting*
United Kingdom	2.4	(indifferent)	(indifferent)
France	2.3	indifferent	importing*
Mexico	2.0	indifferent	exporting*
Italy	1.9	indifferent	importing*
South Korea	1.6	indifferent	importing*
Middle East (SAU,IRN)	2.7	exporting*	exporting*
Spain	1.5	indifferent	importing*
Canada	1.4	indifferent	exporting*
Turkey	1.4	(exporting)	(importing)
Australia	1.0	indifferent	exporting*
Taiwan	1.0	importing*	importing*

Table 4: Classification of G-20 countries into commodity ex- and importers. Section 3.3.1 explains the table entries and the classification procedure in more detail. Also compare Table 1. * = reason for a decision, () = not considered, PPP = purchasing power parity.

VAR Granger Causality/Block Exogeneity Wald Tests
Sample: 1995Q4 2015Q4

Dependent variable: RWDPO_LN

Excluded	Chi-sq	df	Prob.
RFX_PROD_CONS_LN	4.970955	2	0.0833
WDCED_LN	7.092774	2	0.0288
WDY_LN	11.16920	2	0.0038
All	48.24916	6	0.0000

Dependent variable: RFX_PROD_CONS_LN

Excluded	Chi-sq	df	Prob.
RWDPO_LN	10.64095	2	0.0049
WDCED_LN	2.072175	2	0.3548
WDY_LN	9.787909	2	0.0075
All	18.01154	6	0.0062

Dependent variable: WDCED_LN

Excluded	Chi-sq	df	Prob.
RWDPO_LN	7.723996	2	0.0210
RFX_PROD_CONS_LN	5.672505	2	0.0586
WDY_LN	6.485132	2	0.0391
All	25.40017	6	0.0003

Dependent variable: WDY_LN

Excluded	Chi-sq	df	Prob.
RWDPO_LN	10.65452	2	0.0049
RFX_PROD_CONS_LN	11.29249	2	0.0035
WDCED_LN	13.86148	2	0.0010
All	32.15658	6	0.0000

Table 5: Granger causality results for the quarterly data model.

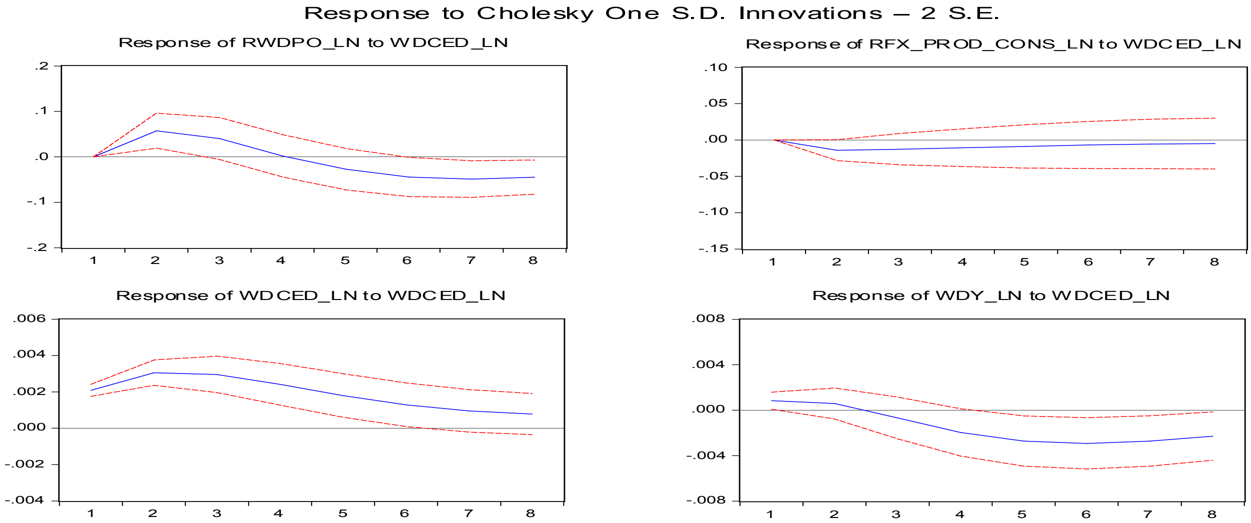

Figure 9: Impulse response to a consumer price shock identified by the following Cholesky ordering: RWDPO_LN → RFX_PROD_CONS_LN → WDCED_LN → WDY_LN. Standard errors are analytic ones. In case of normality, error bands correspond to the 2,5% and 97,5% percentiles.

