

How Strongly Did the 2007/08 Oil Price Hike Contribute to the Subsequent Recession?

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Abstract

What were the economic consequences of the 2007/08 oil price hike for Germany? In this paper we use a structural vector autoregressive model to study the effects of oil price changes driven by different supply and demand shocks on the German economy. We find that a higher oil bill always stifles private consumption expenditures but the response of GDP crucially depends on the underlying shock. On the one hand, an oil supply disruption clearly provokes a recession. On the other hand, positive demand shocks prompt a temporary increase in exports and investment that initially outweigh the cutback on consumption induced by soaring oil prices and thus boost GDP for a while. A disaggregate analysis of the manufacturing sector suggests that a demand-driven oil price rise leads to a shift in world demand towards German export goods. In a counterfactual analysis we show that the world demand shocks that led to the 2007/08 oil price hike triggered a delayed 0.8 percent reduction of German GDP in 2009 and, therefore, notably contributed to the recession of that year.

JEL-Code: C300, E300, E320.

Keywords: German production, oil market, demand shocks, supply shocks, vector autoregressions.

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1 Introduction

What were the economic consequences of the 2007/08 oil price hike for Germany? This question is particularly interesting because in 2009 Germany experienced the deepest recession since 1949—GDP dropped by more than 5 percent. While it is widely agreed that this global recession was caused by the worldwide financial crisis, [Hamilton \(2009\)](#) and [Kilian \(2009a\)](#) argue that the preceding oil price hike reaching 145 US dollars per barrel¹ at the beginning of July 2008 also significantly contributed to this recession. In this paper we take up this point and provide a comprehensive analysis concerning the effects of oil price shocks on the Germany economy. To do so, we implement the structural vector autoregression (SVAR) framework proposed by [Kilian \(2009b\)](#) that distinguishes between oil price changes driven by supply and demand shocks.

Since the worldwide stagflation period in the early 1970s oil price hikes have often been stated as reasons for subsequent recessions. [Hamilton \(1983, 2011\)](#) documents that all U.S. postwar recessions except for the economic downturn in 1960/61 were preceded by oil price hikes. Therefore, extensive research has been carried out to analyze the effects of oil price shocks on aggregate activity. Recently, several studies have concluded that the oil price has lost its strong effect on the production level since 1984. [Blanchard and Gali \(2009\)](#) explain this finding with more flexible labor markets, more credible monetary policy and a smaller share of oil in the production process.² However, these studies typically assume that oil price innovations are homogenous over time. In a seminal contribution [Kilian \(2009b\)](#) forcefully argues that the oil price is affected by structural demand and supply shocks which may have different effects on aggregate production, see also [Kilian \(2009a\)](#) for an assessment of the relevance of these shocks for two important episodes of oil price disruptions. According to this view, the oft-cited structural break in the oil price-macroeconomy relationship only reflects

¹See U.S. Energy Information Agency (EIA).

²Other studies discussing this point are e.g. [Davis and Haltiwanger \(2001\)](#), [Hooker \(1996\)](#), [Kilian \(2008b\)](#) and [Kilian and Edelstein \(2009\)](#).

shifts in the composition of oil demand and oil supply shocks that occurred over time.³ This finding is important against the background that the oil price hike during the years 2002 to 2008 was mainly driven by increasing world demand as pointed out by [Kilian \(2009b\)](#), [Hicks and Kilian \(2011\)](#) and [Hamilton \(2009\)](#). It is even more important in the case of Germany, for which, as an export economy, the positive direct effect on domestic production of a booming world economy can by far overcompensate for the negative indirect effect of a demand-induced oil price increase. In contrast, the impact of a cut in oil supply should be quite different. Thus, focussing on a single structural oil price shock can be misleading for our analysis.

This paper therefore applies the SVAR approach of [Kilian \(2009b\)](#) to the German economy. It contributes to the literature in three ways: first, it studies how different oil supply and demand shocks affect the German economy at the aggregate level during the time period from 1973 until the beginning of 2011. Due to the size and particularly the openness of the German economy⁴, this is important complementary evidence beyond the extensively studied U.S. economy. Second, this paper provides additional disaggregate evidence for the German manufacturing industry, a key feature of which is the great importance of the automobile industry. This sector is highly relevant to explain the consequences of oil price shocks on the U.S. economy as stressed by [Bresnahan and Ramey \(1993\)](#), [Lee and Ni \(2002\)](#) and [Ramey and Vine \(2011\)](#). Interestingly, during the recent recession there was a dramatic decline in the German automobile production that ultimately led to the introduction of a “Cash for Clunkers” program. While this certainly cannot be explained completely by the 2007/08 oil price hike, it seems nevertheless worthwhile to try to understand how oil price shocks affect the German industry. Finally, this study provides an estimate by how much the 2007/08 oil

³[Ramey and Vine \(2011\)](#) also provide evidence that no structural break in the oil price-macroeconomy relationship exists. However, their analysis focuses more on institutional settings like price controls and a complex system of entitlements that led to some rationing and shortages.

⁴Germany is currently the fourth largest economy of the world. While its economic value added in U.S. dollars is less than one fourth of that in the U.S. as published by the IMF, Germany’s share in world merchandise exports was in 2010 with 8.3 percent only slightly lower than the corresponding number for the United States (8.4 percent) and for China (10.4 percent) according to WTO data.

price hike contributed to the subsequent recession. To this end, we perform a counterfactual analysis: we ask by how much German GDP would have declined if there had no shocks occurred after July 2008, the month of the oil price peak.

Even though there exists a large literature concerning the effects of oil price shocks on the United States, the evidence for Germany is scarce: [Cunado and de Gracia \(2003\)](#) and [Jiménez-Rodríguez and Sánchez \(2005\)](#) provide evidence of negative non-linear effects of oil price increases on German production. Using a linear model, [Blanchard and Gali \(2009\)](#) report for the period since 1983 that an oil price increase leads to a rise in German GDP. [Kilian \(2008a\)](#) uses unexpected changes in global oil production to identify oil supply shocks. In his baseline results he finds that German GDP declines a few quarters after an oil supply shock. [Peersman and van Robays \(2009\)](#) use sign restrictions to identify oil demand and oil supply shocks. They find for Germany that a contractionary oil supply shock triggers an increase in German GDP.⁵ Our analysis on the industrial level is motivated by [Davis and Haltiwanger \(2001\)](#), [Herrera et al. \(2011\)](#) and [Lee and Ni \(2002\)](#) who present results for the United States. For Germany [Jiménez-Rodríguez \(2008, 2011\)](#) studies the effects of oil price changes on industry sectors. However, she only analyzes the period between 1975 and 1998.

With the exception of [Peersman and van Robays \(2009\)](#), all studies of the German case assume there is only one structural oil price shock. This is a central difference to our analysis because we use the currently dominating approach proposed by [Kilian \(2009b\)](#), [Kilian and Park \(2009\)](#) and [Kilian et al. \(2009\)](#) that distinguishes between different sorts of oil price shocks. Furthermore, former studies often rely on nonlinear transformations of the oil price variable or assume asymmetric effects of oil price increases versus decreases. While we are aware of potential nonlinearities, it is beyond the scope of this paper to add to the ongoing debate on this topic that has attracted much attention in recent times, see, e.g., [Hamilton \(2011\)](#) and [Herrera et al. \(2011\)](#). Thus, we follow [Kilian and Vigfusson \(2011a\)](#) and [Kilian and Vigfusson \(2011b\)](#) and apply a linear framework.

⁵More recently, [Kilian and Murphy \(2012\)](#) show that using only sign restrictions for identification of oil supply and demand shock leads to distorted results.

Our results show that a contractionary oil supply shock triggers a significant decline in aggregate German production. An expansionary aggregate demand shock raises the real price of oil. Nevertheless, within one year after the shock German GDP increases significantly. Afterwards, however, the negative effects of the oil price hike begin to dominate and German GDP falls considerably. While these two results are broadly in line with those presented by [Kilian \(2009b\)](#) for the U.S., the dynamic response of German GDP following an oil-specific demand shock, which can be interpreted as an innovation to precautionary oil demand, exhibits a completely different picture. German GDP and exports rise persistently after an unexpected increase to oil-specific demand even though the real oil price rises considerably. At the industrial level, this is mimicked by a boost in the production of investment goods and automobiles. Furthermore, firms engaged in the export business seem to benefit more than others. These findings are consistent with the interpretation that oil-specific demand shocks induce shifts in global demand towards German export goods. Finally, we show by means of a counterfactual analysis that the shocks that induced the oil price hike in 2007/08 triggered a 0.8 percent reduction of German GDP in 2009 and, therefore, made a notable contribution to the recession of that year.

The remainder of the paper is structured as follows. Section 2 provides statistics concerning German oil consumption and manufacturing. In Section 3 we outline our empirical framework that is used throughout the whole analysis. The subsequent Sections 4 and 5 present empirical results at the aggregate and disaggregate level. In Section 6 we ask whether the German economy would have experienced a recession in 2009 just because of the shocks that led to the 2007/08 oil price hike. Section 7 concludes.

2 Statistics on German Oil Consumption

In 2008 Germany imported 105 million tons of crude oil and increased its oil imports by more than 17 million tons since 1991.⁶ Petroleum is the single most important energy source

⁶Due to the recession crude oil imports declined to 98 millions tons in 2009. These data are taken from the national working group “Energiebilanzen” and are available at www.ag-energiebilanzen.de.

in Germany. In 2010 it contributed roughly 34 percent to the primary energy consumption in Germany. This figure has not considerably changed during the last 20 years. Further important energy sources are natural gas (22 percent), coal (12 percent) and nuclear energy (11 percent). The pattern of oil consumption, however, differs markedly across sectors. While petroleum is very important for transportation (93 percent of energy consumption in 2009), but also for households (23 percent) and the trade and services sector (15 percent), its contribution to energy consumption in German manufacturing amounted to 6 percent.

