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Abstract

Recent oil price shocks have relatively small effects on real economic activity and inflation compared to the experiences of the seventies and the early eighties. In this paper we analyse possible reasons for these phenomena using the example of the German economy. At first, by estimating a VAR-model and calculating impulse responses to an oil price shock it is confirmed that the macroeconomic effects have become much smaller. Moreover, our simulations show that oil price hikes are more closely related to global economic activity since the early nineties. Then, to get a deeper understanding of the structural changes which are responsible for these results we utilize a new Keynesian open economy model. It becomes obvious that the small effects of the recent oil price shocks on the German economy can be explained by a combination of a reduced energy cost share and good luck in terms of a strong growing global economy. Hence, if global economic growth decreases, pure oil price shocks may still have substantial effects on the German economy, even if the energy pricevulnerability has been reduced. These results should be valid also for other oil importing countries, at least from a qualitative point of view.

JEL Classification: E31, E32, F41

Keywords: Oil prices, new Keynesian open economy model

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1. Introduction

The popular oil price hikes in the 1970s and 1980s were accompanied by economic recessions and higher inflation in most industrialized countries. In consequence, movements of crude oil prices are assumed to be an important explanation for business cycle fluctuations. The recent oil price rise, however, seems to be different: nominal oil prices have increased by over 100 percent since 2002, but world economic activity still grows vigorously and inflation has not increased substantially so far. This raises the question whether the relationship between oil prices and macroeconomic activity has changed; and if this is the case what has changed?

Several explanations for a reduced importance of oil price movements are at hand: First, the sources of oil price shocks may have changed and the origins of the shocks are crucial for the effects on economic growth and inflation. Second, the energy intensity of the production sectors in the developed economies has reduced compared to the oil price shocks of the seventies. Third, the reactions of economic agents have changed. It is argued that labor unions have not tried to hold real wages constant during the latest oil price hike. Related to this, monetary policy was not forced to raise interest rates so strongly.

According to which explanation dominates, different consequences for business cycle fluctuations arise. If the small effects are caused by changes in the economic structure, movements of oil prices are no longer a crucial reason for business cycles. If the recent oil price shock, however, is caused by increasing world demand and therefore different from the seventies and early eighties, pure supply side-driven movements of oil prices may still have pronounced negative effects on economic activity. This is also true for the third explanation but in this case the effects of oil price shocks are assessable by economic agents.

In this paper we analyze the relevance of possible explanations using the example of the German economy. Possible changes over time are captured by dividing the sample into two sub-periods. The first sub-period ranges from 1975:1 to 1990:4 and the second sub-period lasts from 1991:1 to 2006:4.

At first, unrestricted VAR-models which contain the real oil price, a measure of global economic activity and important domestic real and nominal variables are estimated separately for the two sub-periods. The relevant

effects are visualized by impulse response functions. Since the results suggest, that the interaction between oil prices and global economic activity plays a crucial role an oil price hike as well as a world demand shock are simulated.

Then, to get a more sophisticated understanding of the effects of possible structural changes, we calculate standard deviations (Kim, Loungani 1991) and impulse responses (Rotemberg, Woodford 1996) of a new Keynesian open economy model (NOE-model) (McCallum, Nelson 1998, 1999, 2001). A possible change in the economic structure of the economy is introduced by changing the energy intensity of production and the openness of the economy in the steady state. With regard to the behavior of economic agents we concentrate on monetary policy. By including a Taylor rule we can distinguish between two possible shifts. The first is a change in the weights of inflation and of the output gap in the Taylor rule. The other is that the monetary authority changed the price index for measuring inflation. However, we do not find conclusive references for a different behavior of the relevant monetary authorities in the two sub-periods so the model's Taylor-rule remains unchanged. To account for an altered behavior and interaction of the exogenous shocks, oil prices and global economic activity are related within a VAR. We examine the plausibility of our analysis by comparing the properties of the structural model with the impulse responses of an unrestricted VAR and second moments of the data.

The outline of the paper is as follows: in the next section we describe important economic ratios and some stylized facts of the exogenous variables. In section three we discuss the results of the VAR approach. Section four explains the structure of the model. Subsequently, the calibration and the solution methodology are presented. In section six the simulation results are shown and compared to some stylized facts. Section seven summarizes the major findings and draws some conclusions.

2. Why have the effects of oil price shocks changed?

As mentioned in the introduction there is evidence that the effects of oil price movements have weakened during the eighties (Jones et al 2004: 17-20). Several explanations for the weakened relation between oil prices and GDP growth in oil importing countries can be discussed.

At first, oil price hikes can obviously be interpreted as a standard supply shock. In line with most observable stylized facts, rising oil prices then dampen real economic activity, raise the price level and therefore lead to higher interest rates (Brown et al. 2002). Thus, substantial oil price shocks can cause recessions in oil importing countries. This view is in particular

related to the experience of the seventies and early eighties when oil price shocks coincided with recessions in mayor industrialized economies and this coherence is confirmed by several empirical studies (e.g. Burbidge, Harrison 1984; Cuñado, Pérez de Gracia 2003; Darby 1982; Gisser, Goodwin 1986; Hamilton 1983, 2003). The energy intensity of production, however, was reduced substantially after the oil price shocks of the seventies and early eighties, a fact that is also observable in Germany (Frondel, Schmidt 2002; Schmidt, Zimmermann 2005).[1] Nowadays, firms are much less vulnerable to oil price increases and, in consequence, the effects of oil price hikes should be smaller. However, the energy cost share has partly recovered in the very recent past, a trend that can not be precluded to proceed in the future (Figure 5).

Figure 1: Energy cost share as a fraction of German GDP
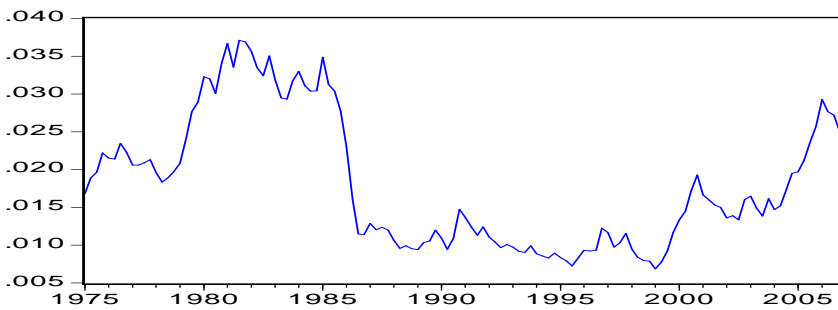
Another explanation why oil price shocks may have different effects on real economic activity and inflation is that the source of the shock matters (Kilian 2006). With regard to the recent oil price shock it is argued that higher oil prices are not caused by political events in the Middle East but by higher demand for crude oil from emerging economies like China and India (Brown et al. 2002:15). In this case higher oil prices are associated with a higher demand for goods. More precisely, the negative impact of increased oil prices is combined with positive effects of a stronger demand for German exports. Figure 2 shows that this argument particularly seems to be relevant for the second sub-period. While world economic activity and energy prices exhibit a reverse development concerning the first sub-period, a positive correlation between the mentioned variables can be identified with regard to the recent past.

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[1] In this paper we use oil and energy as synonyms because prices for other imported fossil sources of energy production are strongly correlated with oil prices (Asche et al., 2003). Moreover, energy efficiency is compared with energy costs, because the focus of this paper lies on the economic but not on the physical dimensions of energy dependence.

Figure 2: Real energy prices and global output

Figure 3: Openness of the German economy
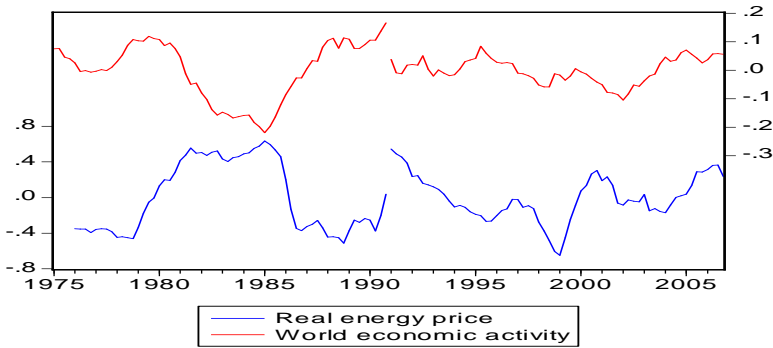
In this context it is also important that the German economy has become more open since the seventies (Figure 7).[2] It is therefore likely that the German economy today is more affected by fluctuations in global economic activity while the vulnerability to oil price shocks decreased. This means that nowadays it is more likely that the effects of higher oil prices are at least offset by higher demand from abroad.