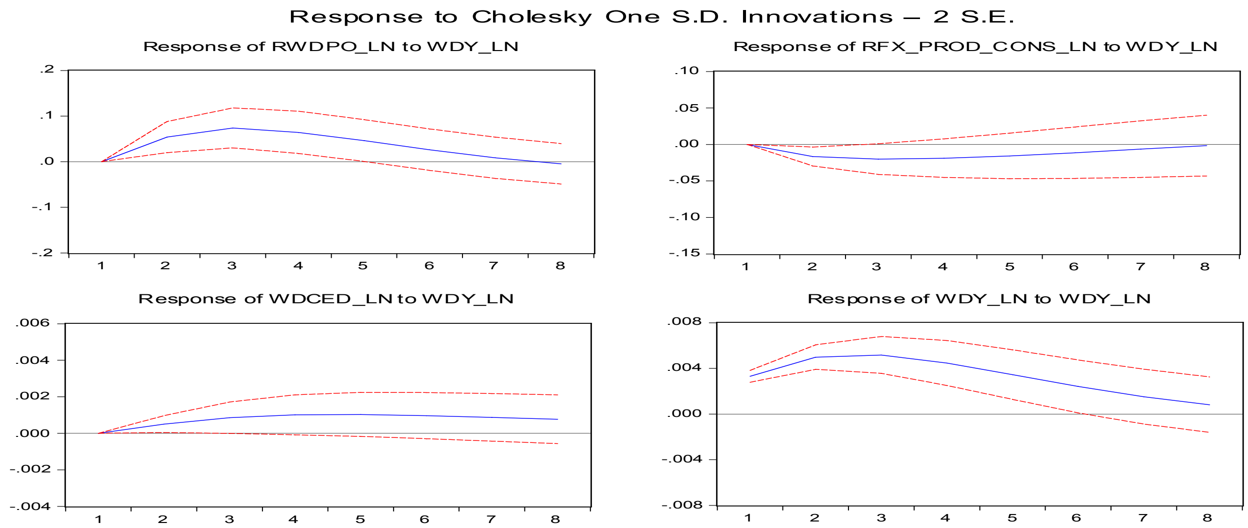

Figure 10: Impulse response to an output shock identified by the following Cholesky ordering: RWDPO_LN → RFX_PROD_CONS_LN → WDCED_LN → WDY_LN. Standard errors are analytic ones.

Variance Decomposition of RWDPO_LN:					
Period	S.E.	RWDPO_LN	RFX_PROD_CONS_LN	WDCED_LN	WDY_LN
1	0.162735	100.0000	0.000000	0.000000	0.000000
		(0.00000)	(0.00000)	(0.00000)	(0.00000)
2	0.214872	79.77694	6.801718	7.120679	6.300664
		(7.37042)	(5.19088)	(4.63449)	(3.81676)
3	0.242369	69.07960	8.291679	8.356195	14.27253
		(9.37899)	(6.07705)	(5.93777)	(6.93202)
4	0.257244	63.95168	9.715467	7.424433	18.90842
		(10.3360)	(6.65386)	(5.77445)	(8.82679)

Variance Decomposition of RFX_PROD_CONS_LN:					
Period	S.E.	RWDPO_LN	RFX_PROD_CONS_LN	WDCED_LN	WDY_LN
1	0.063037	25.31078	74.68922	0.000000	0.000000
		(8.22346)	(8.22346)	(0.00000)	(0.00000)
2	0.096518	18.86654	76.06423	2.134317	2.934914
		(8.27030)	(8.43289)	(2.26943)	(2.39397)
3	0.122351	20.50819	72.56710	2.397268	4.527435
		(9.34084)	(9.81526)	(3.21584)	(4.01643)
4	0.146041	22.89380	70.04494	2.220095	4.841170
		(10.4046)	(10.9922)	(3.72818)	(4.93140)