Similar to countries such as the U.S. or the U.K. manufacturing in Germany has become less important over the last 40 years. Its share in gross value added declined from 37 percent in 1970 to 21 percent in 2010. Nonetheless, the recession in 2009 was to a great extent caused by a collapse of manufacturing production. For our analysis we choose six industrial sectors that feature two characteristics: first, they account for a large share in German manufacturing and, second, energy is a crucial input in their production process. The chosen sectors are displayed in Table 1.⁷

Table 1: STATISTICS CONCERNING GERMAN MANUFACTURING

Industrial sector	Share in manufacturing in percent (volume of sales)	Energy intensity (cost of energy in euro cent for each euro of sale)	Export ratio of production in percent (volume of sales)
Refined petroleum	7.5	0.6	7.2
Chemicals and chemical products	7.7	5.0	58.5
Basic metals	6.5	6.0	38.5
Fabricated metal products	5.9	1.9	32.1
Machinery	13.0	0.9	61.1
Automobile & transport equipment	19.2	0.8	62.9
Other industrial sectors	40.1	2.1	39.0
Manufacturing	100	2.1	46.3

Notes: We use sales and energy cost data from the year 2008 to compute the numbers in the first two columns. The last column presents numbers of establishments with at least 50 employees for 2010.

⁷The data source is the German Federal Statistical Agency. To compute the shares in manufacturing and energy intensities we use data from 2008. Using instead the latest available data from 2009 would not considerably change the results.

The largest German industrial sector is automobile & transport equipment with a production share of almost 20 percent. Machinery and the chemical industry follow on the second and third place. In total, the six selected industrial sectors represent almost 60 percent of total manufacturing production. Compared to the other sectors, chemicals and chemical products and basic metals have the highest energy intensities.

One distinctive feature of German manufacturing is its high export share. Establishments with at least 50 employees exported 46 percent of their production in 2010. The major export industries are automobile & transport equipment, machinery, and the chemical industry, which export considerably more than half of their production.

3 Empirical Framework

3.1 The Structural VAR Model

Our empirical approach is based on the structural VAR model of [Kilian \(2009b\)](#) that describes the global crude oil market. This model accounts for the simultaneity between crude oil supply and demand, and it allows to decompose unexpected oil price changes into shocks to world oil supply, to global demand, and to oil-specific demand. The latter captures shifts in market concerns about the availability of future oil supply and may therefore also be called precautionary demand for oil. The VAR model has the form

$$y_t = c + A(L)y_{t-1} + u_t, \tag{1}$$

where c is a vector of constants and $A(L)$ denotes a lag polynomial. The vector y_t includes the percent change in world crude oil production, a measure of global real activity, and the real price of oil. A more detailed description of the data is given below.

To estimate the effects the shocks to the global oil market have on the German economy, we follow the approach outlined in [Kilian and Park \(2009\)](#) and add one German variable at

a time to the oil market model (1). This yields

$$\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \tilde{c} + \tilde{A}(L) \begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \tilde{u}_t, \quad (2)$$

where z_t is the additional German variable.⁸ We estimate the VAR models using monthly data over the period from January 1973 to March 2011. We include 24 lags to allow for delayed effects of up to two years. To account for conditional heteroskedasticity in the monthly data we construct our confidence bands using the recursive design wild bootstrap proposed by [Gonçalves and Kilian \(2004\)](#). The structural shocks are identified using the recursiveness assumption proposed by [Kilian \(2009b\)](#) and [Kilian and Park \(2009\)](#):

$$\tilde{u}_t \equiv \begin{pmatrix} \tilde{u}_{1,t}^{oil\ production} \\ \tilde{u}_{2,t}^{real\ activity} \\ \tilde{u}_{3,t}^{real\ oil\ price} \\ \tilde{u}_{4,t}^{German\ variable} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{pmatrix} e_{1,t}^{oil\ supply\ shock} \\ e_{2,t}^{aggregate\ demand\ shock} \\ e_{3,t}^{oil-specific\ demand\ shock} \\ e_{4,t}^{German\ shock} \end{pmatrix}. \quad (3)$$

Specifically, we assume that the short-run global oil supply curve is vertical. Hence, only oil supply shocks may lead to instantaneous changes in global oil production. The aggregate demand shock (for industrial commodities) is defined as the innovation in the global real activity index that is not explained by oil supply shocks. This implies that oil-specific demand shocks do not affect the global business cycle within the month. Therefore, oil-specific demand shocks are defined as the part of the surprise changes in the real oil price that is not explained by oil supply and world demand shocks. Finally, we assume that shocks originating in the German economy do not affect the global oil market block within a month.

To analyze the effects of the structural shocks on the quarterly macroeconomic variables q_t , we again follow [Kilian \(2009b\)](#) who calculates quarterly averages of the shocks, say, $\bar{e}_{j,t}$,

⁸One might argue that e.g. German manufacturing production is not able to influence the global oil market at all as its share of world production is rather small. However, our results do not change if we would use instead a subset VAR that does not allow the lags of the German variable z_t to affect the oil market variables summarized in y_t .

$j = 1, 2, 3$, and estimates regressions of the form

$$q_t = \alpha_j + \sum_{i=0}^{12} \phi_{ji} \bar{e}_{j,t-i} + \varepsilon_{j,t}, \quad j = 1, 2, 3. \quad (4)$$

The number of lags is set to 12 quarters. Including the contemporaneous value of $\bar{e}_{j,t}$ amounts to assuming that the global shocks are predetermined to German variables which seems plausible.⁹

3.2 The Data

For the global oil market we use an updated version of the data analyzed by Kilian (2009b). World crude oil production is provided by the U.S. Energy Information Administration. The global real activity index is constructed from single voyage bulk dry cargo ocean shipping freight rates. Assuming that the supply of shipping capacity is fixed in the short run, changes in freight rates reflect the development in world demand for industrial commodities such as grain, coal, and scrap metal. Kilian (2009b) shows that this real activity index is superior to the industrial production index of the OECD countries.¹⁰ Finally, for the real price of oil we use the U.S. refiner’s acquisition cost of crude oil deflated by the U.S. CPI.¹¹

To analyze the impact of the various shocks on the German macroeconomy, we include five real quarterly national accounts variables, namely GDP, private consumption expenditures, gross investment, exports, and imports. All variables are seasonally adjusted and used in percent changes.¹² To avoid a break in the time series due to German reunification in 1991, post-1991 data (which refer to reunited Germany) are extended backwards by using the

⁹As a robustness check, we aggregated monthly German variables such as industrial production to the quarterly frequency and ran both the monthly oil market VAR (2) and the quarterly regression (4). The resulting impulse response functions were—up to the frequency—largely the same.

¹⁰The index is made available by Lutz Kilian at www-personal.umich.edu/~lkilian/paperlinks.html.

¹¹The data sources are the U.S. Energy Information Administration and FRED. The oil price series has been extended backwards by using the original time series of Kilian (2009b) that is available at www.aeaweb.org/articles.php?doi=10.1257/aer.99.3.1053. The real oil price series is expressed as deviations from the mean.

¹²The percent changes are not annualized so a cumulative impulse response can directly be interpreted as the percent difference between the initial level and the level that is triggered by the shock.

growth rates of the pre-1991 data (which refer to Western Germany only).

The monthly German variables are manufacturing production, several price and exchange rate indices. Further, we link currently available real production data at the industry level with discontinued earlier series that are available back to 1970.¹³ We chain these time series for those sectors for which we can ensure that their definition has not changed since 1970. Finally, we adjust all these variables for seasonal and calendar effects and use them as percent changes.

A major strike by the union of metal workers to reduce the weekly workload to 35 hours affected the German automobile industry in May and June 1984. Production went down by 16 and 51 percent, respectively, just to recover with rates of 170 and 18 percent in July and August. To preclude that this exogenous event contaminates any of the estimation results, we replace the four monthly observations with forecasts of an autoregressive model with 12 lags that is fitted to the remaining sample.¹⁴

4 Empirical Results at the Aggregate Level

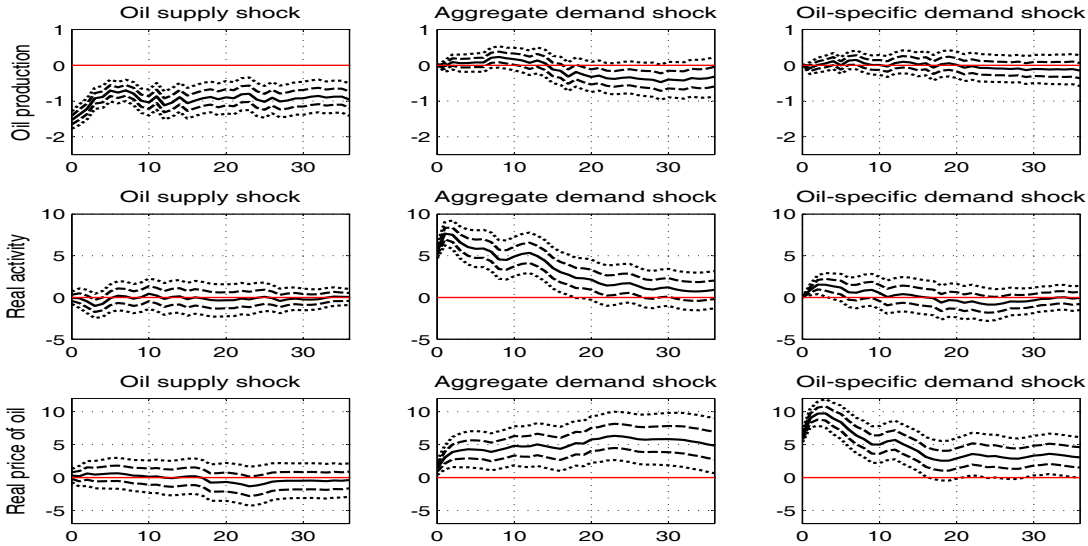
4.1 Results of the Structural Oil Market Model

In this section we briefly present the results of the structural oil market model (1). As already mentioned we update the data set of [Kilian \(2009b\)](#) until March 2011. Therefore, it is not surprising that our results are similar. Figure 1 summarizes the responses of the oil market variables to the structural shocks. An adverse oil supply shock leads to a sizeable and permanent decline in oil production. The real price of oil goes up slightly but without statistical significance. Real activity shows almost no reaction. An expansionary aggregate demand shock immediately triggers a strong and long-lasting increase in real activity. As

¹³All these time series are available at the German Federal Statistical Agency.

