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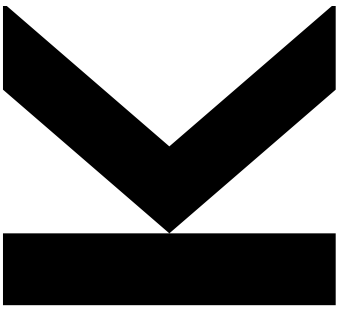
The Impact of Oil Demand and Supply Shocks on Consumer Sentiment: Its Nature and Transmission Channels



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Abstract

This thesis investigates how the US Index of Consumer Sentiment, a measure of uncertainty amongst consumers and their expectations about economic and business conditions, responds to oil supply, aggregate demand as well as other oil demand shocks. As consumption expenditures constitute a large proportion of a country's GDP and are the main transmission channel of oil price shocks to the real economy, it is important to understand how consumer expectations and uncertainty behaves after major oil price changes. The results show that oil supply shocks hardly have any impact on consumer sentiment in the US. Whereas other oil demand shocks have a statistically significant negative effect on consumer sentiment over a two-year horizon, the effect of aggregate demand shocks is positive in the first months and turns negative after three quarters. An analysis of the transmission channels of oil demand and supply shocks to the Index of Consumer Sentiment suggests that also the reasons, why consumers change their expectations, differ with respect to different kinds of oil shocks.

Statutory Declaration

I hereby declare that the thesis submitted is my own unaided work, that I have not used other than the sources indicated, and that all direct and indirect sources are acknowledged as references.

This printed thesis is identical with the electronic version submitted.

Place, Date

Katharina Linsbauer, BSc

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1 Introduction

Decades ago the scientific literature started to extensively discuss the effects of shocks to the price of crude oil on different macroeconomic variables in different countries, and this discussion is still going on. Despite the great interest in this topic, there is no consent on how the oil price influences variables like GDP, inflation or stock market returns or through which channels it transmits to the real economy. Also the best theoretical or empirical methods to be used in analysing the economic impact of oil price shocks are disputed. But not only researchers convey interest in this topic. As crude oil, which is also called the "black gold", is an indispensable raw material for the world economy, directly or indirectly influencing the economic situation of all kinds of market players, the amount of oil supplied as well as its price are closely followed by consumers, enterprises and policy makers alike.

Especially the question whether a rise in the oil price deepens or even causes an economic recession has received vivid attention, as most crises periods, like the recessions of the early 1980s and 1990s, were accompanied by a soaring oil price. To answer this question, it is essential to understand how the oil price transmits to the economy. It has already been acknowledged that an oil price shock does not only represent a cost shock to firms, but mostly a demand shock for the economy. Consumers face a higher price of energy and gasoline if the price of crude oil rises, which strains their budgets as they have less money available for other purchases. Moreover, higher energy and fuel prices raise the operating costs of vehicles and, hence, make buying cars less attractive. In addition to reduced demand due to less disposable income, gloomy expectations of consumers about future economic conditions caused by a rise in the oil price might further depress consumer spending. As consumption expenditures constitute a large proportion of a country's GDP, a rise in the price of oil that reduces consumption inevitably hurts the national or even international economy. Therefore, it is vital to understand how consumers react to oil price shocks in order to be better able to determine their possible effects on the whole economy and to identify suitable policy measures.

This thesis addresses the question of how oil demand and supply shocks affect consumers' expectations and current feelings about their personal financial situation as well as about future economic conditions in the US, which are expressed by the Index of Consumer Sentiment constructed from the Surveys of Consumers by the University of Michigan. A structural vector autoregressive (SVAR) model is used to identify different kinds of oil shocks according to the underlying cause of the shock and to estimate the dynamic effects of these shocks on consumer sentiment in the US. Moreover, it is analysed what the transmission channels of oil price shocks to consumer sentiment are. Is it for example that consumers expect higher inflation or that they are hesitant to buy a new car if oil prices rise? This question is also answered in this thesis by looking at the respective

responses of various disaggregates of the Index of Consumer Sentiment.