Variance Decomposition of WDCED_LN:					
Period	S.E.	RWDPO_LN	RFX_PROD_CONS_LN	WDCED_LN	WDY_LN
1	0.002256	12.80348	1.709629	85.48689	0.000000
		(6.95424)	(3.13520)	(7.38139)	(0.00000)
2	0.003890	5.721580	2.222763	90.39061	1.665045
		(4.90155)	(4.10894)	(6.25119)	(1.51907)
3	0.005005	3.474631	3.131861	89.49290	3.900606
		(3.85766)	(5.12149)	(7.05473)	(3.55904)
4	0.005736	2.792680	5.272514	85.86461	6.070194
		(3.72382)	(6.33232)	(8.78983)	(5.52995)

Variance Decomposition of WDY_LN:					
Period	S.E.	RWDPO_LN	RFX_PROD_CONS_LN	WDCED_LN	WDY_LN
1	0.003587	8.004031	1.782886	5.363507	84.84958
		(5.79102)	(3.27011)	(4.88979)	(7.46116)
2	0.006344	2.597403	6.051786	2.565645	88.78517
		(3.07634)	(5.76935)	(3.79435)	(7.12140)
3	0.008433	1.691840	8.324608	2.113724	87.86983
		(2.87282)	(7.02577)	(2.93293)	(7.82492)
4	0.009986	1.322003	10.65692	5.365830	82.65525
		(3.49472)	(7.95291)	(5.02272)	(9.62948)

Table 6: Variance Decomposition under the following Cholesky Ordering: RWDPO_LN → RFX_PROD_CONS_LN → WDCED_LN → WDY_LN. Standard Errors: Monte Carlo (1000 repetitions).

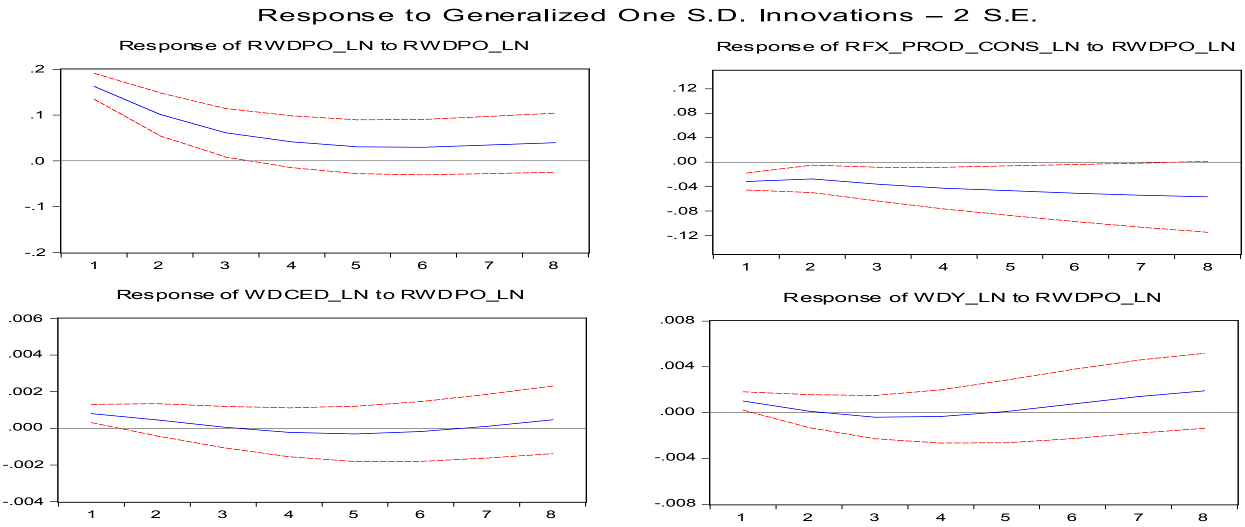

Figure 11: Generalized impulse response to an oil price shock. Identification follows the methodology by Pesaran and Shin (1998). Standard Errors: Monte Carlo (1000 draws).