Another factor, that could be important for the transmission of oil price shocks, is monetary policy. Price shocks have real effects if monetary policy reacts by raising interest rates. For example Bernanke et al. (1997) find empirical evidence for this channel. In this case the downward trend of the inflation rates since the eighties may has reduced the necessity for central banks to tighten monetary policy after an oil price shock. On the other hand Hamilton and Herrera (2004) challenged this view by reestimating their

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[2] Openness is defined as the sum of exports and imports divided by GDP.

model with a higher lag order. The authors found that the effects of oil price shocks are much more pronounced than in the primary paper. It is also possible that the reactions of monetary policy to oil price shocks have changed. A more modest reaction could be enabled by the behavior of labor unions because in recent years they did not any longer try to keep real wages constant after an oil price shock. Besides, economic trends which are often summarized by globalization cause downward pressure on wages, import prices, producer prices and, as an end, consumer prices. Overall, the true role of monetary policy in the transmission of oil price shocks is not assessed adequately yet.

2. What are the effects of an oil price shock on the German economy?

To get a first impression of the effects of energy price hikes on the German economy we initially estimate an unrestricted VAR-model. We check whether the effects of oil price shocks on the German economy have changed by dividing the investigation period into two distinct sub-periods (1975:1 to 1990:4 and 1991:1 to 2006:4). Though most of the available information criteria suggest a relative small lag-length, further calculations reveal that three (four) lags are necessary to avoid significant autocorrelation of the residuals in the first (second) sub-period. The VARs include the real energy price in euro, a measure of global economic activity, real GDP, real private consumption, inflation and a short term interest rates (in the order of their entry). Worldwide GDP includes that of the most important industrialized countries, except Germany. All variables are measured in logs (except the nominal interest rate) as deviations from a linear trend. To investigate the effects of oil price hikes and world demand shocks we compute impulse responses. We set the impulses to one unit of the residuals. This option ignores the units of measurement and the correlations in the VAR residuals so that no transformation is performed. Apart from that, this approach has two striking advantages. First, the ordering of the variables is not crucial.[3] Second, the results are better comparable with the impulse responses of the NOE-model in the reminder of this paper.

Figure 4 presents impulse responses to an energy price shock. Solid lines show the estimated effects in the first sub-period. Initially, oil prices show a considerable amount of persistence. After a one percent increase the same variables deviates significantly 4 quarters from its initial value. Significance, in this context, means that even the responses +/- two standard deviations

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[3] Further calculations, however, reveal that a different ordering does not change the results dramatically even if a Cholesky decomposition of innovations is used.

have the same property. Then, the impulse responses show that oil price shocks have significant negative effects on world GDP. For Germany we find significant effects on private consumption. Since the effects on GDP are insignificant, the German economy seems to be less vulnerable than the world economy with regard to energy price hikes. As expected, consumer prices and the interest rate show a significant positive response. Generally, the reaction of domestic real variables is slightly delayed, in particular in comparison to oil prices and global economic activity. Approximately after four years the effects start to go into reverse before energy prices rebound to their initial value after roughly ten years. From a statistical point of view, significant responses, however, can only be derived for the subsequent 12 quarters after the initial energy price hike. Overall, the results point to a strong negative relationship between energy price hikes and world as well as domestic economic activity while the link between oil prices and domestic nominal variables seems to be positive. These findings suggest, that oil prices, a least during the first sub-period, act as a standard supply shock, a result that seems to be true both concerning Germany and the global economy.

Dashed lines represent the impulse responses to an oil price shock in the second sub-period. To illustrate variances of the magnitude of the responses, the axes are scaled in common with the first sub-period. First of all, it can be seen that the estimated development of the energy prices has changed. Instead of shaping a low-frequency wavy pattern as before, a high-frequency, oscillatory recovering is indicated. The persistency of oil price shocks – measured in terms of significant deviations, however, has not changed. Then, the link between energy prices and worldwide GDP seems to have vanished, since the effects on worldwide GDP are insignificant in the second sub-period. Moreover, by taking a closer look, a positive correlation between these variables may be identified. Concerning the domestic variables the VAR-model does not produce any significant results concerning the second sub-period. Combining the results of both estimates, we conclude that the effects of energy price shocks on the global economy and even more on domestic aggregates have declined dramatically.

Figure 4: Impulse response functions of the VAR-model to an oil price shock
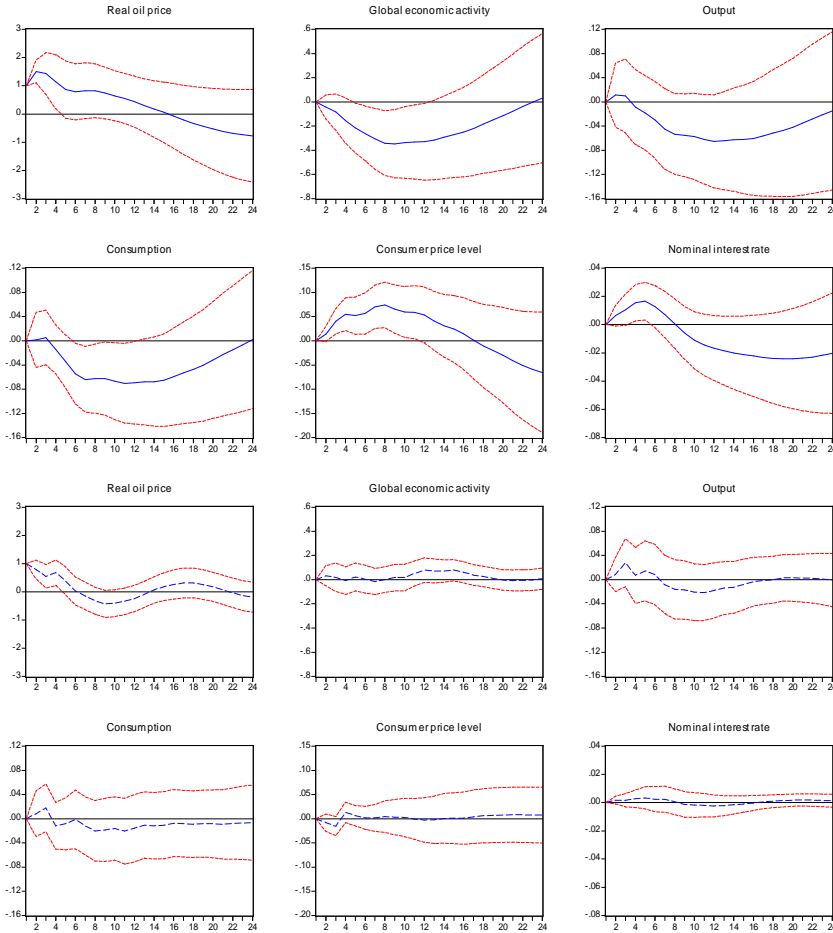
To test whether oil prices and the domestic variables are related to global economic activity we also calculate impulse responses to a shock to the last mentioned variable. Figure 5 shows that the effects of worldwide demand shocks on energy prices and domestic variables have also changed. Even though most of all effects are not statistically significant some findings are noteworthy. Concerning the first sub-period (solid lines) a negative reaction of energy prices subsequent to world economic activity hikes can be measured. Then, the simulated effects on all domestic variables except the consumer price level are positive. The short term interest rate shows the only significant response.