A very influential contribution to the oil price literature by Lutz Kilian (Kilian, 2009) finds that "not all oil price shocks are alike". He means that knowing the source of the oil shock is crucial for determining its impact on the economy. In the light of his findings, previous studies only estimated the effects of an average oil price shock, whereas he distinguishes between oil price shocks due to physical oil supply disruptions, due to changes in world aggregate demand for all industrial commodities as well as due to changes in oil demand that are specific to the oil market, like precautionary or speculative demand. Kilian was able to show that these three different types of oil shocks differ substantially in their impact on economic variables. Various authors adopted and extended Kilian's methodology to investigate the effects of oil price shocks e.g. on stock market returns as well as on production and prices (compare Kilian and Park, 2009; Fukunaga et al., 2011; Güntner, 2014a). This thesis contributes to the literature by employing an extension of Kilian's identification strategy and methodology in order to estimate structural impulse response functions (IRFs) of the Index of Consumer Sentiment to three different kinds of oil price shocks, which to the best of my knowledge has not been done so far. Indeed, Edelstein and Kilian (2007, 2009) provide an interesting analysis in which they estimate the response of the Index of Consumer Sentiment to purchasing power shocks caused by an increase in energy prices. However, they do not distinguish between different oil demand and supply shocks. Furthermore, what also differentiates this thesis from most existing studies is that it uses a quite recent sample which includes the Global Financial Crisis and post-crisis years as well as the period of historically low oil prices starting in 2014.

The importance of this specific question is emphasised by Richard Curtin, the Director of the Surveys of Consumers at the University of Michigan. He mentioned that although in the past consumer sentiment closely followed the ups and downs of the crude oil price (by being lower in times of a high oil price), this has not been the case for the high oil price periods in the early 2000s, which might be due to a wrong perception amongst consumers about the underlying reason for the oil price change (Curtin, 2005). In his opinion consumers expected the price increase to be due to a temporary shortfall in supply rather than a permanent increase in demand for oil. This statement suggests that for consumers it indeed matters why the price of oil rises and that the change in consumption expenditures and consequently the impact on the real economy might differ greatly. Another argument highlighting the significance of understanding fluctuations in consumer sentiment is the finding by Matsusaka and Sbordone (1995), who concluded that consumer sentiment contributes significantly to fluctuations in GDP. Hence, this thesis will contribute valuable insights into how consumer expectations in the US change due to oil demand and supply shocks, which in turn will be useful to understand how these shocks further affect consumption spending and other macroeconomic variables.

To the best of my knowledge, this thesis also offers the first evaluation of the response of some more detailed US consumer sentiment indices, e.g. representing expectations about unemployment or real income, to the three identified oil shocks, which enables me to determine the transmission channels of these shocks to the overall Index of Consumer Sentiment.

The rest of this thesis is structured as follows: In Chapter 2 a literature review is provided, summarizing the most important findings about how oil price shocks influence various macroeconomic variables as well as consumer behaviour. Chapter 3 describes the dataset used in the empirical analysis of this thesis. Chapter 4 presents the methodology applied in the empirical analysis, comprising the structural VAR model used, the identification strategy and the theory behind the estimated impulse responses. The results of the empirical estimations and the resulting impulse response functions for the overall Index of Consumer Sentiment as well as the more detailed sentiment indices are discussed in Chapter 5. This chapter also provides a comparison of the results of this thesis with the ones from Edelstein and Kilian (2007, 2009) and a discussion of possible limitations of the empirical analysis. Chapter 6 concludes.

2 Literature Review

The aim of this chapter is to provide an overview of prior research on oil shocks that has been conducted as well as of the results of these studies. In order to obtain a more complete picture of the effects of oil price shocks, not only the identified effects on consumption spending and consumer sentiment are discussed, but also those results focusing on output, prices, investment and asset markets. The body of literature investigating the impact of the oil price on the real economy is extensive and started quite early. Hamilton (1983) was the first to report a systematic and statistically significant relationship between oil price shocks and US recessions for the period from 1948 to 1972, although he was very cautious to say that the oil shocks actually caused these recessions. He further argued that this relation probably also holds for later recessions (occurring after the sample period he investigated which he calls the post-OPEC world) and that the price of oil is an important variable for explaining macroeconomic performance. Burbidge and Harrison (1984) came to similar conclusions. They also used vector autoregressions, but with the goal of computing impulse response functions for a number of economic variables to a one-standard-deviation oil price shock in different countries. Their findings suggest that the 1973/1974 oil price shock indeed had a significant effect on real GDP and prices in the US, whereas they could not find such a relationship for the 1979/1980 oil price increase. On the contrary, Gisser and Goodwin (1986) found evidence that the impact of oil price shocks on the US economy was quite stable over both periods. They concluded that the price of oil has statistically significant