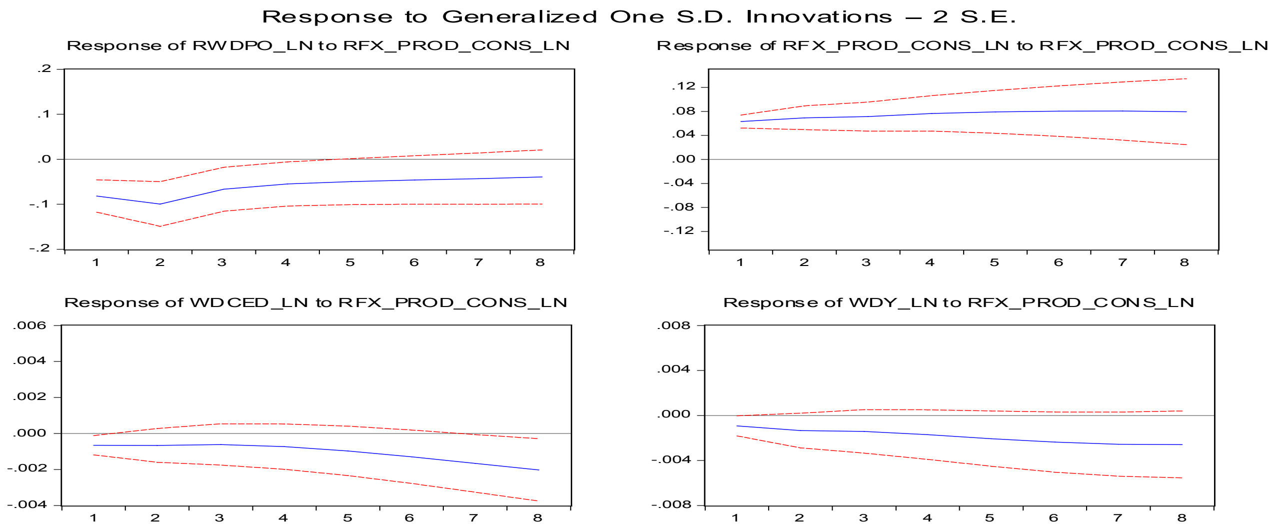

Figure 12: Generalized impulse response to an exchange rate shock. Identification follows the methodology by Pesaran and Shin (1998). Standard Errors: Monte Carlo (1000 draws).