¹⁴Our estimation results reported below are robust to different lag orders for the autoregressive adjustment model or to using average growth rates instead. The effect of the strike is also visible in total manufacturing production as well as in GDP and exports. However, replacing the respective observations with autoregressive forecasts yields only negligible changes in our results. Therefore, we prefer to use the original data.

Figure 1: Responses to Structural Shocks to the Global Oil Market

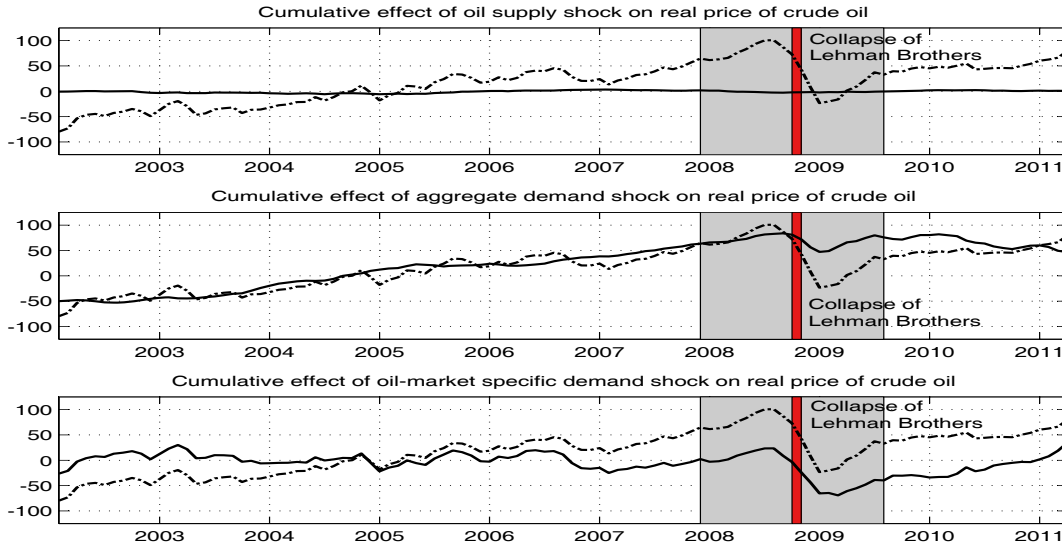


Notes: The impulse response functions are estimated with model (1). The time dimension (horizontal axis) is measured in months. The confidence bands (one and two standard deviations) are constructed using the recursive design wild bootstrap of [Gonçalves and Kilian \(2004\)](#).

a consequence, the real oil price significantly increases for a sustained period of time. In contrast, the rise in oil production comes with a delay of seven months and is only marginally significant. An unanticipated increase in oil-specific demand causes a strong hike in the real price of oil while oil production does not react significantly. The shock also triggers a statistically significant short-lived increase in economic activity.

Figure 2 shows the cumulative contributions of the structural shocks to the historical evolution of the real oil price. We concentrate on the oil price developments since 2002. Between 2002 and 2008 the oil price hike was fueled almost exclusively by expansionary aggregate demand shocks. The cumulative effects coming from changes in oil supply or in precautionary oil demand played only a minor role in this episode. However, the rapid fall in the oil price witnessed during the recent recession was only partly due to reduced global demand for industrial commodities but mainly caused by negative oil-market specific shocks. Probably market participants were concerned about how quickly the world economy would recover and the world demand for oil would pick up again. Therefore, the precautionary

Figure 2: Historical Decomposition of the Real Price of Oil 2002:1 to 2011:3



Notes: Estimates are based on model (1). The dot-dashed lines denote the real price of oil. The solid lines show the fluctuations in the real price of oil that are explained by the respective structural shock. The shaded grey areas define the last U.S. recession dated by the NBER. The red vertical bar represents the date of the collapse of Lehman Brothers. The time dimension (horizontal axis) is measured in years.

demand for oil fell considerably. By the end of the sample, confidence seems to have returned as oil-market specific shocks contributed positively to the real oil price.

4.2 The Reaction of German Macroeconomic Aggregates

The reaction of German macroeconomic aggregates to the three structural shocks are displayed in Figure 3. To help interpret our results, we show in addition the responses of exchange rates and prices in Figure 4.

An oil supply disruption lowers GDP instantaneously.¹⁵ However, this decline becomes statistically significant only after seven quarters. Three years after the shock, GDP is roughly 1.5 percent below the initial level which accords well with the finding of Kilian (2008a) for

¹⁵This stands in contrast to findings by Kilian (2008a) who reports an immediate increase in German GDP after a contractionary oil supply shock. He argues that this finding might be caused by a “spurious sample correlation between economic expansions in Germany and exogenous oil supply disruptions” and should disappear as more observations are added. Our result is based on an extended sample and seems to confirm this view.

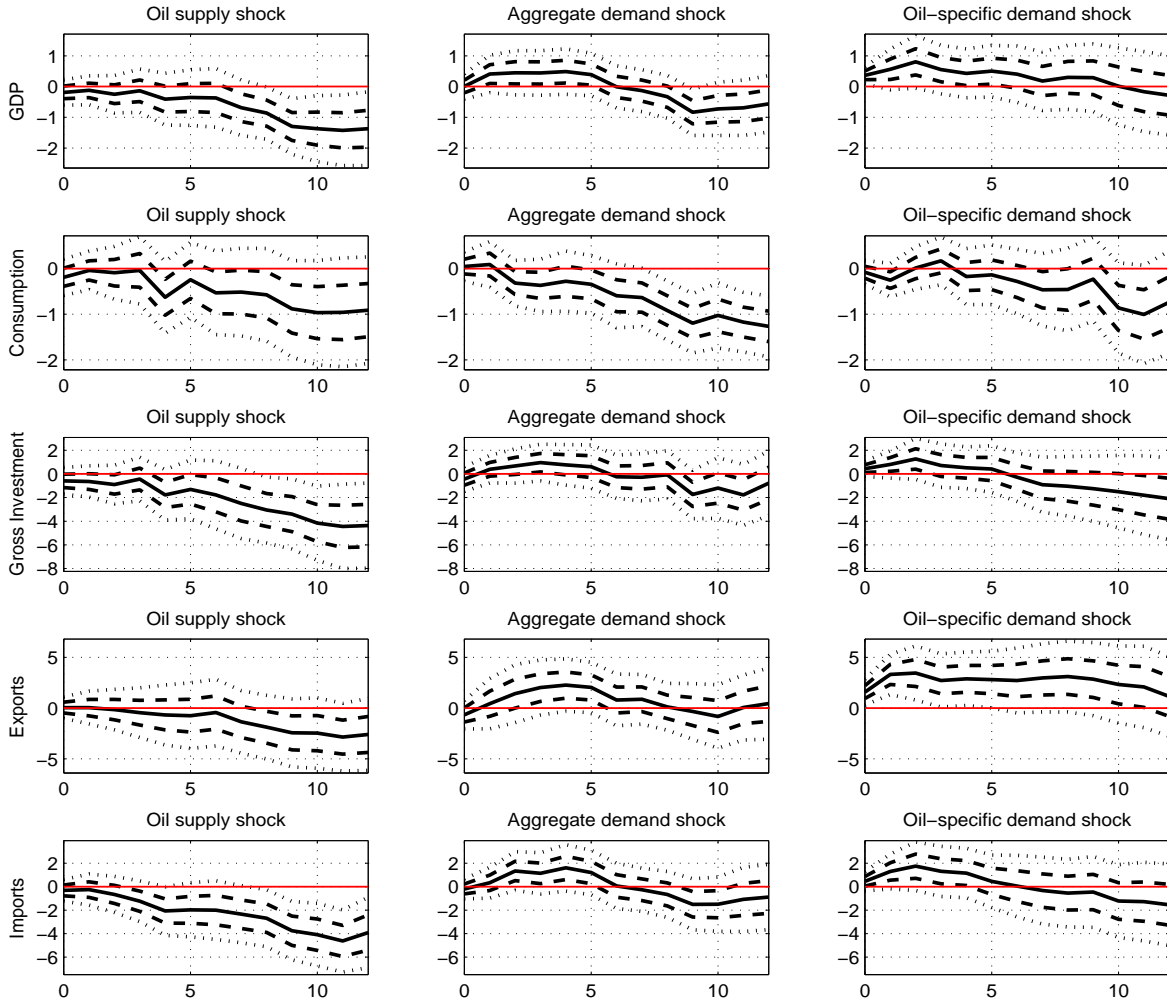
Germany. However, the effect is much more persistent than in the U.S., see [Kilian \(2009b\)](#). The decline in German GDP significantly extends to all demand aggregates.¹⁶ Within three years, private consumption falls by 1 percent, gross investment by 4.4 percent, imports by 4 percent, and exports by 2.7 percent. Initially, however, only gross investment declines significantly as measured by the one-standard-error bands. Imports follow closely behind, while consumption and particularly exports react with a considerable delay.