Figure 5: Impulse response functions of the VAR-model to a world GDP shock
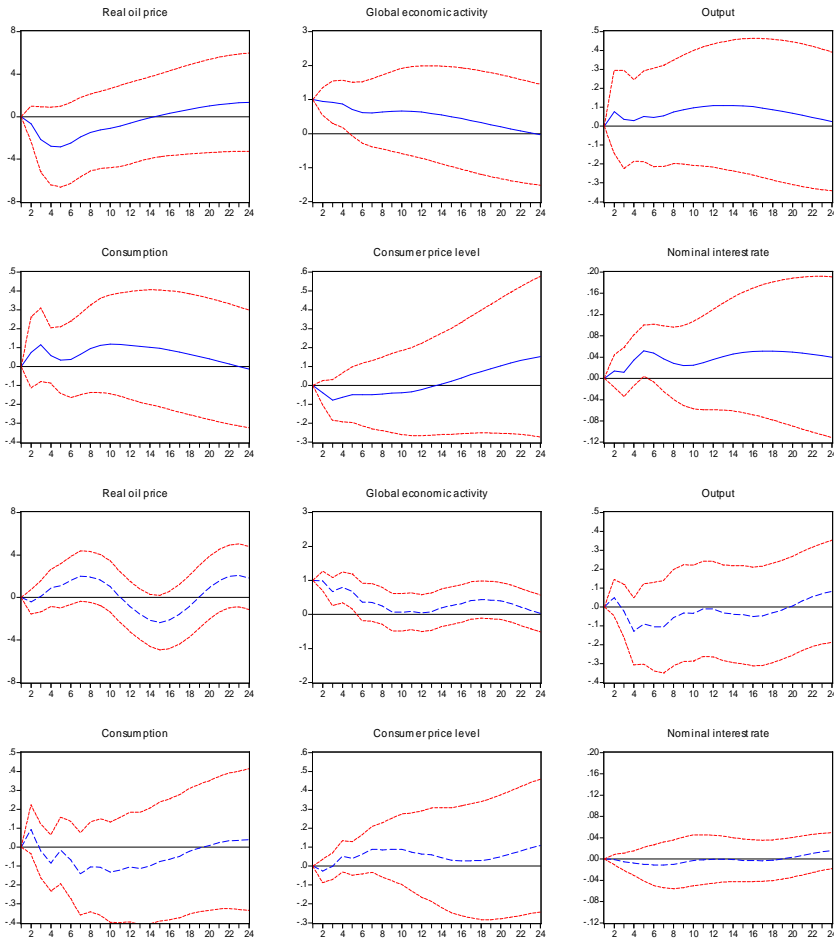
For the second sub-period (dashed lines) some findings tend to result in the reverse: Here, a global economic activity boom leads to an increase of real oil prices some periods after. Furthermore, output and consumption show initially a positive but subsequently a negative reaction. The opposite is true for the consumer price level. However, all of the mentioned responses are insignificant from a statistical point of view.

To summarize, as indicated by the well-known recessions, energy price hikes have statistically significant negative effects on world economic activity and important domestic variables in the first sub-period. Concerning the second

sub-period, no statistically significant reactions to energy price hikes can be confirmed. Moreover, significant effects of world economic activity on energy prices and most domestic variables are not detected in both sub-periods. The last mentioned calculations, however, convey the impression that real oil prices and global economic activity are negatively related in the first- but positively related in the second sub-period. From a global perspective, therefore, the role of oil prices seems to have changed dramatically: while the supply shock variant is supported in first sub-period, oil prices seem to be rather endogenous, i.e. strongly influenced by global economic activity in recent times. From a German perspective, on the contrary, oil price shocks are and have always been standard supply shocks, because none of the VARs indicates a positive correlation between real German variables and real oil prices. But, in contrast to the 70s and 80s, nowadays the effects of global economic activity and oil price movements seem to compensate each other. The small effects of recent oil price shocks on the German economy, therefore, could be caused by both a more energy efficient structure of the German economy and good look, i.e. a compensation of negative supply effects by booming global economy. Concerning monetary policy the VAR-models claim that central banks react to oil price shocks and world GDP shocks in the first but to none of the impulses in the second sub-period. These findings, however, can not be taken as a proof for an altered reaction function of the monetary authority, but rather affirm smaller price level effects of exogenous shocks in the later period.[4]

The results of the VAR-analysis particularly raise two questions: First, to what extent have the supply effects of oil price hikes become weaker and, second, to what extent are they considerably compensated by a booming global economy. In the following we address these questions in more detail and try to quantify the particular effects.

4. The NOE model

To get a better understanding of what has reduced the effects of energy price hikes we utilize a standard open-economy model with optimizing agents and sticky prices (McCallum, Nelson 1998, 1999, 2001; Kamps, Pierdzioch 2002). Because the derivation of the NOE-model is well documented in the literature, we present only a short summary. Moreover, only linearized first order conditions and a few underlying functions are presented. Note that lower case letters denote logs of the original variables.

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[4] Besides, we do not find conclusive evidence for a shift of the relevant Taylor rule in the literature. A short overview is given in the calibration section.

The equation for private consumption is derived from households maximizing their expected lifetime utility with respect to total consumption, cx_t, real money balances, m_t, domestic and foreign bonds. In this model utility is not time separable over consumption. Instead, preferences $u_t = (cx_t, cx_{t-1}, m_t)$ include habit formation, using a special case of the functional form which is proposed by Carrol et al. (1995). By combining the first order conditions with regard to consumption and bonds the expectational difference equation for the change in consumption is:

$$\beta g_1 E_t \Delta cx_{t+2} + g_2 E \Delta cx_{t+1} + g_3 E \Delta p_{t+1}^{cx} = g_1 E \Delta cx_t + g_3 R_t \tag{1}$$

Here $g_1 = h - \sigma h, g_2 = 1 + \beta h^2 - \sigma \beta h^2 - \sigma \beta h$ and $g_3 = \sigma(1 - \beta h)$. Total consumption is the sum of domestic consumption, c_t, and foreign consumption, imc_t, which leads to the following linear approximated identity for the consumer price level, pcx_t:

$$p_t^{cx} = \alpha p_t^c + (1 - \alpha) p_t^{im^C} \tag{2}$$

where $1 - \alpha$ stands for the average share of imported goods in total consumption. The remaining first order conditions of the representative households are represented by the following uncovered interest parity:

$$R_t = R_t^* + E_t \Delta s_{t+1} + \kappa_t . \tag{3}$$

Here R_t and R_t^* represent the domestic and foreign nominal interest rates which are defined as $R_t = r_t + E\Delta p_{t+1}$ and $R_t^* = r_t^* + E\Delta p_{t+1}^*$, respectively. The variable s_t stands for the nominal exchange rate. In this model the foreign variables are treated as exogenous. To close the model we follow Schmitt-Grohe and Uribe (2003) by modelling the risk premium, κ_t, as a function of the ratio of the nominal value of foreign bonds and domestic nominal output. In linear term this yields:

$$\kappa_t = \varphi \left(s_t + b_t^* - p_t^Y - y_t \right) . \tag{4}$$

To complete the model we specify a Taylor rule that determines the domestic nominal interest rate.

$$R_t = \mu_0 + (1 - \mu_3) \left[\Delta p_t^i + \mu_1 \left(\Delta p_t^i - \overline{\pi} \right) + \mu_2 y_t \right] + \mu_3 R_{t-1} \tag{5}$$

$\bar{\pi}$ represents the inflation objective of the central bank. The expression Δp_t^i indicates that the monetary authority has the opportunity to target different price indices. Hence, the effects of energy price shocks do not only depend on the structure of the model economy but also on the behaviour of the central bank. For instance, energy price shocks can have diverging effects on a consumer price index and on the GDP deflator. The output gap

$$y_t = y_t - \bar{y}_t \tag{6}$$

is characterized as the difference between actual output, y_t, and its potential, $\bar{y}_t$, which, in turn, is defined as the amount of production that would prevail under flexible prices. Because of its monopoly power each firm treats the price of his good as a choice variable while the aggregate and foreign price level are taken as given. After setting the profit maximizing price each firm produces whatever quantity of his output is demanded. It is assumed that firms behave according to a price adjustment mechanism similar to the one introduced in Fuhrer and Moore (1995). This approach rationalizes a reasonable degree of inertia in inflation dynamics. More precisely, it claims that inflation, measured as the change of the price index of domestically produced goods, is a function of the output gap and of the weighted average of lagged and expected inflation

$$\Delta p_t^c = 0.5\left(\Delta p_{t-1}^c + \Delta p_{t+1}^c\right) + \Psi\left(y_t - \bar{y}_t\right). \tag{7}$$

Domestic output is produced by a CES-production function

$$Y_t = \left[\alpha_1\left(A_t N_t\right)^{\upsilon_1} + \left(1-\alpha_1\right)\left(IM_t^Y\right)^{\upsilon_1}\right]^{\frac{1}{\upsilon_1}}. \tag{8}$$

In the original paper McCallum and Nelson interpret the variable IM_t^Y as the quantity of inputs, which are imported from abroad. However, it is straight forward to use this variable as a measure for imported oil only. Recalling that under price flexibility, labour input equals one for all t, energy imports (for production) under price flexibility

$$\overline{im}_t^Y = \bar{y}_t - \frac{1}{1-\upsilon_1} p_t^{im^Y}$$

and output under price flexibility

$$\bar{y}_t = \left[1 - (1-\alpha_1)\left(im_Y^{SS} \right)^{\upsilon_1} \right] a_t + (1-\alpha_1)\left(im_Y^{SS} \right)^{\upsilon_1} \overline{im}_t^Y$$

can be derived. The parameter im_Y^{SS} represents the energy intensity of pro-duction in the steady state. By combining both relations imports under flexible prices can be eliminated.

$$\bar{y}_t = a_t - \frac{(1-\alpha_1)\left(im_Y^{SS} \right)^{\upsilon_1}}{(1-\upsilon_1)\left[1 - (1-\alpha_1)\left(im_Y^{SS} \right)^{\upsilon_1} \right]} p_t^{im^Y} \tag{9}$$

Output under flexible prices positively depends on the state of production technology and negatively on real energy prices measured in domestic cur-rency. Since we abstract from all imports besides energy and the real energy price is directly measured in Euro, the real exchange rate does not appear explicitly in equation (9).