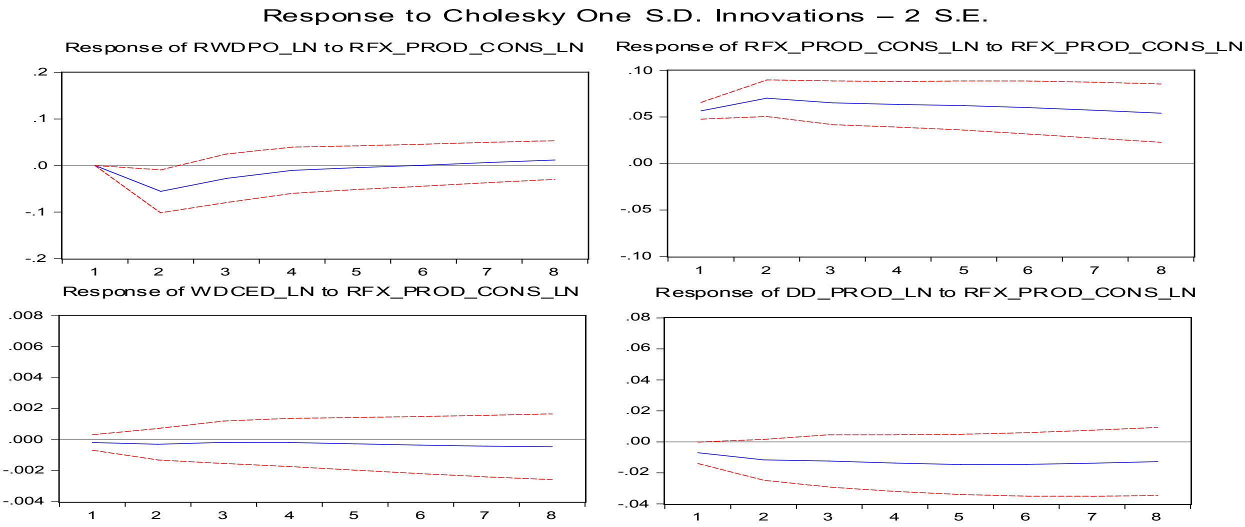

Figure 13: Impulse response to an exchange rate shock. Here, the system includes domestic demand from commoditiy exporting regions instead of world GDP. The Cholesky identification is the same as above. Standard errors are analytic ones.

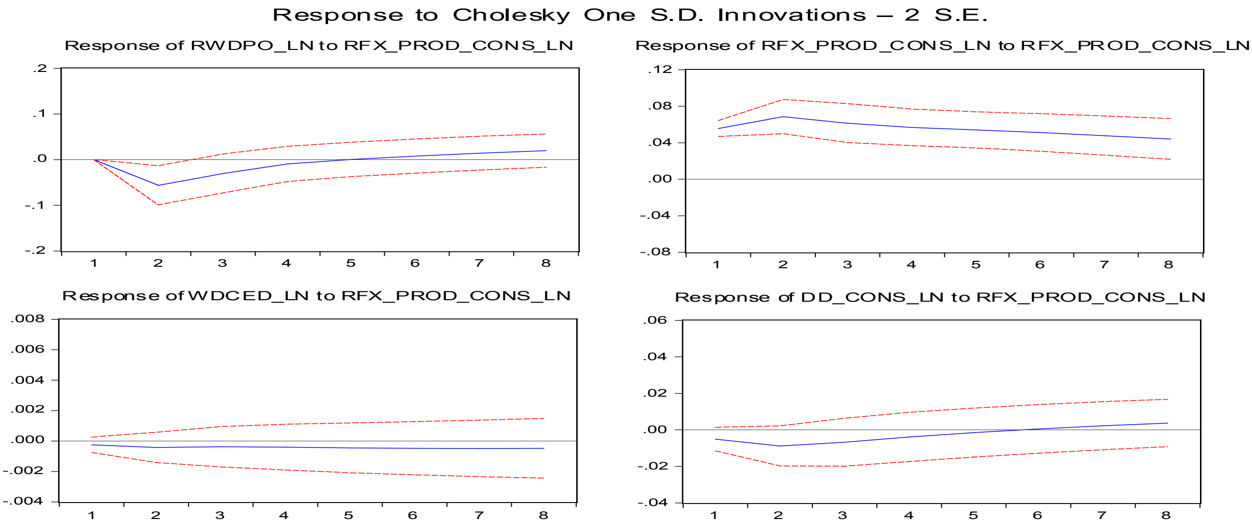

Figure 14: Impulse response to an exchange rate shock. Here, the system includes domestic demand from commoditiy importing regions instead of world GDP. The Cholesky identification is the same as above. Standard errors are analytic ones.