real and inflationary effects in the US, which are of similar magnitude for the pre- and post-OPEC world. More recent studies include the work of Engemann et al. (2011), who found that oil price shocks have predictive power in forecasting recessions. Hamilton (2009) included the period of the run-up to the Global Financial Crisis in 2007/2008 into his analysis and found that oil price shocks led to significant declines in GDP during past recession periods due to their large negative impact on consumption spending and automobile purchases. Although Hamilton noted that the reasons for the oil price increase in 2007/2008 were different than those for past price shocks, he observed similar consequences of these oil price shocks. Whereas the studies mentioned so far mainly focused on the US, Cuñado and Pérez De Gracia (2003) investigated whether oil price shocks matter for a sample of 14 European economies. They used different proxies for oil price shocks and found that also in their sample of European countries effects of oil price shocks on inflation and industrial production growth can be observed, with significant differences across countries. They even documented asymmetries in the response of industrial production growth to oil price increases and decreases. Whereas the first lead to declines in production growth, the latter do not lead to increases in economic activity. Moreover, Berument et al. (2010) analysed growth effects of oil price shocks on a sample of selected Middle Eastern and Northern African (MENA) countries. For mainly oil-exporting countries like Iran and Iraq they found a positive and significant contemporaneous effect of oil price shocks on economic growth, whereas they found no impact on oil-importing MENA countries or small exporters. When decomposing oil shocks into demand and supply shocks (using a different method than Kilian (2009)), the authors concluded that oil supply shocks cause negative effects on output growth in the oil-importing countries and that oil demand shocks have a positive impact. However, one shortcoming of the study by Berument et al. (2010) is that it uses annual data which considerably limits the number of observations to a bit more than 50 years only. Some studies do not investigate the consequences of oil price shocks on the aggregate country level but concentrate on investment decisions and output on the firm level. For example, Lee et al. (2011) used firm stock price volatility as a measure for the level of uncertainty a firm faces. They found that investment in firms facing higher levels of uncertainty (i.e. firms confronted with higher stock price volatility) is depressed more due to an oil price shock than investment in lower risk firms. Lee et al. (2011) identified this to be the dominant channel through which oil prices affect investment on the firm level.

On the other hand, a number of studies contradicts these findings of a significant relationship between oil prices and the real economy. Barsky and Kilian (2004) concluded from their discussion of the major insights gained from earlier studies that the effect of oil price shocks on the US macroeconomy is not as large as commonly thought. Even though they admit a possible impact of oil price shocks on economic growth, they reason that theoretical explanations for such a relation are not supported by the data or are

not convincing as the expected magnitude would be too small. Similarly, Segal (2011) argued that the price for crude oil is only one out of many variables influencing output and that the oil price affects the macroeconomy mainly through its impact on monetary policy. Through increasing inflation oil price shocks trigger a tighter monetary policy with higher interest rates, which slows down economic growth. Segal (2011) did not back the view that oil prices have been decisive for past recessions. Yet it has to be remarked that both studies did not conduct an own empirical analysis, but rather reviewed existing findings in the light of theoretical considerations. This discussion, therefore, suggests that although researchers were often able to confirm a statistically significant relationship between oil price shocks and macroeconomic variables empirically, these results are quite difficult to explain theoretically.

Another large strand of the literature deals with the response of asset markets to oil price shocks. Although so far there has been no agreement in the literature whether there truly is a relationship between oil price shocks and stock markets, some more recent studies found asset markets to be an important transmission channel of oil shocks to the real economy (compare Güntner, 2014a; Kilian and Park, 2009, and the references therein). Kilian and Park (2009) claimed that this is the result of a great shortcoming of the earlier literature, which concerns its failure to distinguish between different types of oil price shocks. The two authors argued that the response of asset markets to oil price changes will depend on whether these changes are caused by demand or supply factors. If this is not accounted for, only the effect of an average oil price change can be estimated, which is often either not statistically significant or varies with respect to the investigated sample period. That oil prices are not only driven by supply disruptions caused by exogenous political events in the Middle East, as it is often argued, but also by global aggregate demand for crude oil or oil demand driven by other factors has already been stated by Barsky and Kilian (2002, 2004). Kilian (2009) was the first to document empirically that not all oil price shocks are the same, regardless of what is the underlying reason for the oil price change. He developed an empirical model that allows to disentangle oil price shocks according to their sources. In his paper he proposed a division of oil price shocks into oil supply shocks, which are shocks to the price of oil due to oil production disruptions, aggregate demand shocks, influencing the oil price through changes in global demand for all industrial commodities, and oil-market-specific demand shocks, like shocks to precautionary or speculative demand, which represent changes in oil demand and its price due to uncertainty about the future price, demand and availability of crude oil. The latter kind of shock also encompasses speculative demand in the physical market for crude oil as suggested by Kilian and Lee (2014). In anticipation of a future rise in the price of oil, speculators might demand more crude oil in the current period to store and sell it later on. Also this would represent demand for oil that is specific to the oil market and which may have a strong effect on the oil price.