To put these results into perspective, it is informative to consider the responses of exchange rates and prices. As also documented by [Kilian \(2008a\)](#), the nominal exchange rate of the euro against the U.S. dollar depreciates quickly after the shock, see Figure 4. The real effective exchange rate shows the same reaction suggesting that the euro prices of oil and of imported goods in general increase. This exchange rate effect may explain the swift decline in imports and the lagged reaction of exports and could account for a major difference between the responses within the U.S. and Germany. While there is an immediate drop in U.S. GDP as reported by [Kilian \(2009b\)](#), German GDP declines more sluggishly. As one factor behind this difference, after an adverse oil supply shock U.S. exports suffer from the immediate appreciation of the U.S. dollar while German exports are temporarily shielded by an external devaluation. Consistent with this interpretation, there does not seem to be a need for an internal devaluation in Germany as the CPI remains largely unaffected. Given the hike in import prices however, this implies that domestic prices fall, probably triggered by the reduction in consumption demand.

A positive aggregate demand shock leads to an increase in GDP within the first year that is statistically significant in terms of one-standard-error bands. This suggests that the primary effect of higher world demand initially outweighs the contractionary effect of higher oil prices. Two years after the shock, however, the price effects begin to dominate and GDP turns significantly negative. This interpretation is supported by the observation that

¹⁶Using a VAR model with sign restrictions, [Peersman and van Robays \(2009\)](#) find that Germany—unlike all other euro area countries—experiences a persistent increase in GDP, consumption and investment after an oil supply disruption.

Figure 3: Responses of GDP and its Components to the Structural Shocks



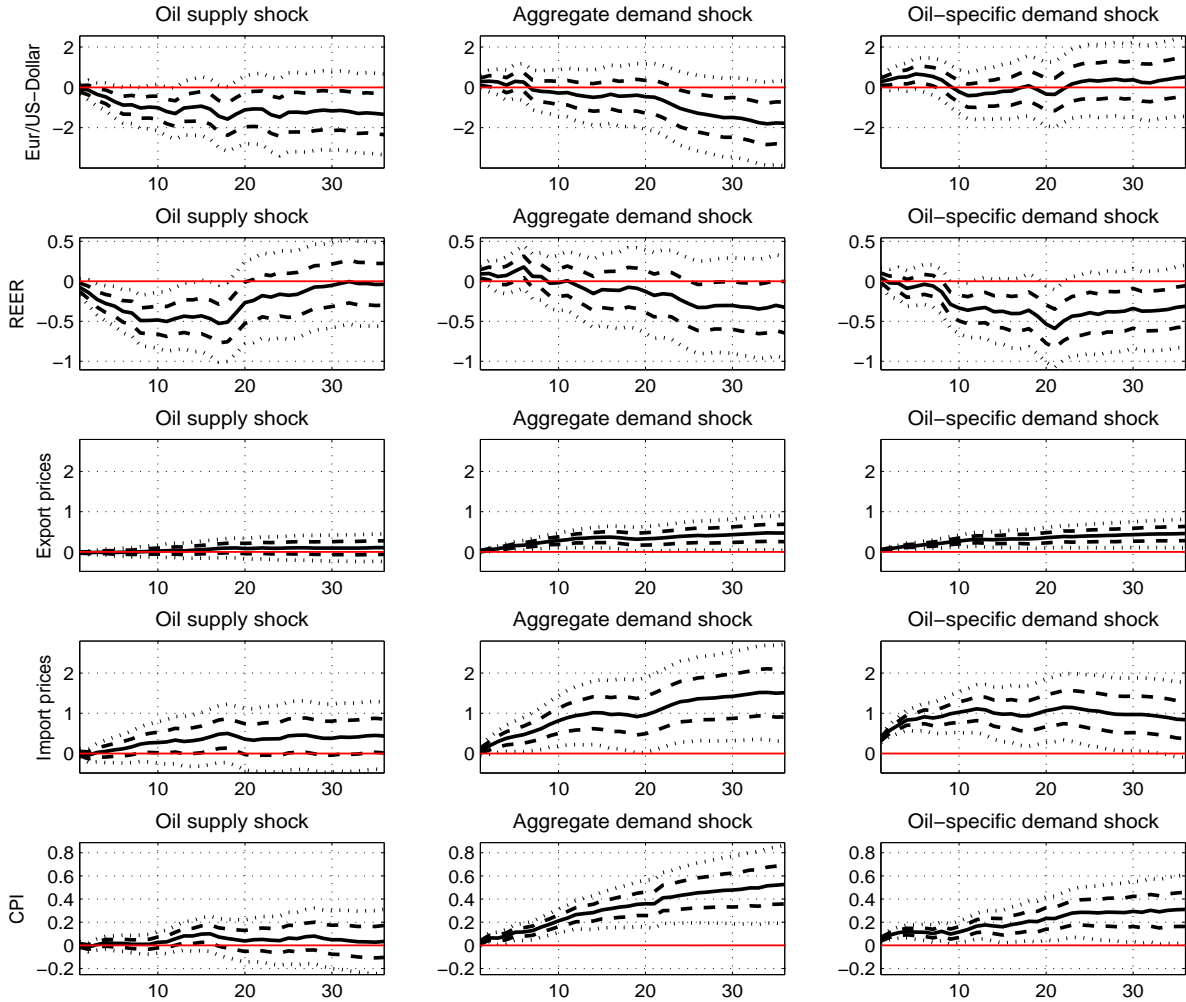
Notes: Impulse response functions are estimated with model (4). The time dimension (horizontal axis) is measured in quarters. The confidence bands (one and two standard deviations) are constructed using a block bootstrap method with block size 4 and 20,000 bootstrap replications.

export and investment demand show a significant positive reaction within the first seven quarters, while private consumption falls steadily and all prices climb up persistently and highly significantly. Three years after the shock, consumption is 1.3 percent below the initial level, while consumer prices have gone up by 0.5 percent.

These findings are similar to those obtained by Kilian (2009b) for the U.S. economy.¹⁷

¹⁷Note that the difference in magnitude is mainly caused by Kilian's approach to cumulate annualized quarter-on-quarter growth rates while we cumulate raw growth rates which seems a more natural way when one is interested in comparing levels.

Figure 4: Responses of Exchange Rates and Prices to the Structural Shocks



Notes: Impulse response functions are estimated with model (2). REER denotes the real effective exchange rate against the main trading partners, CPI is the headline consumer price index. The time dimension (horizontal axis) is measured in months. The confidence bands (one and two standard deviations) are constructed using the recursive design wild bootstrap of [Gonçalves and Kilian \(2004\)](#).

However, the initially positive GDP response is somewhat more pronounced for Germany which might reflect the greater export dependency of the German economy. Additionally, we find that German exports benefit from international price movements. The expansionary world demand shock leads to a deterioration of the German terms of trade, i.e., import prices increase faster than export prices. This, in turn, improves the price competitiveness of German firms.

An unexpected increase in oil-market specific demand initially raises GDP which is con-

sistent with the previous result that world activity accelerates within the first few months. This response is mirrored by a quick and long-lasting rise in exports which is supported by a real devaluation as export prices rise by less than import prices. On the flip side, the strong hike in real oil prices significantly feeds through to consumer prices. The corresponding loss in purchasing power lowers private consumption demand and eventually pulls down GDP.

The result of a temporary rise in German GDP after an oil-specific demand shock contrasts with the U.S. experience reported by [Kilian \(2009b\)](#) that GDP declines steadily. Three observations may help explain this difference. First, German exporters do not completely pass the higher oil price into their export prices. This leads to a gain in their price competitiveness and, therefore, a relatively higher demand for their products. This argument is supported by the reactions of import and export prices shown in Figure 4. Second, the immediate increase in the real oil price after an oil-specific demand shock triggers shifts in global demand. The most prominent example of such demand shifts is the U.S. automobile market. [Kilian and Edelstein \(2009\)](#) document that after energy price shocks the demand for U.S. automobiles falls, whereas the demand for foreign more energy-efficient cars evolves much more positively. Third, the German export portfolio mainly consisting of a broad range of investment goods seems to fit well the demands of many oil-exporting countries, i.e., Germany benefits from petrodollar recycling. For all these reasons, German exports react positively to an oil-specific demand shock which temporarily outweighs the negative consumption effect of higher oil prices.

Taken together we conclude that it matters which of the three shocks hits the German economy. While we find that consumption declines markedly in all cases, the reactions of exports and gross investment—and finally GDP—depend on the type of the structural shock. Not surprisingly, the primary effect of an expansionary world demand shock on GDP is positive until the oil price effect weighs in and the boom loses momentum. Somewhat more unexpectedly, however, after an oil-market specific demand shock a redirection of world demand towards German export goods seems to counteract the contractionary effect

of higher oil prices on consumers' demand. This implies that the consumption demand effects stressed by [Kilian and Edelstein \(2009\)](#) and [Kilian \(2008b\)](#) could be much less important for, and thus less harmful to, the German compared to the U.S. manufacturing sector. In the following section, we analyze this interpretation in more detail.