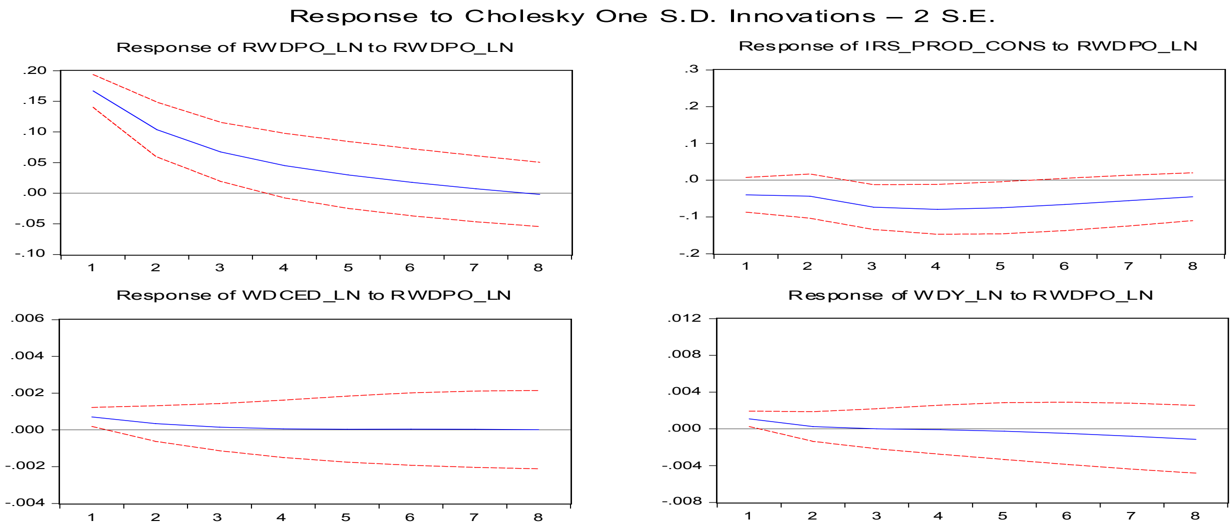

Figure 15: Impulse response to an oil price shock. Here, the system includes the real interest rate spread between commodity exporting and importing countries instead of the corresponding real exchange rate. The Cholesky identification is the same as above.

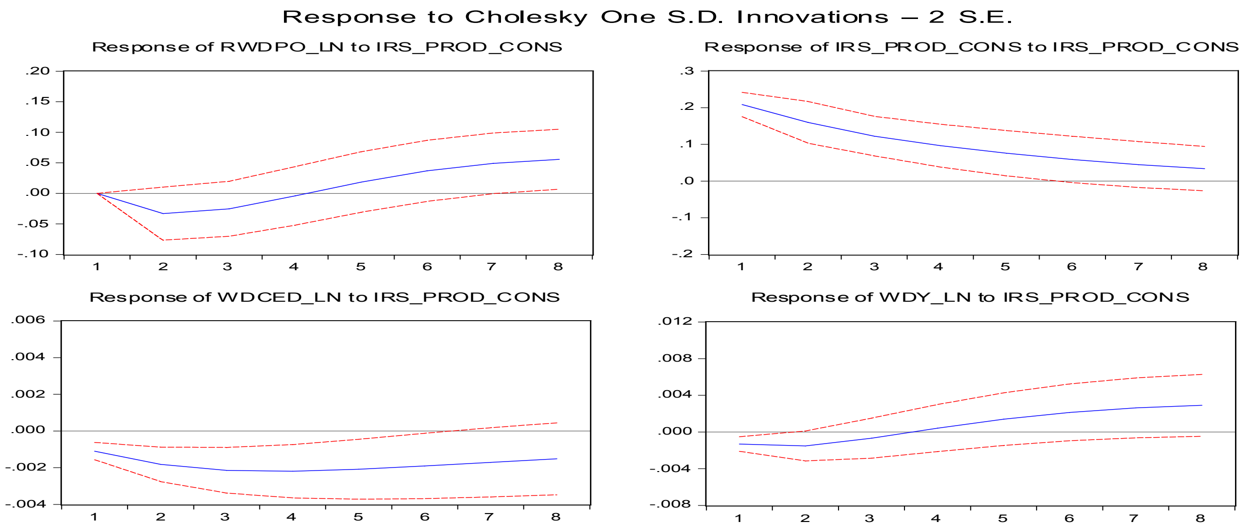

Figure 16: Impulse response to an exchange rate shock. Here, the system includes the real interest rate spread between commodity exporting and importing countries instead of the corresponding real exchange rate. The Cholesky identification is the same as above.