Furthermore it is assumed that the total demand for exports is given by

$$ex_t = b_1 q_t + b_2 y_t^* \tag{10}$$

where the real exchange rate, q_t, is given by

$$q_t = s_t + p_t^{cx^*} - p_t^{cx}. \tag{11}$$

The following relation is specified to capture effects of the relative domestic price level on relative domestic consumption

$$c_t - cx_t = -b_3 \left(p_t^c - p_t^{cx} \right). \tag{12}$$

Since we disregard capital accumulation total domestic production is spent solely for domestic consumption and exports

$$y_t = \left(1 - ex^{SS} \right) c_t + ex^{SS} ex_t. \tag{13}$$

The model is completed by the definition of the various price indices. The price index of domestically produced goods, p_t^c, which is simultaneously the gross output deflator, p_t^Y, and the consumer price index, p_t^{cx}, are already specified according to equation (2) and (7). The price index of imported

consumption goods, as a first order linear approximation, can be expressed as follows:

$$p_t^{im^C} = \gamma p_t^{im^E} \tag{14}$$

where γ denotes the share of imported energy in imported consumption. The change of prices for imported inputs for production can be expressed as

$$p_t^{im^Y} = p_t^{im^E} . \tag{15}$$

Here it again becomes obvious that imports, which are used in the production process, exclusively consist of energy. The domestic GDP deflator can be specified by reshaping the overall consumer price index to account for the effects of net exports.

$$p_t^{GDP} = \frac{1}{c^{SS}} \Big[c^{SS} p_t^{cx} + ex^{SS} \alpha \big(p_t^c - p_t^{im} \big) \Big] \tag{16}$$

Changes in import prices, p_t^{im}, can be derived according to the following specification

$$p_t^{im} = \frac{1-\alpha}{\alpha} \frac{c^{SS}}{ex^{SS}} \big(p_t^{im^C} - p_t^{im^Y} \big) + p_t^{im^Y} \tag{17}$$

Equations (1) – (7) and (9) – (17) establish a system of 16 difference equations in the endogenous variables ex_t, c_t, cx_t, κ_t, p_t^c, p_t^{cx}, p_t^{GDP}, p_t^{im}, $p_t^{im^C}$, $p_t^{im^Y}$, q_t, R_t, s_t, y_t, y_t, $\underline{y}_t$. In addition we incorporate the exogenous shocks oil prices and world GDP. To take into account that oil price movements are caused by global economic activity to a certain extent we introduce this link explicitly into the model. As mentioned earlier we model the processes for the exogenous variables as a VAR(1) (Ireland 2004).

5. Calibration and Solution

We calibrate most of the models' parameters on the basis of average data ratios and own estimations. If these options are not possible we additionally utilize information from other studies.

A crucial parameter for the magnitude of adverse supply effects of energy price hikes on domestic output is the energy cost share in domestic produc-

tion. To calculate this figure we assume that 70 percent of the imported energy is spent for production while 30 percent are consumed by private households. This distribution is a very rough estimate based on information from the *Arbeitsgemeinschaft Energiebilanzen*.

The ratio of energy costs and domestic production characterizes an important dimension of the models' steady state. According to the production function different combinations of α_1 and υ_1 can assure an appropriate calibration. We choose a very simple approach by setting the parameter υ_1 close to zero. In this case the production function can be interpreted as Cobb Douglas and α_1 stands for the non-energy cost share in domestic production. Hence, the supply side of our economy resembles the approach that has been taken in Kim and Loungani (1991) as well as Schmidt and Zimmermann (2005). However, due to the omission of capital, important substitution effects between energy and capital as well as between consumption and savings are neglected in the model.

The parameter γ marks the share of imported energy in total imported consumption. To assign γ a reasonable value, information on the distribution of total imports between the production and the household sector would be needed. Because we disregard consumption imports other than energy, γ must be equal to one and the fraction of domestically produced consumption, α, is not much lower. Even though this calibrated feature of the model does not describe reality properly, some strong arguments can be made in favour of it. By eliminating consumption imports except energy, we rule out the possibility that households can substantially substitute domestically produced consumption for imports in the case of energy price hikes. Even though this possibility presumably exists in reality, the elasticity between relative demand for foreign consumption and the relative foreign price level is difficult to determine. Besides, and perhaps even more important, to utilize this relation, the (positive) effects of energy price movements on the foreign price level must be specified in advance. Since for simplicity our model treats the foreign price level as exogenous and constant, our approach seems to be appropriate.

A reasonable value for the share of exports in GDP, ex^{ss}, can be gathered directly from the data. As a consequence of an increasing openness of the German economy, this ratio is larger in the second sub-period.[5]

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[5] Note that the corresponding parameter c^{ss} is not calculated on the basis of the data. Since the model abstracts from saving and Capital accumulation all output beside exports is spent for consumption purposes. c^{ss} is therefore simply $1 - ex^{ss}$.

Concerning preferences we differ from the benchmark calibration in McCallum and Nelson (1999). There preferences are characterized by a low intertemporal elasticity of substitution, σ, and strong habit formation, h. These features lead to distinctive consumption smoothing, which becomes apparent by low relative standard deviations and only very limited responses of this variable to exogenous shocks. Both characteristics can not be found in our data set and are not supported by the estimated VARs. Concerning habit persistence ambiguous empirical evidence for Germany is available: Strong habit persistence is established by Willman (2003). In his investigation he estimates values up to 0.924 for Germany depending on the assumptions of the estimated model and the estimation strategy. However, Fuchs-Schündeln (2005) argues that the empirical evidence for habit formation in Germany remains inconclusive and at best very weak. Dibartolomeo et al. (2004) find support for this argument. They estimate a standard new Keynesian model for the G7 countries. The German model exhibits the lowest habit persistence of all countries ($h = 0.610$). As a compromise the habit formation parameter, h, is calibrated to 0.5 in our paper, which is thus slightly below the lowest direct empirical evidence for Germany. However, the intertemporal elasticity of substitution, σ, is maybe even more important for consumption fluctuations. For simplicity reasons and to achieve a better comparability we set this parameter to one, a value that is also used in our earlier paper (Schmidt, Zimmermann 2005) and many other well established studies. We assign β the conventional value of 0.99.

Like McCallum and Nelson (1999) we assume that the exchange rate elasticity of the export demand function, b_1, is equal to 0.33. Different from them, we assign the same value to the income elasticity of the export demand, too, because the relative volatility of exports decreases to a level that is roughly comparable with our data set. Finally we set the output gap coefficient of the price setting equation to 0.02 as proposed by Kamps andPierdzioch (2002) and the coefficient of the risk premium equation to -0.02 (Ambler et al., 2004).

The relative foreign price level elasticity of domestically produced consumption, b_3, describes the willingness and possibilities of households to substitute domestically produced goods by imports. Because we only want to allow for slight differences between the two consumption variables we choose a very low value for this parameter.

To calibrate the coefficients of the Taylor rule, we combine information from other studies and own estimates. Well established estimates of the coefficients of a Taylor rule for Germany can be found in the paper of Clarida et al. (1997). Since they exclusively utilize West German data for the

period 1979:4 – 1994:12, the results seem to be very useful for calibrating our model for the first sub-period. The point estimates for the parameters μ_1 and μ_2 are 0.31 and 0.25, respectively. Work of Peersman and Smets (1998) and Faust et al. (2001) find similar values for these coefficients, albeit for slightly diverging periods. All of the mentioned papers suggest a distinctive tendency to smooth interest rates over time. For instance, according to Clarida et al. (1997), the point estimate of the relevant coefficient is equal to 0.91. However, Clausen and Hayo (2002) come to quite different results ($\mu_1 = 2.89$ and $\mu_2 = 0.49$). But, in contrast to the papers mentioned so far, they use quarterly data, a multi-equation framework and a slightly differing sample period.