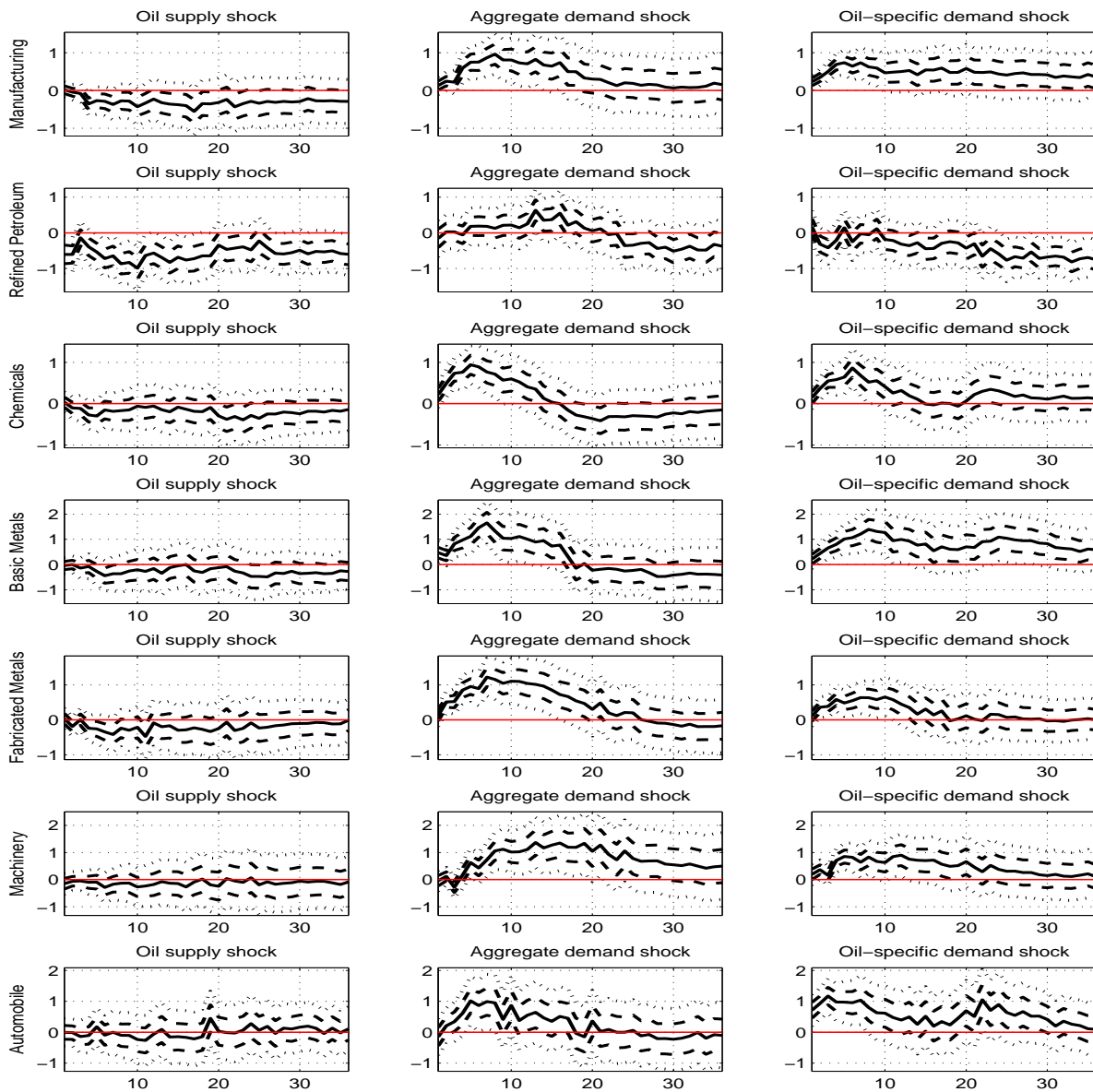
5 Results at the Industrial Level

One of the leading explanations why oil price hikes have harmed the U.S. economy more than the cost share of oil suggests, is that households not only cut back on consumption due to a loss in purchasing power and an increase in precautionary savings but also shift their demand for automobiles away from U.S. products, see [Kilian and Edelstein \(2009\)](#). To the extent that this demand is targeted to automobiles produced in Germany, the German automobile industry should be less affected than its U.S. counterpart. Since, in addition, German production of investment goods in general may benefit from petrodollar recycling, in a next step we examine several important industrial sectors in more detail. Subsequently, we analyze whether exporting and non-exporting firms react differently as our interpretation suggests that exporters which benefit directly from the redirection effect do better after an oil price shock than non-exporters which might be more strongly exposed to the slump in domestic consumption demand.

5.1 The Reaction of Industrial Production

After an oil supply shock industrial production declines within a few months and persistently remains below the initial level, see Figure 5. This decline is statistically significant according to the one-standard-deviation band but economically moderate.

Figure 5: Responses of Total Manufacturing and Industry-Level Production to the Structural Shocks



Notes: see notes to Figure 4. The time dimension (horizontal axis) is measured in months.

Petroleum refinery is the industrial sector which suffers most from reduced oil supply. However, compared to the GDP response even this effect is moderate, with a minimum at -1 percent after 10 months. The production of more primary goods such as chemicals and basic metals also persistently declines, even though the reactions are at most significant according to the one-standard-deviation band. In contrast, output in the machinery and automobile sectors remains largely unaffected. The visual impression that oil supply shocks seem to play no important role for German manufacturing is further supported by considering the forecast error variance in Table 2. Oil supply shocks are not able to explain a noticeable fraction of the forecast error variance at all horizons with the only exception being petroleum refinery. All in all, we conclude that oil supply disruptions have not been a relevant source of gross industrial output fluctuations in Germany. This implies that the transmission of oil supply shocks works mainly through changes in the exchange rate and in private demand rather than through industrial production.

An expansionary world demand shock triggers a swift and statistically significant increase in industrial production that peaks at 1 percent after eight months and subsequently phases out. In contrast to the GDP response, there is no medium-term decline below the initial level. The production of chemicals, basic metals and fabricated metal products rises quickly while the automobile and particularly the machinery sector lag somewhat behind which is a typical characteristic of the German business cycle. Interestingly, after 18 months the production of more primary goods such as refined oil, chemicals and basic metals undershoots the initial output level which indicates that rising prices for oil and presumably other commodities tend to reduce the demand for these goods considerably. In contrast, machinery production is less affected by these price effects and remains persistently positive. In terms of the forecast error variance decomposition, the aggregate demand shock is much more important in explaining output fluctuations than the oil supply shock. At the one-year horizon it explains almost 17 percent of the forecast error in total manufacturing production. This share varies between 0.8 percent for petroleum refinery and 21.5 percent for fabricated metal products.

Table 2: FORECAST ERROR VARIANCE DECOMPOSITION OF MANUFACTURING AND INDUSTRY-LEVEL OUTPUT

	Shock	1M	3M	6M	1Y	2Y	5Y
Manufacturing	Oil supply shock	0.01%	0.15%	2.07%	2.76%	4.24%	4.56%
	Aggregate demand shock	0.65%	2.16%	11.47%	16.64%	14.13%	7.99%
	Oil-specific demand shock	1.92%	7.25%	13.21%	11.35%	11.36%	10.17%
	Other shocks	97.42%	90.44%	73.24%	69.26%	70.27%	77.28%
Refined petroleum	Oil supply shock	2.41%	3.44%	5.74%	12.76%	16.44%	18.60%
	Aggregate demand shock	0.16%	0.12%	0.33%	0.79%	2.70%	8.87%
	Oil-specific demand shock	0.19%	1.39%	1.43%	1.51%	4.55%	21.11%
	Other shocks	97.24%	95.06%	92.51%	84.95%	76.31%	51.42%
Chemical products	Oil supply shock	0.03%	0.26%	1.04%	0.81%	1.88%	2.46%
	Aggregate demand shock	1.00%	8.46%	15.12%	13.55%	11.23%	6.84%
	Oil-specific demand shock	0.46%	4.68%	9.57%	8.51%	6.72%	4.17%
	Other shocks	98.52%	86.60%	74.27%	77.13%	80.17%	86.53%
Basic metals	Oil supply shock	0.02%	0.12%	0.72%	0.82%	1.18%	2.14%
	Aggregate demand shock	2.50%	5.58%	12.87%	15.09%	13.41%	8.16%
	Oil-specific demand shock	0.52%	3.67%	8.38%	12.84%	15.08%	17.87%
	Other shocks	96.96%	90.62%	78.03%	71.25%	70.33%	71.83%
Fabricated metal products	Oil supply shock	0.02%	0.35%	1.31%	1.81%	2.06%	1.62%
	Aggregate demand shock	0.26%	5.42%	13.97%	21.55%	19.71%	11.14%
	Oil-specific demand shock	0.18%	2.87%	5.45%	6.76%	4.81%	2.70%
	Other shocks	99.54%	91.36%	79.28%	69.88%	73.43%	84.54%
Machinery	Oil supply shock	0.24%	0.21%	0.46%	0.51%	0.43%	0.34%
	Aggregate demand shock	0.02%	0.67%	2.41%	9.64%	16.42%	12.92%
	Oil-specific demand shock	0.38%	1.38%	7.23%	7.75%	6.74%	4.23%
	Other shocks	99.37%	97.74%	89.90%	82.10%	76.42%	82.51%
Automobile and transport	Oil supply shock	0.12%	0.11%	0.40%	0.47%	2.09%	1.78%
	Aggregate demand shock	0.15%	0.11%	0.76%	1.92%	2.41%	2.78%
	Oil-specific demand shock	0.65%	4.95%	6.55%	6.60%	8.04%	7.44%
	Other shocks	99.08%	94.84%	92.29%	91.01%	87.46%	87.99%

Notes: see notes to Figure 4.