Forecast error variance decomposition linked to Table 2

Variable	Horizon	Supply shock	Demand Shock	Financial Market Shock	Sum
Oil price	M=12	16	14	11	41
	M=24	18	13	11	42
Oil quantity	M=12	13	16	10	39
	M=24	18	15	14	47
Exchange rate	M=12	15	9	23	47
	M=24	20	11	15	46
Interest rate rate	M=12	14	10	16	40
	M=24	13	11	15	39
Consumer price	M=12	10	10	8	28
	M=24	20	11	9	40
Industrial production	M=12	8	14	15	37
	M=24	10	14	15	39

Table 7: The table displays variance shares explained by the oil supply and demand as well as by the exchange shock. M = 12 indicates the corresponding value one year after the shock occured.

Forecast error variance decomposition linked to Table 3

Variable	Horizon	Supply shock	Demand Shock	Financial Market Shock	Sum
Oil price	M=12	16	13	22	51
	M=24	20	13	17	50
Oil quantity	M=12	17	19	11	47
	M=24	17	15	22	54
Exchange rate	M=12	12	8	32	52
	M=24	17	9	25	51
Interest rate	M=12	11	10	25	46
	M=24	11	11	25	47
Industrial production	M=12	9	14	17	40
	M=24	12	15	20	47

Table 8: The table displays variance shares explained by the oil supply and demand as well as by the exchange shock. M = 12 indicates the corresponding value one year after the shock occured.