These three different kinds of shocks are expected to imply different consequences for the investigated macroeconomic variables like GDP, stock market returns or inflation. Accordingly, prior studies rather identified the impact of an average oil price shock over the sample period on the economy, which is a huge loss of information and does not allow to identify adequate policy measures (compare Güntner, 2014a; Kilian, 2009; Kilian and Park, 2009). Applying an SVAR model which is able to isolate the magnitude and impact of the different shocks, Kilian (2009) found that in the US oil supply shocks only cause a temporary decrease in real GDP, whereas after around two years the impact vanishes. This result is consistent with the one in Kilian (2008), where he further concluded that oil supply shocks did not matter much for the development of the US economy since the 1970s. With regard to aggregate demand shocks, he found a statistically significant negative influence on GDP after three years. In the first year the effect is positive but cannot be distinguished from zero. Oil-specific demand shocks gradually decrease real GDP. Moreover, for CPI inflation he concluded that inflation rises due to aggregate and oil-specific demand shocks, whereas oil supply shocks do not have a significant impact. Additionally, Kilian (2009) investigated how the price of oil itself responds to different oil shocks. While a negative oil supply shock causes only a small and temporary rise in the real price of oil, an unanticipated aggregate demand shock or an oil-market-specific demand shock cause an immediate, large and persistent price increase. Most of the effect of the first type of demand shock is delayed by a few months, but the latter type even leads to a kind of overshooting of the oil price.

Building on this pioneering work by Kilian (2009), other researchers started to investigate how certain macroeconomic variables react to various kinds of oil shocks. Kilian and Park (2009) reported significant differences in the response of cumulative real stock returns to oil supply and demand shocks in the US. With respect to oil supply shocks, their empirical evidence suggests that there is no impact on cumulative US stock returns. In contrast, aggregate demand shocks due to increased global real economic activity lead to a significant increase in US cumulative real stock returns in the first seven months after the shock, whereas precautionary oil demand shocks have a negative effect on stock returns for half a year. Kilian and Park (2009) further showed that stock returns of different industries also respond differently to the various oil demand and supply shocks, which implies that investors have to undertake different portfolio adjustments depending on what caused the oil price change. Güntner (2014a) undertook a similar analysis, however, he extended it to comprise six OECD countries and not only the US. Specifically, he investigated the effects of oil demand and supply shocks on the two net oil-exporting countries Canada and Norway as well as on the four net oil-importing countries France, Germany, Japan and the US, in order to identify differences in the response of stock returns between oil-exporting and oil-importing countries. His findings for oil supply shocks for these six countries are consistent with the results for the US

in Kilian and Park (2009) as well as with results for a measure of global real stock returns: A negative oil supply shock has no significant impact on national stock markets in these six countries. Positive aggregate demand shocks that raise the real price of oil have a positive effect on national stock markets in both oil-exporting and oil-importing countries. Yet, whereas the effect quickly vanishes for the oil-importing countries, it remains positive and significant for a longer horizon for the two net oil exporters. Oil-market-specific demand shocks are found to hurt stock markets in France, Germany, Japan and the US, while they lead to increases in real stock returns in Norway and have no effect in Canada. Fukunaga et al. (2011) investigated the impact of oil demand and supply shocks on production and prices of different industries in the US and Japan, using a similar methodology as Kilian (2009) but different data. The authors concluded that different kinds of oil shocks have different effects on production and prices in the 12 investigated industries in the US and Japan, caused by differences in the oil-intensity of the various industries. According to the direction of the responses of production and prices, they classify the oil price shocks as either influencing the demand for the output (demand shock) or the production (supply shock) of the industries. If both production and prices increase or decrease, they call it a demand shock. If one increases and the other decreases, it is a supply shock. They found that aggregate demand shocks, which raise the price of oil, represent a demand shock for most industries in both countries. Oil-specific demand shocks are supply shocks for most industries in the US, whereas they produce mixed results in Japan.

Additionally to the above mentioned shortcoming of earlier studies concerning the failure of accounting for different types of oil price shocks, Kilian (2009) also mentioned a second deficiency. In regression analyses of what drives country GDP or other macroeconomic variables, the world crude oil price is often included as an exogenous independent variable. This may be a suitable specification when small countries are investigated, whose economy is too small to have an impact on the world price of crude oil (Berument et al., 2010). As soon, however, as nations are investigated that have enough market power to exert pressure on the world price of crude oil through their oil demand, reverse causality is an issue. Whereas the oil price might influence certain macroeconomic variables in a country, these variables like GDP growth or industrial production might in turn impact on the real price of oil since they affect the demand for oil. This fact was often ignored in previous studies.