A positive oil-specific demand shock leads to a statistically significant and persistent increase in industrial production. Even after three years, production is 0.3 percent above the initial level. This is consistent with our previous discussion of favorable international price movements and, in particular, shifts in global demand towards German products. These effects do not apply to the refinery sector which exports less than 10 percent of its production and is most directly affected by the oil price hike. Therefore, it not surprising that this is the only sector that exhibits a decline in output while all other sectors show a positive response. Most striking is the impact response of the automobile sector which, unlike all other sectors, immediately increases production by almost 1 percent. Using the forecast error variance decompositions, it turns out that a noticeable fraction of the gross industrial output fluctuations can be explained by the oil-market specific demand shock. For total manufacturing production the maximum share is 13 percent at the six-month horizon, again with considerable variation between individual sectors.

The automobile sector receives particular attention in the discussion of the effects of oil price changes on the U.S. economy (see, e.g., [Bresnahan and Ramey, 1993](#), as well as [Ramey and Vine, 2011](#)). [Kilian \(2008b\)](#) and [Kilian and Edelstein \(2009\)](#) document that oil price hikes do not only depress total automobile demand but also shift demand towards foreign cars with the consequence that non-U.S. carmakers temporarily increase their U.S. sales. This is consistent with the view that European and Japanese producers have a comparative advantage with respect to smaller and more energy-efficient cars, as argued, e.g., by [Lee and Ni \(2002\)](#). Thus, the net effect on German automobile production is unclear. Our analysis reveals in the bottom panel of Figure 5 that demand driven oil price hikes go hand in hand with increases in German automobile production. However, Table 2 shows that all three structural oil price shocks together do explain less than 13 percent of the observed variation in production. Hence, oil price shocks seem to have a rather limited effect on German automobile production.

Altogether, we conclude that German manufacturing benefits from positive shocks to the

real oil price: on the one hand, the energy cost share of most German industry sectors is small (see Section 2). On the other hand, the effects of favorable international price movements and shifts in global demand towards German products seem to dominate a general slump in private consumption. However, this result does not mean that the German economy as a whole is better off after an oil price shock. Our findings indicate that the reaction of German households is not much different from that documented for the U.S. This may have adverse consequences for the service sector. An analysis along these lines is left for future research.

5.2 The Reaction of Exporters and Non-Exporters

So far we have seen that German manufacturing is positively affected by aggregate and oil-specific demand shocks. The above explanations for this finding imply that exporting firms are affected by oil price shocks in a different way than non-exporting firms. Using data of the IFO Business Climate Survey (IFO-BCS) of German manufacturing firms allows us to check this conjecture. The IFO-BCS index is a much-followed leading indicator for economic activity in Germany. It is based on a firm survey which has been conducted since 1949 and, therefore, is one of the oldest and broadest monthly business confidence surveys available (see [Becker and Wohlrabe, 2008](#), for details). One of its main advantages is the broad coverage including approximately 5,000 respondents at the beginning of our sample and still about 2,500 towards the end.¹⁸ Firms are asked about their business situation as well as their expectations and actual realizations for a broad set of firm-specific variables such as production, prices, demand and export situation.

In our analysis we focus on the following two questions concerning expected and current business situation:

Q 1 *“Expectations for the next six months: Our business situation with respect to XY will in a cyclical view: improve, remain about the same, develop unfavourably.”*

¹⁸The IFO-BCS is a survey at the product level, so that these numbers do not exactly correspond to firms. The reduced number at the end of the sample reflects the declining weight of the manufacturing sector for the aggregate economy.

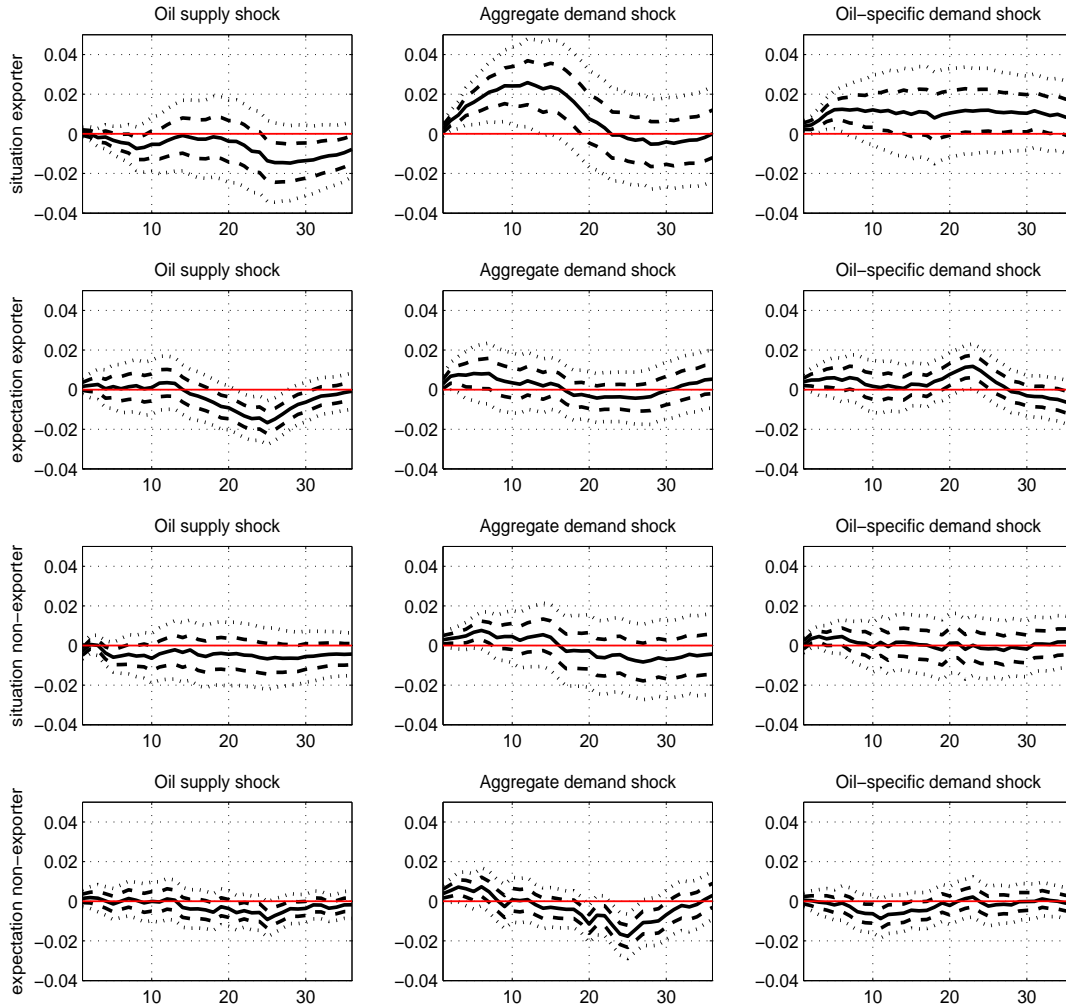
Q 2 “*Current situation: We evaluate our business situation with respect to product XY as: good, satisfactory, unsatisfactory.*”

It is noteworthy to mention that question Q1 refers to a *change* in the future business situation whereas the question Q2 concerns the actual business state of a firm. The IFO-BCS enables us to distinguish between exporting and non-exporting firms.¹⁹ Therefore, we are able to compute and compare aggregate survey results for these two groups of firms in each month. Specifically, we calculate for each group balance statistics that are defined by the difference between the percentage shares of positive and negative responses for the respective question (Q1 or Q2). After seasonal adjustment, we add one of these time series at a time as fourth variable, z_t , to the structural oil market model (2). Due to data availability, the sample for this exercise starts in January 1980.

Figure 6 presents the results. The upper two panels show the reactions of the current and expected business situation for the exporting firms. The lower two panels display the same for the non-exporting firms. There are two main results: first, the business situation of exporting firms increases significantly after both an expansionary aggregate demand shock and a positive oil-specific demand shock, while non-exporting firms report almost no change. Second, the business expectation of non-exporting firms deteriorates significantly at the one-standard-error band after an oil-specific supply shock, whereas exporting firms are rather optimistic. This suggests that only firms serving the domestic market anticipate a weakening in demand. In summary, these results support our view that it is the export industry which makes a difference. Export firms benefit from the effects of favorable international price movements and shifts in global demand towards German products.

¹⁹We use the monthly IFO-BCS question concerning expected development of export trade. If a firm states that it does not export, then we regard this firm as a non-exporter in this month.

Figure 6: Responses of Exporting and Non-exporting Firms to Structural Oil Shocks



Notes: see notes to Figure 4. The time dimension (horizontal axis) is measured in months. The upper two panels show the reactions for the exporting firms and the lower two panels provide evidence for the non-exporting firms. We consider balances of the questions concerning expected and current business situation (Q1 and Q2). Balances are defined as the difference between the fraction of positive responses and the negative responses for the respective question. We use accumulated impulse responses for the expected business situation (Q1) as it defines a change in business situation.

5.3 Robustness Checks

In this section we provide three robustness checks: first, we include the German terms of trade in our baseline model. This variable ensures that the structural oil price shocks are orthogonal to independent movements in the real exchange rate which could distort our results. Second, we replace in our baseline specification the real price of oil by the nominal

WTI oil price in US dollars and the indicator of global activity by the industrial production index of the OECD countries plus the six major non-member economies. The use of different global activity and oil price variables serves as a sensitivity analysis. Third, we question the identification assumption concerning the oil-specific demand shock. Specifically, we replace the zero restriction of aggregate activity with respect to an oil-specific demand shock by a plausible impact elasticity. This elasticity is derived by employing a structural VAR model that is identified with sign restrictions and further inequality assumptions as proposed by [Kilian and Murphy \(2012\)](#). For all three exercises we obtain the same set of results: a partially significant decline in German manufacturing production after a contractionary oil supply shock and a highly significant increase of production after both an aggregate demand and an oil-specific demand shock.