For the second sub-period coefficient estimates for a Taylor rule seem to be far from clear. Most results (for instance Gerdesmeier, Roffia 2003; Ulrich 2003; Sauer, Sturm 2003) suggest that the ECB reacts to a rise in expected inflation by raising nominal short-term interest rates by a relatively small amount and thereby letting real interest rates decline. If this is the case, monetary policy in the Euro area would be destabilising with respect to inflation. On the other hand the ECB seems to respond much more to changes in the business cycle than the Bundesbank (Sauer, Sturm 2003). However, these results may be due to the lack of a forward-looking perspective in their estimated Taylor rule (Sauer, Sturm 2003). Clausen and Hayo (2002) differ also with respect to the second sub-period, because they again suggest larger coefficients. A recent paper by Gerdesmeier et al. (2007) affirms that the reaction function of the ECB still fulfils the Taylor principle. They estimate a Taylor rule for the Euro area close to the period of our second sub-sample (1993:1 – 2004:12). The results are the following: $\mu_1 =$ 0.50 and $\mu_2 = 0.83$. Again, a high degree of interest rate smoothing is confirmed ($\mu_3 = 0.90$).

To summarize, a review of the related literature does not give clear suggestions. The point estimates of reaction functions of monetary policy that are relevant for Germany are far from conclusive. For the first sub-period, the results of Clarida et al. (1997) seem to be verified, in a sense, but not completely fitting for our purposes because they utilize monthly data. Albeit Clausen and Hayo (2002) fulfil these criteria they establish a multi equation framework. So far it does not seem to be clear how this framework interacts with our NOE model. For the second sub-period the picture is even more puzzling. While most studies deny a stabilizing role of the ECB with respect to the inflation objective, a recent investigation comes to the conclusion that the monetary authority strongly satisfies the Taylor principle.

To come to a compromise, we utilize the point estimates from Clarida et al. (1997) for the calibration of μ_1 and μ_2 for both sub-periods. The calibration of the interest rate smoothing coefficient is not controversial. Its estimated value is roughly 0.9 in all studies. Table A.1 which can be found in the appendix summarizes the parameter values that are used for our simulations.

To capture the interactions between both exogenous variables we estimate a VAR(1)

$$
\begin{pmatrix} p_t^{IM^E} \\ y_t^* \end{pmatrix} = \begin{pmatrix} \rho_E & \rho_{EY^*} \\ \rho_{Y^*E} & \rho_{Y^*} \end{pmatrix} \begin{pmatrix} p_{t-1}^{IM^E} \\ y_{t-1}^* \end{pmatrix} + \begin{pmatrix} \varepsilon_t^{IM^E} \\ \varepsilon_t^{Y^*} \end{pmatrix}
\tag{18}
$$

which contains changes in real energy prices, a measure of global output and one lag of each variable ($\varepsilon_t^E \quad N(0, \sigma_E)$, $\varepsilon_t^{Y^*} \quad N(0, \sigma_{Y^*})$). Both time series are detrended by a linear trend. In a first step we estimate a VAR(1) including the two exogenous variables for the complete investigation period.

One aim of this paper is, however, to analyse whether changing effects of energy price hikes on the German economy are a result of altered exogenous shocks or rather an effect of a changed energy cost or export share, which means a different economic structure. As Figure 2 indicates, the relationship between the exogenous variables may have changed. In the first sub-period both variables seem to be strongly negatively correlated. Contrary, especially in the recent past a positive correlation shows up. To get an idea of these considerations we repeat the detrending procedure and the estimation of the VAR separately for the two sub-periods.

Table 1 summarizes the estimation results concerning the exogenous variables. In particular in the first sub-period the estimated autocorrelation coefficient of the oil price has an absolute value greater than one. Further calculations reveal that both shocks together still build a stationary system, which exhibits slowly vanishing oscillatory fluctuations. In the second sub-period the relationship between the exogenous variables has loosened dramatically concerning one direction and both variables have become more independent AR(1)-processes. However, as already indicated by the wider VAR-approach, that is estimated before, the magnitude of the coefficient, which reflects the effects of world economy booms on energy prices, has reduced only little.

The models are solved according to the procedure which has been proposed by Blanchard and Kahn (1980). To conduct stochastic simulations and we

use DYNARE – a pre-processor and a collection of Matlab routines (Juillard 2003).

Table 1: Estimation results concerning exogenous shocks (standard deviations in parenthesis)

Parameter	1975:1 - 2006:4	1975:1 - 1990:4	1991:1 - 2006:4
ρ_E	1.018286 (0.02200)	1.075703 (0.04405)	0.893620 (0.04282)
ρ_{EY^*}	0.333763 (0.11399)	0.560611 (0.16683)	0.508254 (0.24919)
$\sigma_E^{\,2}$	0.008046	0.007544	0.006712
ρ_{Y^*}	0.923537 (0.02640)	0.882571 (0.04037)	0.908831 (0.05875)
ρ_{Y^*E}	-0.015453 (0.00509)	-0.040167 (0.01066)	-0.010153 (0.01010)
$\sigma_{Y^*}^{\,2}$	0.000431	0.000442	0.000373
$\sigma_E\,\sigma_{Y^*}$	-0.000331	-0.000628	-0.000087

6. Simulation Results

In this section we present simulation results of oil price and world GDP shocks in the model economy and compare them with second moments of the data and impulse responses of corresponding VAR models.[6] At first, we present simulation results under the assumption that the exogenous shock processes do not distinguish between the sub-periods. Then, we incorporate the estimated change in the behaviour of exogenous variables: that means that we present results of at least two simulations for each sub-period. To get an idea of the pure supply side effects of energy price hikes, we furthermore run simulations where the indirect effects of energy price changes which are caused by changes of world wide GDP, are eliminated from the model. To consider sample uncertainty, all second moments of our models are averages across 1,000 simulation data sets, each with 64 observations.

Table 2 presents second moments for the first sub-period which lasts from 1975:1 to 1990:4. The simulated moments are calculated under the assumption that only the economic structure but not the exogenous shock processes distinguish between the sub-periods. For each variable we show the absolute volatility, the relative volatility in respect to output and the contemporaneous correlation with output. As indicated by table 2 output in Germany fluctuates by roughly 1.1 percent in both sub-periods. Private consumption is roughly as volatile as GDP, a feature that is also found by other studies (for instance Fiorito, Kollintzas 1994; Schmidt, Zimmermann 2005; Zimmermann 2005). Exports exhibit a much larger volatility than output, a feature that manifests by a relative standard deviation of more than three. The relative volatility of consumption and exports is slightly lower in the second sub-period while the opposite is true concerning contemporaneous correlations with GDP.

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[6] Note that the VARs, which are estimated in section 3 can not serve for a rough comparison. Since the lag-length of these VARs is bigger, the exogenous variables show certainly richer dynamics than in the NOE-model. Instead, VAR-models where only one lag is included are compared because the NOE-model seems to be acceptable if certain shocks are similarly transferred on the endogenous variables.

Table 2: Second moments assuming constant exogenous shock processes (HP-filtered series ($\lambda = 1600$), standard errors in parenthesis)

Variable (x)		1975:1 – 1990:4			1991:1 – 2006:4		
		Output	Consumption	Exports	Output	Consumption	Exports
(1)	σ_x	1.14	1.12	3.94	1.12	0.99	3.54
	σ_x/σ_Y	-	0.98	3.46	-	0.88	3.16
	ρ_x	-	0.67	0.57	-	0.71	0.79
(2)	σ_x	0.85* (0.36)	0.90* (0.35)	2.39 (0.96)	0.52 (0.21)	0.65 (0.25)	1.75 (0.68)
	σ_x/σ_Y	-	1.11* (0.27)	2.97* (0.91)	-	1.33* (0.45)	3.56* (1.01)
	ρ_x	-	0.76* (0.16)	0.60* (0.24)	-	0.39 (0.30)	0.63* (0.21)
(3)	σ_x	0.74 (0.30)	1.01* (0.41)	-	0.43 (0.17)	0.65 (0.26)	-
	σ_x/σ_Y	-	1.37 (0.00)	-	-	1.52 (0.00)	-
	ρ_x	-	1.00 (0.00)	-	-	1.00 (0.00)	-

(1) Data

(2) NOE model incorporating energy price and world economic activity shocks

(3) NOE model incorporating energy price shocks and constant exports

Concerning simulated moments, it becomes obvious that according to our model energy price and world economic activity shocks can explain, as an approximation, 75% of the fluctuations of the German output in the first sub-period.[7] Moreover, all relative standard deviations and correlation with output are close to the corresponding data values, which underlines that our model is acceptable for the explanation of business cycles in Germany. By comparing the moments that are calculated for the second sub-period, it shows up that the reduced energy intensity of German production has decreased the vulnerability concerning energy price hikes. More precisely, the explainable output fluctuations reduce to slightly less than one half of the fluctuations that can be observed in reality. That means that the reduced energy intensity overstates the effects of a bigger export share. The overall ability of the model to account for certain features of the German business cycle is slightly reduced, a feature which should be rather interpreted as an effect of missing important shocks than as an argument against the general

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[7] This figure is calculated by dividing the standard deviation of a model's variable by the standard deviation of the actual variable in Germany (Kydland, Prescott 1991).

theoretical approach. To sum up, the altered calibration of the model leads to an obvious reduction of the effects of energy price and world economic activity shocks. Relative standard deviations and correlations are remarkably well for the first sub-period, approving that our model constitutes a useful approach to explain German business cycles. However, it has to be noted that the division of the investigation periods into two sub-samples seriously aggravates sample uncertainty.