While the literature discussed above mainly focuses on the relationship between oil price shocks and macroeconomic variables concerning aggregate and firm output, asset markets and prices, the demand side of the economy has received much less attention in this respect. Only few studies investigate the response of total consumption expenditures or various consumption aggregates in an economy to oil demand and supply shocks. This is a great shortcoming when considering some more recent studies, which mentioned that

oil shocks act as a demand rather than a supply or cost shock for an economy (compare Fukunaga et al., 2011; Kilian and Park, 2009). Consumers are directly influenced by an increase in the price of oil due to higher energy and gasoline bills. Moreover, as discussed above, some evidence exists that the oil price drives inflation and impairs output at least in some industries. Consumers might therefore also react to inflationary developments and potential job losses after major oil price fluctuations by adjusting their consumption expenditures. Hence, knowing how consumers act after oil price changes might be very important in order to understand the transmission of these shocks to other macroeconomic performance variables. An analysis of how consumers respond to oil shocks is, however, not limited to the impact of the latter on actual consumption expenditures. Consumer sentiment, an indicator for how consumers feel about current and future financial and business conditions, in their personal life as well as in the country as a whole, provides very valuable additional insights. It can be seen as a measure of consumer expectations and uncertainty. Households might not only react to oil price changes due to their direct effects on personal finances but also because major disruptions in the oil market increase their uncertainty about the future. Increased pessimism about future economic conditions might impede consumers from following their usual consumption patterns. Hence, consumer sentiment can be an important predictor of future consumption expenditures and knowledge about its development after major oil price changes thus might help to assess the long-term consequences of the latter on the national economy. Many studies focusing on different countries came to the conclusion that this is indeed the case. Carroll et al. (1994) found that lags of consumer sentiment have some explanatory power for current changes in household spending in the US. They also see consumer sentiment as a kind of uncertainty indicator and explain the relationship between sentiment and spending with a mixture of precautionary savings behaviour and habit formation: Increased uncertainty induces consumers to spend less but due to their habits the adjustment in consumption does not happen immediately. Similar results were found by Ludvigson (2004), Souleles (2004) and Gelper et al. (2007). Interestingly, a very recent study by Lachowska (2016) concluded that the relationship between consumer expenditures and consumer sentiment found in lower frequency data vanishes when using daily data. Day-to-day consumption spending does not seem to react to short-lived daily changes in confidence, whereas monthly or quarterly consumer sentiment changes may have a persistent impact on future spending. Additionally, to underscore the importance of consumer sentiment, Matsusaka and Sbordone (1995) provided evidence that exogenous changes in consumer sentiment cause changes in real output in the Granger sense. Specifically, they estimated that 13% to 26% of the variance of the fluctuations in GNP are triggered by shocks to consumer sentiment. As a major channel the authors state uncertainty. Consumer sentiment reflects how uncertain consumers are about the future and already Keynes mentioned that recessions are fuelled by uncertainty ("mass psychology of the market") (compare Matsusaka and Sbordone,

1995). Therefore, in the following the relevant literature investigating the effects of oil (demand and supply) shocks on consumption expenditures and consumer sentiment is discussed.

Probably the two most valuable studies for this thesis are the ones conducted by Edelstein and Kilian (2007, 2009), which is why I discuss them in greater detail here. They investigated a number of questions concerning the nature and magnitude of the relationship between retail energy prices and consumer expenditures. However, they did not distinguish between different kinds of energy demand and supply shocks in their analysis, but rather treat energy price shocks as shocks to the purchasing power of consumers. Thus, they estimated the effect of a shock to purchasing power caused by higher retail energy prices on consumption spending and different consumer sentiment indices. They offered the following results:

First of all, they did not find any asymmetries in the response of consumer spending and consumer sentiment to positive and negative energy price shocks, which is why they used a VAR model in their subsequent analysis. Moreover, they came to the conclusion that the impact of energy price shocks on consumption has become smaller over time. This is a trend reported by various studies (see e.g. Hooker, 1996), for which Edelstein and Kilian (2007, 2009) found the following possible explanations: Firstly, a change in the structure of the automotive industry in the US could be partially responsible. Before the late 1980s US car producers mainly produced large cars with high fuel consumption, which made it necessary for consumers to buy smaller and more efficient cars from abroad when oil prices were very high. This made the US car industry particularly vulnerable to oil price shocks, which changed when manufacturers in the US started to produce more efficient cars in the late 1980s. Secondly, an additional and probably much more important reason has been the changing composition of energy price shocks over time. Recent energy price hikes can be rather explained by increased global demand, which has a direct positive effect on consumption rather than only a negative effect due to rising energy prices.