The upper panel of Figure 7 depicts the impulse response of German manufacturing to the structural oil price shocks orthogonalized with respect to terms of trade movements.²⁰ Evidently, the dynamic responses are qualitatively and quantitatively very similar to our baseline findings. Thus, our results are robust with respect to controlling for independent real exchange rate movements.

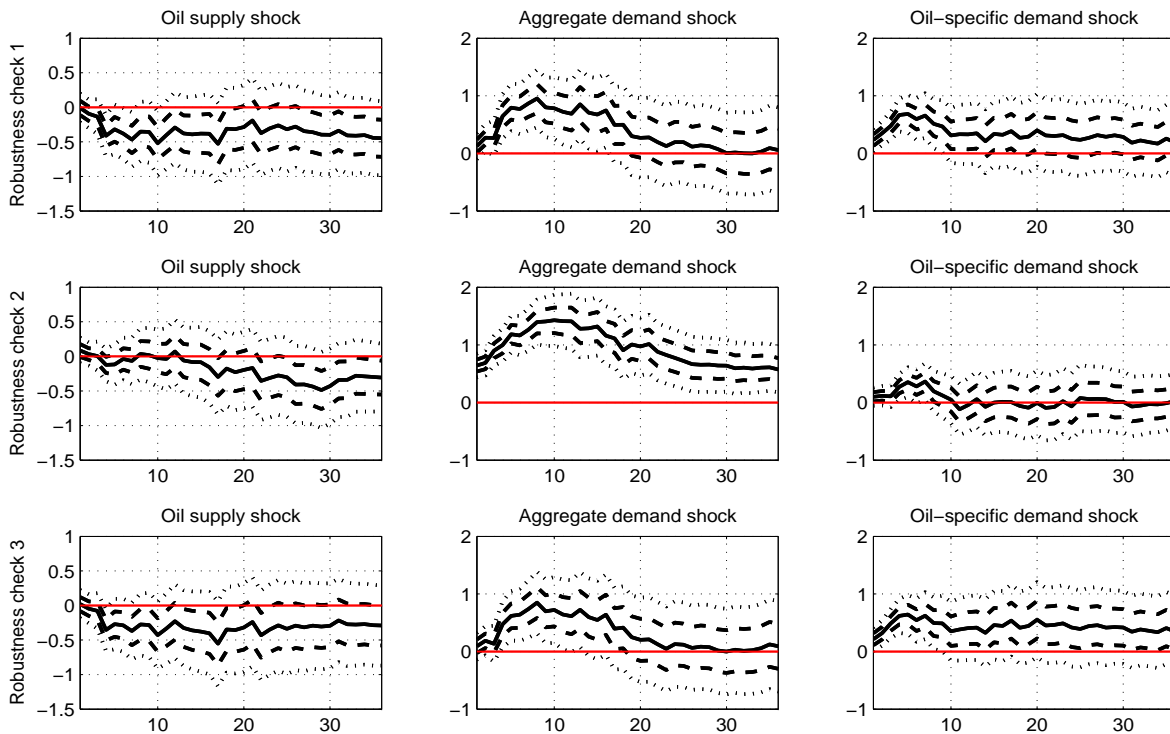
The second check addresses the selection of variables for the oil market block. We replace in our baseline specification the real price of oil by the nominal WTI oil price in US dollars and the indicator of global activity by the industrial production index of the OECD countries plus the six major non-member economies. By using these two variables we follow [Fukunaga et al. \(2010\)](#).

While there is no disagreement that in most economic theories the real price of oil is the preferred specification, one could motivate the use of the nominal oil price by the argument that German economic agents presumably respond more to changes in the more visible WTI oil price rather than the U.S. refiner's acquisition cost of crude oil deflated by the U.S. CPI.²¹ In addition, using the aggregate industrial production of the OECD countries plus

²⁰Using instead an indicator of price competitiveness does not change our results.

²¹[Kilian and Vigfusson \(2011a\)](#) cast doubts on this behavioral argument that relies heavily on [Hamilton](#)

Figure 7: Robustness Checks



Notes: see notes to Figure 4. The time dimension (horizontal axis) is measured in months. In Robustness check 1 we extend our baseline model with the German terms of trade. In Robustness check 2 we use the WTI oil price and an industrial production index as proxy for aggregate activity. In Robustness check 3 we assume an impact response of real activity to an oil-specific demand shock of -0.87.

the six major non-member economies, including China and India, we provide another proxy for aggregate activity. Kilian (2009b) names three reasons why his proposed dry cargo single voyage ocean freight rate index is superior to this industrial production index: first, it is difficult to measure each country's contribution to global real economic activity. Second, technological change could break the link between industrial production and the demand for industrial commodities. Third, there exists a lack of suitable monthly data for real economic activity in many countries. The dry cargo single voyage ocean freight rate index addresses all these issues and is therefore used in our baseline analysis. Nonetheless, it seems instructive to replace this index by the aggregate industrial production index in a robustness check.

(2011). Note, however, that our aim is not to contribute to the recent debate between Kilian and Vigfusson (2011a) and Hamilton (2011) whether the use of the nominal price is completely inappropriate.

The middle panel of Figure 7 shows the results for German manufacturing. In comparison to our baseline results we observe a more pronounced production increase after an aggregate demand shock and a less pronounced production increase after an oil-specific demand shock. It seems that the global demand shock identified within this VAR setup includes components of the oil-specific demand shock identified in our baseline specification. But overall, our main statements remain unaltered.

As a final check, we review the identification of the oil-specific demand shock. As mentioned by [Kilian and Murphy \(2012\)](#) it is surprising that the immediate oil price hike after an oil-specific demand shock induces an expansion rather than a contraction in real activity. To address this issue we reconsider the assumption that oil-specific shocks do not affect real activity within the same month. Specifically, we derive a plausible estimate for the impact elasticity of aggregate activity to an oil-specific demand shock by proceeding in three steps: first, we identify a structural VAR model with sign restrictions and the further inequality assumptions proposed by [Kilian and Murphy \(2012\)](#). Then, we derive the median impact response of real activity with respect to an oil-specific demand shock. Finally, we use this number as the impact elasticity of aggregate activity to an oil-specific demand shock and impose otherwise the same identification assumptions as described (3).

Table 3 summarizes the sign restrictions that are used to identify the structural oil market model (1).²²

Table 3: Sign Restrictions (Restriction Period of 1 Month)

	Oil supply shock	Aggregate demand shock	Oil-specific demand shock
Oil production	≤ 0	≥ 0	≥ 0
Real activity	≤ 0	≥ 0	≤ 0
Real oil price	≥ 0	≥ 0	≥ 0

These restrictions imply that a contractionary oil supply shock raises the price of oil and reduces real activity and oil production. A positive oil-specific demand shock induces

²²The sign restrictions are the same as in the analyzes of [Baumeister and Peersman \(2008, 2009\)](#) and [Peersman and van Robays \(2009\)](#).

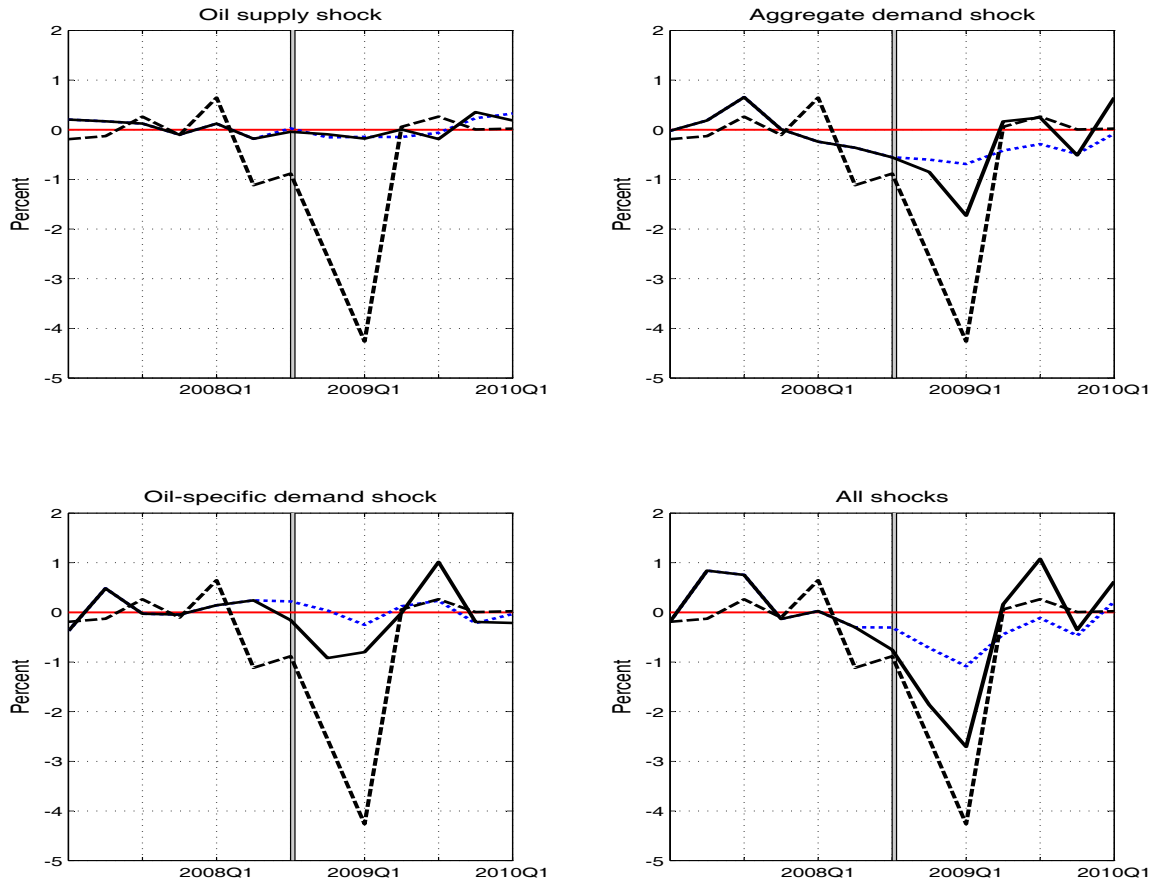
a contraction of real activity while the price and the supply of oil increase. A positive global demand shock raises oil production, real activity and the real oil price. We impose that the sign restrictions need to hold for the impact period. Following [Kilian and Murphy \(2012\)](#), we further assume that after an oil price hike the short-run elasticity of oil production with respect to the real oil price is not larger than 0.0258. This upper bound is imposed for the aggregate demand and oil-specific demand shock. The last restriction concerns the impact response of aggregate activity after an oil-specific demand shock. This response is not allowed to be lower than -1.5. With these assumptions we employ the sign restriction procedure outlined in [Uhlig \(2005\)](#). Our results are based on 200 accepted draws. Figure 9 and Table 4 in Appendix A provide the results of this exercise. But more importantly, the median impact response of real activity with respect to an oil-specific demand shock is -0.87.