The last three rows of table 2 show the results of a pure supply side approach. Here exports are assumed to be constant so that indirect effects of energy price shocks are eliminated. It should be noted that energy price movements can account for more than 60 percent in the first but not even 40 percent of the aggregate fluctuations in Germany in the second sub-period. Both values seem to be rather large in comparison to results available in the literature (Schmidt, Zimmermann 2005; Zimmermann 2007). These varieties may be explained by the following differences. At first, and maybe most important, our investigation utilizes quarterly data which implies more innovations and a higher persistency of supply shocks. Then, our production function abstracts from capital whereas the production function originally proposed by Kim and Loungani (1992) allows for substantial substitution of energy by capital in the face of energy price hikes. Since the exclusion of world economy effects lowers the standard deviation of output to a bigger extent in the second sub-period, the higher export ratio that is assumed in the recent past shows up also in table 3.

The effects of a reduced energy cost share and a higher export share can also be illustrated by impulse response functions (Figure 6). In the following solid (dashed) lines represent reaction functions to a one percent increase of the exogenous variables for the first (second) sub-period. Note that the reaction of the real variables output and consumption to an oil price hike is reduced by roughly one half. The increase in the consumer price level is also reduced and not as persistent as in the first sub-sample. Then, automatically, the monetary authority shows a weaker reaction.

Figure 6: Impulse Response Functions of the NOE-model to an oil price shock assuming unchanged exogenous shock processes
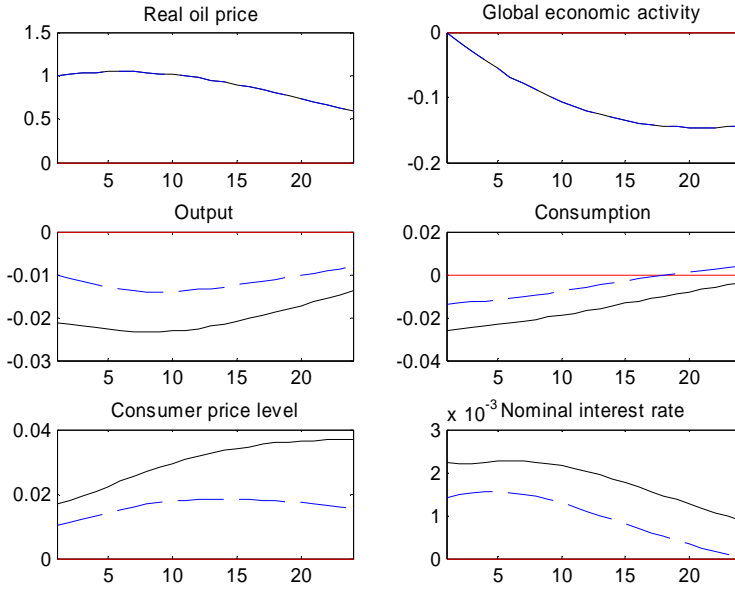

Figure 7 visualizes the effects of a reduced energy cost share and a higher export share on the reaction of the endogenous variables in consequence of an increase of worldwide economic activity. The higher export share causes a stronger initial positive (weaker initial negative) reaction of output (consumption). Because of the reduced energy cost share, the succeeding dampening effects of the higher oil prices are weaker than in the first-sub-period.

To summarize the altered calibration leads to weaker supply side effects of energy price hikes. Moreover, the initial positive effects of an increase in worldwide economic activity become stronger, whereas the succeeding negative effects caused by the related energy price hike are reduced.

Figure 7: Impulse Response Functions of the NOE-model after a world GDP shock assuming unchanged exogenous shock processes
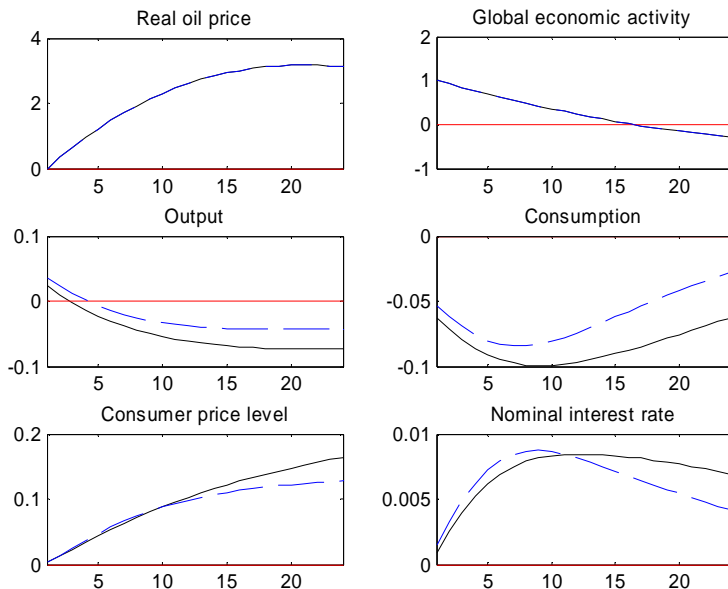

Table 3 presents the same moments that are reported above, but know altered shock processes are incorporated. At a first glance it becomes obvious, that the differences between the sub-periods become distinctive and statistically significant if sample uncertainty is considered. Energy price and world economic activity explain slightly more than 100 percent of the output fluctuations in Germany in the first but only one fourth of the aggregate fluctuations in the second sub-sample. Other results are also pronounced. The NOE-model for the first sub-period performs very well concerning German business cycle characteristics. Then, the opposite is true for the more recent past. None of the moments shows up as acceptable. Again our interpretation is that important drivers of business cycle fluctuations in Germany during recent times are missing. The last three lines claim that energy price movements alone can account for all of the output fluctuations in Germany, whereas the same variable can only be made responsibly for 15 % in the second sub-period.

Table 3: Second moments allowing for changed exogenous shock processes (HP-filtered series ($\lambda = 1600$), standard errors in parenthesis)

Variable (x)		1975 - 1990			1991 - 2006		
		Output	Consumption	Exports	Output	Consumption	Exports
(1)	σ_x	1.14	1.12	3.94	1.12	0.99	3.54
	σ_x/σ_Y	-	0.98	3.46	-	0.88	3.16
	ρ_x	-	0.67	0.57	-	0.71	0.79
(2)	σ_x	1.22* (0.49)	1.13* (0.46)	4.46* (1.82)	0.27 (0.06)	0.54 (0.16)	1.18 (0.27)
	σ_x/σ_Y	-	0.94* (0.14)	3.69* (0.46)	-	1.98 (0.48)	4.39 (0.95)
	ρ_x	-	0.60* (0.11)	0.73 (0.08)	-	0.38 (0.21)	0.38 (0.23)
(3)	σ_x	0.99* (0.40)	1.36* (0.55)	-	0.17 (0.00)	0.26 (0.01)	-
	σ_x/σ_Y	-	1.37 (0.00)	-	-	1.54 (0.00)	-
	ρ_x	-	1.00 (0.00)	-	-	1.00 (0.00)	-

(1) Data

(2) NOE model incorporating energy price and world economic activity shocks

(3) NOE model incorporating energy price shocks and constant exports

As indicated by the second moments the different calibration in combination with the altered shock processes leads to very different properties of the endogenous variables which manifests also in very different impulse response functions. If the theoretical model is a reasonable interpretation of the transmission mechanisms that are relevant in reality, impulse response functions of a VAR(1) - richer dynamics of the exogenous variables are not implemented in the model - should roughly equal the estimated reactions presented above. To check for these properties, the confidence bands of estimated VAR(1)-models can act as a rough benchmark. For clarity they are not drawn in the following.[8]

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[8] Impulse responses of this specification can be found in the appendix. Exact numbers should not be taken too seriously, because the estimates may be biased as a result of autocorrelated residuals.