In addition to these findings, Edelstein and Kilian (2007, 2009) estimated the effect of energy-price related purchasing power shocks on consumption expenditures and consumer sentiment in the US. Their main conclusion is that without a response of consumption to energy price shocks, their impact on the overall economy would be small. Yet, repeated unexpected shocks to the price of energy goods, which add up over time, are needed to generate a relevant response of consumption, although the latter is still larger than suggested by the actual share of energy in consumption. According to their estimates, total US consumption decreases by 0.15% in response to a 1% energy price increase, which is mainly driven by the elasticity of motor vehicle sales of 0.84%. The authors attributed this result to a precautionary savings behaviour caused by rising uncertainty in case of higher energy prices, which they can confirm with estimations of the

response of different consumer sentiment indices (which are seen as a measure of consumer uncertainty) to energy price shocks. Specifically, they investigated the response of the US Index of Consumer Sentiment constructed from the University of Michigan Surveys of Consumers as well as of several more detailed sentiment indices concerning unemployment, real interest rate and real family income expectations, the expected change in business conditions, the expected change in large household goods as well as vehicle buying conditions and the expected change of the personal financial situation. All indices except for interest rate expectations drop on impact and these effects remain negative and statistically significant for 18 months. Only the effect on the index for the expected change in business conditions becomes insignificant after around 4 to 5 months. These results provide evidence that consumers' expectations change in response to energy-related purchasing power shocks and the increased pessimism is probably a reason for the excess response of consumption spending to energy price shocks.

Hamilton (2009) tried to replicate the results in Edelstein and Kilian (2007) and came to the same conclusions. The very recent study of Baghestani (2016) tested whether the US Index of Consumer Expectations (ICE), an index constructed from the Surveys of Consumers by the University of Michigan, responds asymmetrically to gasoline price changes. First, in contrast to Edelstein and Kilian (2007, 2009) as well as to the findings in this thesis, where no unit roots have been found for similar sentiment indices, he detected a unit root in the ICE time series and in a further step found that the ICE and the price of gasoline are cointegrated. This difference in results may be due to the shorter sample period used by Baghestani (2016), who employed monthly data from 1993 to 2015 only, whereas Edelstein and Kilian and I have a sample of more than 30 years. The conclusion of Baghestani (2016) is that there exists a long-run negative relationship between the ICE and the gasoline price in the US, but that the ICE only responds to price increases and not to price declines. Another interesting and quite recent study by Wong (2015) investigated whether oil price shocks (without distinguishing between oil demand and supply shocks) impact on inflation expectations and whether the possible change in inflation expectations in turn transmits to actual inflation in the US. As a measure of inflation expectations the median expected inflation rate by US households determined by the Michigan Surveys of Consumers was used. Wong (2015) concluded that although inflation expectations are sensitive to oil price shocks, these movements in expectations seem to be of little relevance for changes in actual inflation. While Elder and Serletis (2010) did not investigate the relation between oil price shocks and consumer sentiment, they provided estimates for the effect of oil price uncertainty on consumption expenditures on durables. Using a bivariate GARCH-in-mean VAR model they found evidence for a significant and negative relationship between durables consumption and uncertainty about the price of oil.

This thesis investigates the impact of oil supply, aggregate demand and oil-specific de-

mand shocks on consumer sentiment in the US, using a sample of monthly data from January 1978 to June 2015. Therefore, I contribute to the existing literature (1) by distinguishing between different types of oil price shocks when estimating the impact of oil price changes on consumer sentiment and (2) by including the period of the Global Financial Crisis as well as the period of historically low oil prices starting in 2014 into my sample. Derived from the discussion of the literature, I will test the following two core hypotheses:

1. *Hypothesis 1*:
   The Index of Consumer Sentiment in the US responds differently to oil price shocks depending on the underlying cause of the shock, ceteris paribus.
2. *Hypothesis 2*:
   The transmission channels of oil price shocks to consumer sentiment differ depending on the underlying cause of the shock, ceteris paribus.