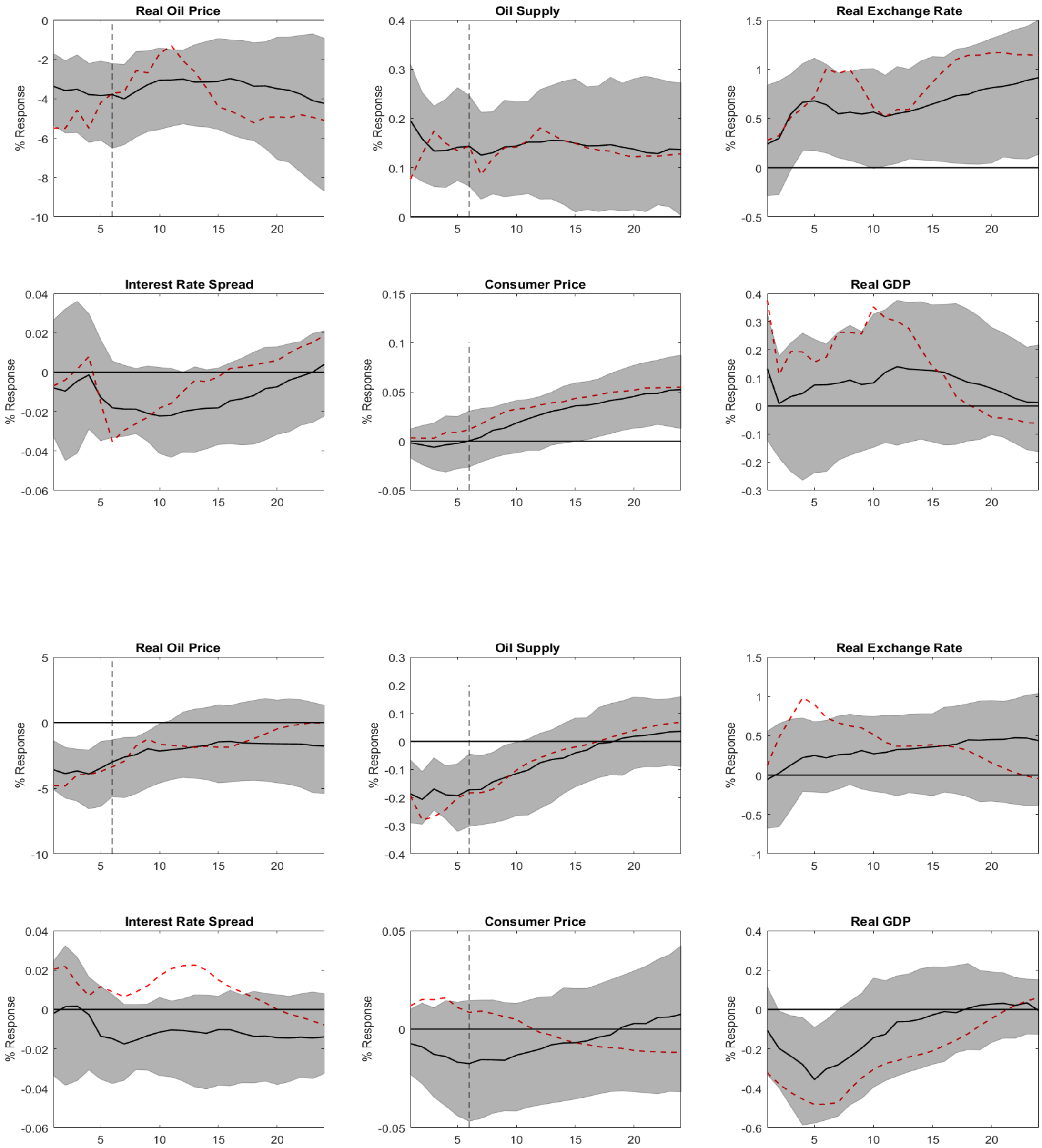

Figure 17: Impulse response to oil supply (top) and demand shocks (bottom) over a 24-month horizon as identified in Table 2. Solid lines denote the median impulse responses from a BVAR (100 draws), shaded areas indicate the 16% and 84% percentiles of the posterior distribution. Vertical lines indicate the restriction horizon. The red dotted line displays the response generated by the close-to-median model.

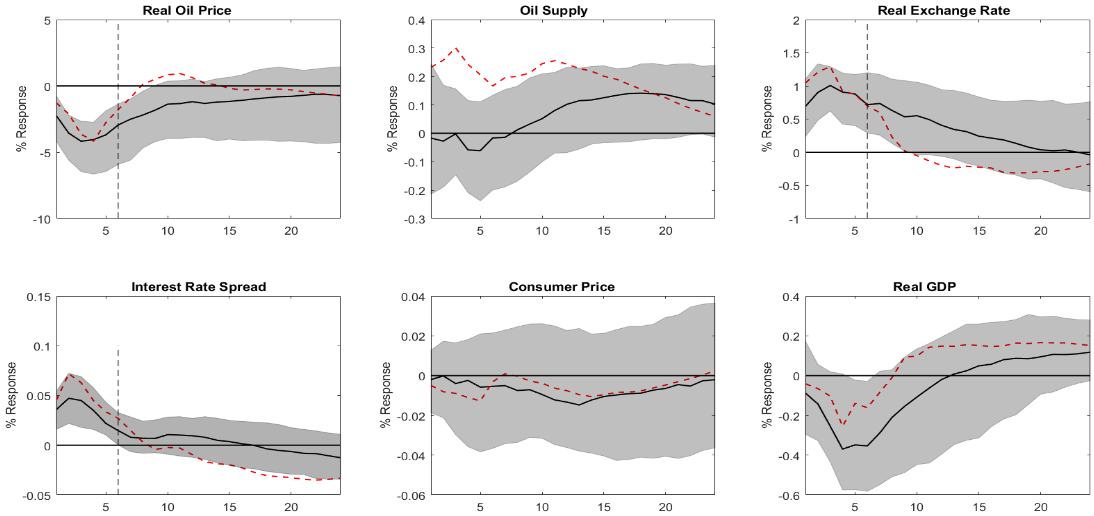

Figure 18: Impulse response to an exchange rate shock over a 24-month horizon as identified in Table 2. Solid lines denote the median impulse responses from a BVAR (100 draws), shaded areas indicate the 16% and 84% percentiles of the posterior distribution. Vertical lines indicate the restriction horizon. The red dotted line displays the response generated by the close-to-median model.

Impressum

Publisher: Hans-Böckler-Stiftung, Hans-Böckler-Str. 39, 40476 Düsseldorf, Germany
Phone: +49-211-7778-331, IMK@boeckler.de, http://www.imk-boeckler.de

IMK Working Paper is an online publication series available at:
http://www.boeckler.de/imk_5016.htm

ISSN: 1861-2199