A comparison reveals that reactions of the model's endogenous variables to oil price hikes (figure 8) lie inside the confidence bands of a VAR(1)-model in the first sub-period. Moreover, the shape of the reactions can be explained remarkable well concerning output, the price level and the interest rate. However, the reaction of private consumption differs from the estimated response, because in the model consumption reacts immediately, while the VAR-model shows a more delayed response. Also the recovery of consumption proceeds earlier in the NOE-model.

Dashed lines represent the impulse response functions to an oil price shock for the second sub-sample. Some findings are worth to mention: At first, the altered exogenous processes cause a less persistent reaction of domestic variables since energy price themselves are less persistent and the interaction with world economic activity has weakened. Besides, the initial reaction becomes weaker in consequence of an altered less energy intensive economic structure.

According to all estimated VARs of the second sub-period none of the domestic variables react in a statistically significant dimension. The sole exception is the estimated response of the nominal interest rate. For this reason a comparison of the models IRF with the responses of the estimated VAR(1) is not really a useful task. For completeness, it should be mentioned that the magnitude of the reaction of the nominal interest rate can explained by our model whereas the shape of the response can not.

Because the NOE-model has shown up as a satisfying approach to explain the main characteristics of business cycle fluctuations in Germany and the transmission of oil price shocks, it seems to be worthy to name some numbers. Concerning the first sub-period the simulated energy price hike leads to a maximum output (consumption) reduction of roughly 0.03 (0.02) percent. The same shock causes an increase in the price level of roughly 0.3 percent, which forces the central bank to raise nominal interest rates by 25 basis points. In the second sub-period the magnitude of the reaction of the domestic variables is less than one half of the named values. Moreover, the maximum deviations take place immediately after the initial response and are reducing constantly without showing a wavy pattern. So as suggested by the previous analysis, the combination of altered economic structure and distinguished exogenous processes leads to weaker and less volatile responses in consequence of oil price hikes.

Figure 8: Impulse Response Functions of the NOE-model to an oil price shock allowing for changed exogenous shock processes
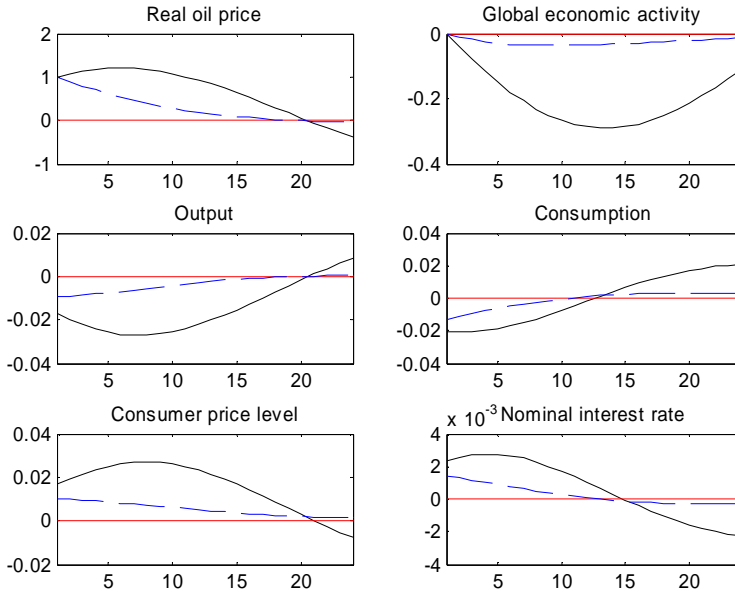

Figure 9 shows impulse response functions to world GDP shocks of the NOE-models incorporating altered parameters and distinguished shocks. A world economic boom leads to an initial increase in domestic output. But, subsequently, after energy prices have hiked this result turns into the opposite. Besides, the world demand shock and the following energy price hike causes an increase of the price level which, in turn, forces the monetary authority to raise the nominal interest rate. The last mentioned nominal variables show the maximum response 10 or 15 periods after the initial impulse. The response of consumption is negative in the short run. The reaction of consumption turns only into positive direction more than 20 periods after the initial impulse and, additionally, only in the first sub-period because the wavy response is more distinctive, then. The last mentioned point is true for all variables, what is an automatic consequence of the altered shock processes. More precisely, the initial response of German GDP to world demand shocks is bigger for the second sub-period in consequence of a higher export share. The opposite occurs for the subsequent counter reaction as a result of lower energy intensity.

Figure 9: Impulse Response Functions of the NOE-model to a world GDP shock allowing for changed exogenous shock processes
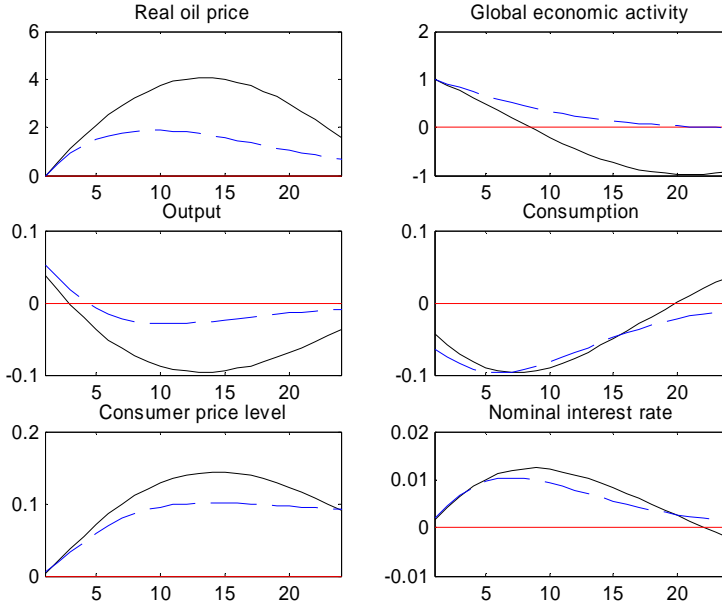
Though most responses to world demand shocks are not statistically significant, a comparison with the VAR(1) results seems to be useful for plausibility purposes. At first both calculations lead to similar results what stresses the quality of our theoretical approach. However, two objections are noteworthy. At first, the positive response of real variables takes place with more delay according to the VAR-approach. Then, and more important, the VAR-model does not imply a negative reaction of consumption. This feature seems to be the only theoretical weakness of our NOE-approach. Because of the lack of statistical significance, these objections should not be taken too seriously.

7. Conclusions

In this paper we try to answer the question why the effects of oil price shocks on the German economy have reduced in recent years. A first explanation is that the oil intensity of production was reduced since the oil price shocks of the seventies and early eighties. In this case oil prices would have become of minor importance for business cycle analysis. Another interpre-

tation is that the recent oil price hike was caused by increasing demand related to strong global economic activity. In this case the dampening effects of raising oil prices were offset by raising world demand. This means that a pure oil supply shock would still have pronounced effects on economic activity.

To analyse the effects of oil price hikes we initially estimate unrestricted VARs for two sub-samples. While significant negative reactions of global economic activity and consumption plus positive responses of the price level and the nominal interest rate can be measured for the first sub-period, none of these results is valid in the recent past. We also compare a pure oil price shock to a shock of world demand in both sub-samples. In the first period a world demand shock only affects the nominal interest rate. In the second sub-sample the demand shock has no significant effects. The impulse response functions, however, suggest that since the early nineties changes in oil prices are at least to some extent positively related to world demand while the opposite is true for the 70s and 80s. In combination these results indicate, that the role of oil price shocks may have changed from a global point of view but are still standard supply shocks from a German perspective.

To get a better understanding of the quantitative effects of these developments we utilize a NOE-model with optimizing agents and sticky prices. According to the model global economic activity affects exports and in turn domestic production while the energy cost share is a crucial parameter for the supply side effects of oil price hikes. That way, this approach gives us the opportunity to account separately for the effects of an altered economic structure and of distinctive exogenous shocks. To estimate the magnitude of the effects of oil price shocks and to check for the appropriateness of our approach we calculate some second moments and impulse responses of the structural model. Note, that especially in the first sub-period the model shows relative standard deviations and correlations that are very close to the data moments. Very most of them are statistically equal to the data pendants if sample uncertainty is considered. Moreover, we check if the impulse response functions of the NOE-models lie inside the confidence bands of a corresponding VAR(1). The NOE-model also passes this rough plausibility test.

Our simulations show that the small effects of energy price hikes on the German economy can only partly be traced to a lower energy intensity of production and increased openness. These changes, as an approximation, have moderated the effects of energy price shocks by only 40 percent – according to standard deviations of output. The same results indicate that energy price shocks (and succeeding movements in worldwide production)

can not explain all fluctuations (75 percent) in the energy intensive sub-period but anyway over 40 percent in the recent past. The magnitude of the responses after initial energy price impulses reduces by approximately one half.