3 Data Description

In the empirical analysis, I use monthly data from the period 1978:01 to 2015:06. In total this amounts to a sample of 450 monthly observations for each of the three oil market variables world crude oil production ($\Delta lprod_t$), real economic activity (rea_t) and the real price of crude oil ($lrpo_t$) as well as for the Index of Consumer Sentiment ($senti_t$) and ten additional sentiment indices concerning different aspects of consumer sentiment. Table 1 provides summary statistics for these 14 variables.

3.1 Oil Market Variables

Data on monthly world crude oil production in thousand barrels per day ($\Delta lprod_t$) was obtained from the Monthly Energy Review for August 2015 provided by the US Energy Information Administration (EIA). Conducting an augmented Dickey-Fuller unit root test shows that the null hypothesis of a unit root cannot be rejected at conventional levels. This result is plausible when considering the technical aspects of oil production. Given that changing the volume of oil produced is costly and takes time, it is not frequently adjusted (Kilian, 2009). It is therefore very likely that a time series of oil production is integrated of order one, which was not rejected by the conducted unit root test. Due to this result the data on world crude oil production is transformed by taking first differences of the natural logarithm and converted to annualized percentage changes for better illustration.

To measure global real economic activity, the real economic activity index (rea_t) created by Lutz Kilian (Kilian, 2009) is used. The index is based on single-voyage dry cargo

Table 1: Summary statistics

Variable	Mean	Std.Dev.	Min	Max
$\Delta lprod_t$	1.821	15.487	−69.776	70.106
rea_t	−1.078	24.171	−63.864	62.484
$lrpo_t$	3.005	0.515	1.786	4.076
$senti_t$	85.243	12.911	51.700	112.000
$pago_t$	105.969	16.628	58.000	142.000
$pexp_t$	121.262	10.821	90.000	145.000
$bus12_t$	100.362	29.796	31.000	165.000
$bus5_t$	89.729	18.410	40.000	136.000
dur_t	144.569	19.569	77.000	182.000
$infl_t$	3.675	1.742	0.400	10.400
$ratex_t$	65.218	24.655	18.000	133.000
$rinc_t$	78.962	10.855	52.000	101.000
$umex_t$	81.860	16.557	33.000	129.000
veh_t	130.193	18.294	68.000	165.000

Notes: The sample period is from 1978:01 to 2015:06. $\Delta lprod_t$ represents annualized percentage changes in world crude oil production. The real price of oil is expressed in logs, but for illustration purposes not yet in deviations from the mean.

ocean shipping freight rates and is expressed as the deviation of real freight rates from their long run trend.[1] The idea behind this index is that increased world demand for industrial commodities will increase ocean shipping freight rates due to the inelastic short-run supply of shipping space. It takes time to build new ships, hence, in the short-run freight rates for shipping industrial commodities are expected to rise if world demand for the latter rises. Such a measure of world demand for industrial output is much more useful for the analysis conducted in this thesis than an indicator of the value-added of industrial production like the OECD industrial production index, since the aim in the empirical section is to decompose oil price shocks into oil supply shocks, oil demand shocks due to increased global real economic activity and oil-market-specific demand shocks. The real economic activity index proposed by Lutz Kilian is expected to track changes in economic activity and aggregate demand in the industrial commodity market quite closely and thus serves well to identify aggregate demand shocks to the oil price. Additionally to the real economic activity index being a better measure of aggregate demand than an industrial production index, it is also a truly global measure, whereas the commonly used OECD industrial production index does not include rapidly growing developing economies (compare also Kilian and Park, 2009). Of course, Kilian's index is not without limitations. He admits that the index might lag behind increases in global aggregate demand, as first spare capacities are used before freight rates rise. Moreover, Ravazzolo and Vespignani (2015) criticize that different commodities and

[1] For the exact procedure of how the index was constructed and for a discussion of its limitations and drawbacks see Kilian (2009).

shipping routes are equally weighted in constructing the index, which may cause bias since the importance of different types of commodities and different shipping routes may have changed over time. Despite these drawbacks, the real economic activity index has become quite popular in the empirical literature about oil and commodity price shocks, e.g. Büyükşahin and Robe (2014) use this index for an empirical investigation of how economic fundamentals affect the commodity-equity return correlation. As this index is already stationary by construction, no further transformations have been applied.

The oil price data represents the refiner acquisition cost of domestic and imported crude oil in the US in dollars per barrel[2] ($lrpo_t$), which was also obtained from the Monthly Energy Review for August 2015 by the EIA. The price series was deflated by the US Consumer Price Index as reported by the US Bureau of Labor Statistics. This variable is taken in logs and expressed in deviations from its mean. Although unit root tests give mixed results about whether the real oil price series contains a unit root, Güntner (2014a) notes that falsely differencing a series may render the estimates inconsistent, whereas not differencing a series with a unit root only leads to a loss in efficiency but not to inconsistency. Hence, the series is not used in log differences but, by convention, in log deviations from its mean multiplied by 100.