Using this elasticity to replace the zero restriction imposed in our baseline identification 3, yields the impulse responses shown in the lower panel of Figure 7. Somewhat surprisingly, the restriction that real activity contracts after an oil-specific demand shock does not change the response of German manufacturing with respect to an oil-specific demand shock. Therefore this check supports our main findings.

6 How Strongly Did the 2007/08 Oil Price Hike Contribute to the Subsequent Recession in Germany?

In this section we analyze the economic consequences of the 2007/08 oil price hike for Germany. To do so, we use the quarterly regression model (4) described above to study the cumulative effects of the structural oil price shocks on German GDP during the years 2007 until 2010. Figure 8 shows the historical contributions of all three structural shocks to the observed variation in German GDP growth. We also depict the total effects of all structural shocks on GDP in the bottom right panel. The dashed lines display the actual demeaned GDP quarterly growth rates and the solid lines show the cumulative effects of the respective structural shock.

Figure 8: Cumulative Effect of the Structural Oil Shocks on German GDP Growth



Notes: Estimates are based on model (4). The time dimension (horizontal axis) is measured in quarters. The dashed lines denote the actual demeaned GDP growth rates. The solid lines show the cumulative effects of the respective structural shock. The dotted lines display the cumulative effects of the counterfactual analysis in which all structural oil price shocks after July 2008 are set equal to zero. The grey vertical lines represent the date of the collapse of Lehman Brothers.

German GDP growth was largely unaffected by oil supply shocks during this sub-sample. In contrast, both the aggregate demand shock and the oil-specific demand shock contributed markedly to the evolution of GDP. In the first two quarters 2008, oil-specific demand shocks had a slightly positive impact but the negative effects originating from the aggregate demand shocks dominated, which is the reason why the German downswing started in the second quarter 2008 and thus well before Lehman Brothers collapsed in September 2008. Of the extreme GDP slump in the fourth quarter 2008 and the first quarter 2009, roughly two thirds can be explained by the structural oil market shocks.

To assess how much of the decline in German GDP was due the oil price hike, we implement a counterfactual analysis which switches off all shocks that might be more directly related to the financial crisis. Specifically, we set all shocks after July 2008, the month of the oil price peak, equal to zero. To the extent that previous shocks mainly reflected the boom in demand preceding the worldwide crisis which led to rising oil prices and eventually to a drop in GDP, this experiment is a way to quantify the (lagged) effect of the oil price hike on the German business cycle. However, a cautious interpretation is warranted because rising oil prices were certainly a quantitatively important but probably not the only transmission channel by which the preceding upswing in Germany would have been terminated even without the financial crisis.

The results of the counterfactual analysis are as follows. Without shocks after July 2008, the real oil price would have fallen from July 2008 to July 2009 by slightly more than 12 percent which is much less than actually observed. Similarly, the decline in German GDP would have been much more moderate, see the dotted lines in Figure 8 which denote the counterfactual quarter-on-quarter GDP growth rates. The maximum GDP decline observed in the first quarter 2009 was -4.3 percent whereas the counterfactual decline is only -1.1 percent. Still, however, the effects of the structural shocks that occurred before July 2008 had a sizeable negative effect on GDP growth.

To condense the result in a single number, we calculate the year-on-year growth rates for 2009 both from the actual and the counterfactual development of quarterly GDP. It turns out that actual GDP in 2009 was 6.6 percent below the level of 2008 while counterfactual GDP fell by 2.3 percent. Note that these numbers are calculated from mean-adjusted growth rates. Adding the average growth rate of 1.5 percent, one obtains the actual GDP decline of 5.1 percent reported by the German Statistical Office for 2009 and a counterfactual decline of 0.8 percent. Hence, the structural shocks that triggered the oil price hike in 2007/08 were sufficient to produce a recession in Germany. However, this recession would have been much less dramatic than actually observed.

7 Conclusion

In this paper we showed that the impact of unanticipated oil price changes on the German economy depends on the underlying shocks. While private consumption expenditures always react negatively, the dynamic responses of exports and gross investment—and finally GDP—differ between supply and demand shocks. Contractionary supply shocks are clearly recessionary. In contrast, positive oil-specific and aggregate demand shocks lead to a temporary rise in GDP triggered by favorable international price movements and shifts in global demand towards German export goods. These effects initially overcompensate for the accompanied increase in the oil bill that provokes consumers to cut back on consumption. Over time, however, the decline in consumption weighs in and drags GDP down. Importantly, unlike the economy as a whole, the export-oriented German manufacturing industry benefits rather persistently from demand-driven oil price hikes. This illustrates how diverse the effects of oil price changes on an economy are and that an analysis of one sector alone might not be sufficient.

Concerning the economic consequences of the 2007/08 oil price hike we demonstrated that the sustained sequence of positive aggregate demand shocks, that pushed up the real oil price, led to a 0.8 percent reduction in German GDP in 2009. From this perspective, the oil price hike made a notable contribution to the subsequent recession in Germany which resembles the U.S. result discussed by [Hamilton \(2009\)](#) and [Kilian \(2009a\)](#). At the same time, our finding is not in conflict with the view that the oil price was not the most important driver of the 2009 recession because German GDP slumped by more than 5 percent in this year.

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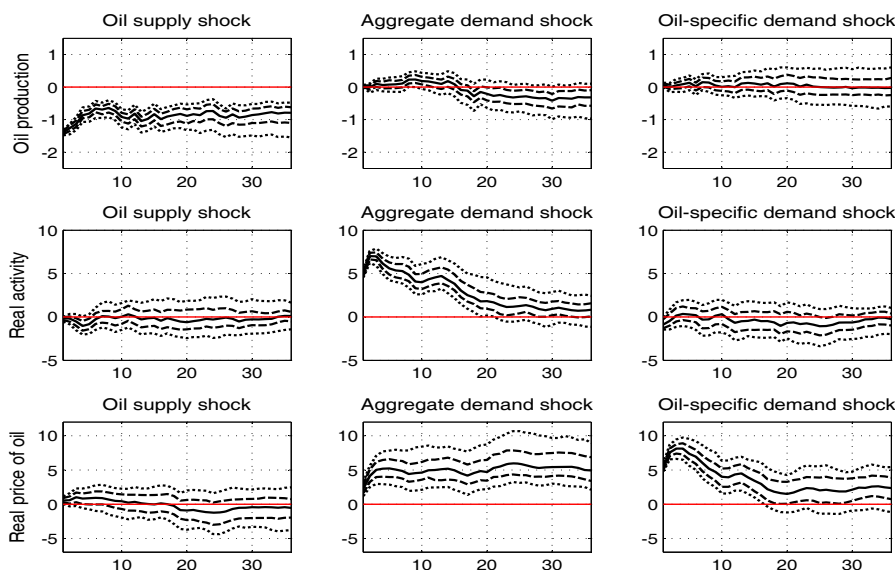
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A Model with Sign Restrictions and Additional Restrictions Imposed

Figure 9: Responses to Structural Shocks to the Global Oil Market Model Using Sign Restrictions and Additional Restrictions Imposed



Notes: This figure is a replication of Figure 10 in Kilian and Murphy (2012) with an updated data set. The time dimension (horizontal axis) is measured in months. Results are based on 200 accepted draws of the model with sign restrictions and additional restrictions imposed. The solid lines refer to the median of the accepted draws at each horizon. The 68- and 95 percent confidence bands are the 16th/84th and 2.5th/97.5th percentiles of the accepted draws for each horizon.

Table 4: Impact Matrix—Sign Restrictions Combined with Additional Restrictions Imposed

	Oil supply shock	Aggregate demand shock	Oil-specific demand shock
Oil production	-1.3994	0.0246	0.0687
Real activity	-0.1563	4.9735	-0.8713
Real oil price	0.5514	2.2677	5.3249

Notes: see notes to Figure 9.