However, these findings do not allow for changes of the persistence and interaction of the model's exogenous variables. To consider this we do the same exercises but incorporate separately estimated shock-VARs. By that we find a dramatic reduction in the importance of energy price shocks, because effects of a less energy intensive production are amplified by less persistent energy price movements and a remarkably altered interaction with worldwide economic activity. While energy price shocks (and succeeding movements in worldwide production) can account for more than all fluctuations in output in the earlier sub-sample, the importance of energy price movements is reduced to approximately one fourth in the recent sub-period. The differences concerning the other endogenous variables are similar. The maximum response of domestic output after an energy price shock is reduced by more than one half and, additionally, the deviations show much less persistency and no oscillating pattern.

To summarize, on the one hand the negligible effects of recent oil price hikes on the German economy are related to a reduced oil intensity of production. This explanation means that also future oil price hikes will not have the same dampening effects of the seventies. On the other hand, because a substantial part of the moderation is caused by good luck in terms of a strong growing global economy, oil prices are still important for business cycles in Germany. Though only German data has been used so far, the qualitative aspects of our results should also be valid for other oil importing countries.

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Appendix A: Calibration of model versions

Table A.1:Parameter values

Parameter	1975:1 – 1990:4	1991:1 – 2006:4
Production		
$1 - \alpha_1$	0.022633	0.013446
im_Y^{ss}	0.022633	0.013446
υ_1	-0.001	-0.001
Preferences		
σ	1	1
β	0.99	0.99
h	0.6	0.6
Shares		
ex^{ss}	0.229153	0.308110
α	0.983719	0.990155
γ	1	1
Aggregate supply		
Ψ	0.02	0.02
Elasticities		
b_1	0.33	0.33
b_2	0.33	0.33
b_3	0.1	0.1
φ	-0.02	-0.02
Taylor rule		
Δp_t^i	Δp_t^{cx}	Δp_t^{cx}
$\bar{\pi}$	0	0
μ_0	0	0
μ_1	0.3	0.3
μ_2	0.25	0.25
μ_3	0.9	0.9

Appendix B: Impulse responses of a VAR(1)-model

Figure B.1: Impulse response functions of the VAR(1)-model to an oil price shock (1975:1-1990:4 – solid lines; 1991:1-2006:4 – dashed lines)
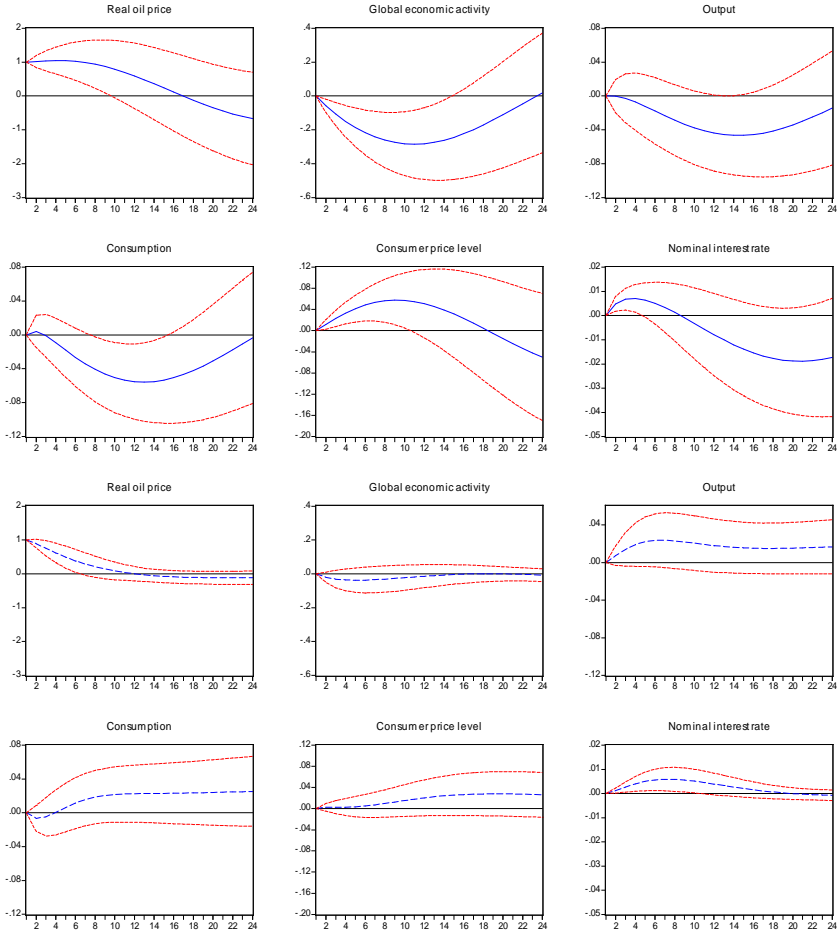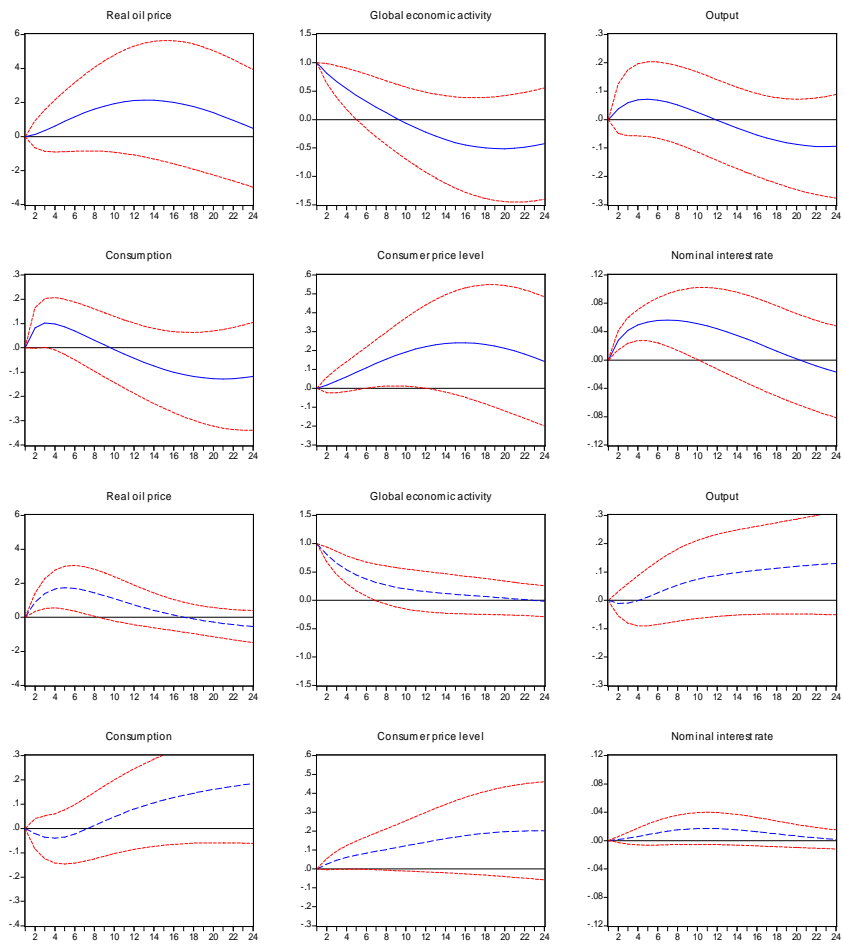
Figure B.2: Impulse response functions of the VAR(1)-model to a world GDP shock (1975:1-1990:4 – solid lines; 1991:1-2006:4 – dashed lines)

Appendix C: Data description

GDP: Real Gross Domestic Product. Chain index. Seasonally adjusted by official source. National Accounts. Federal Statistical Office Germany.

Consumer price level: GDP, implicit Price Deflator. National Accounts. Federal Statistical Office Germany.

Consumption: Real private household consumption. Chain index. Seasonally adjusted by official source. National Accounts. Federal Statistical Office Germany.

Exports: Real exports. Chain index. Seasonally adjusted by official source. National Accounts.Federal Statistical Office Germany.

Real Energy imports: Nominal energy imports – GDP-deflated. Foreign trade statistics. Statistical Office Germany.

Real oil price: Imported energy price index 2000 = 100 – GDP-deflated. Foreign trade price statistics. Federal Statistical Office Germany.

Nominal interest rate: three month interbank rate. German Bundesbank.

Global GDP: Real Gross Domestic Product of Belgium, Canada, Denmark, France, Italy, Japan, Korea, Mexico, Netherlands, Spain, Sweden, United Kingdom, USA. OECD.