3.2 The Index of Consumer Sentiment and Its Disaggregates

The Index of Consumer Sentiment and its five subindices as well as the five other more detailed sentiment indices used are obtained from the Surveys of Consumers by the University of Michigan (also called the Michigan Consumer Survey). This is an extensive monthly consumer survey asking approximately 50 questions about the private households' attitudes and expectations of various business, buying and financial conditions. The survey uses a representative sample of US households consisting of 500 telephone interviews. The different consumer sentiment indices constructed from the survey are widely used in the literature as an indicator of uncertainty among consumers and also as an accurate predictor of economic developments in the US. The Index of Consumer Expectations is even included in the Leading Indicator Composite Index of the Bureau of Economic Analysis of the US Department of Commerce, which is a confirmation of the relevance of the index.[3] The core Index of Consumer Sentiment ($senti_t$) consists of five subindices concerning current personal financial conditions and consumer expectations

[2] Kilian and other authors use only the refiner acquisition cost of imported crude oil in the US in dollars per barrel as a measure for the world price of crude oil. However, this difference in the chosen data will hardly impact on the results. Compare Kilian (2009), Kilian and Park (2009) and Güntner (2014a).

[3] Compare the following document published on the website of the University of Michigan Surveys of Consumers: `https://data.sca.isr.umich.edu/fetchdoc.php?docid=24774`.

regarding future developments; the questions to these subindices are:[4]

1. "We are interested in how people are getting along financially these days. Would you say that you (and your family living there) are better off or worse off financially than you were a year ago?" ($pago_t$)
2. "Now looking ahead - do you think that a year from now you (and your family living there) will be better off financially, or worse off, or just about the same as now?" ($pexp_t$)
3. "Now turning to business conditions in the country as a whole - do you think that during the next twelve months we'll have good times financially, or bad times, or what?" ($bus12_t$)
4. "Looking ahead, which would you say is more likely - that in the country as a whole we'll have continuous good times during the next five years or so, or that we will have periods of widespread unemployment or depression, or what?" ($bus5_t$)
5. "About the big things people buy for their homes - such as furniture, a refrigerator, stove, television, and things like that. Generally speaking, do you think now is a good or bad time for people to buy major household items?" (dur_t)

Moreover, five other sentiment indices constructed from more specific survey questions are used in the analysis of this thesis. These five additional indices should give further insight into the drivers of the fluctuations in consumer sentiment and ask about inflation expectations, interest rate expectations, expectations about real household income, unemployment expectations and expected vehicle buying conditions. The survey questions are:[5]

6. "During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?" And "By what percent do you expect prices to go up, on the average, during the next 12 months?" ($infl_t$)
7. "No one can say for sure, but what do you think will happen to interest rates for borrowing money during the next 12 months - will they go up, stay the same, or go down?" ($ratex_t$)
8. "During the next year or two - do you expect that your (family) income will go up more than prices will go up, about the same, or less than prices will go up?" ($rinc_t$)

[4] This information is taken from the Index of Consumer Sentiment calculation information provided on the website of the Surveys of Consumers of the University of Michigan under `https://data.sca.isr.umich.edu/fetchdoc.php?docid=24770`.

[5] See the codebook of the Surveys of Consumers: `https://data.sca.isr.umich.edu/fetchdoc.php?docid=45121`.

9. "How about people out of work during the coming 12 months - do you think that there will be more unemployment than now, about the same, or less?" ($umex_t$)

10. "Speaking now of the automobile market - do you think the next 12 months or so will be a good time or a bad time to buy a vehicle, such as a car, pickup, van, or sport utility vehicle?" (veh_t)

The value of the Index of Consumer Sentiment is then expressed as the difference between positive and negative replies plus 100 for each of the five subindex questions and then dividing the sum of all questions by the value of the base period.[6] Hence, a higher index value indicates greater optimism amongst private households. For each of the five subindices and the five more detailed survey indices the calculation is the same, except for inflation expectations, which are not represented by an index but by the median of the inflation expectations reported by the households. Interest rate expectations are defined such that a higher index represents expectations of lower interest rates and for unemployment expectations a higher index represents lower expected unemployment. As the indices are stationary and fluctuating around their long-run mean of 100 by construction, no further transformation is applied to these indices. The stationarity of the Index of Consumer Sentiment was further backed by the results of an augmented Dickey-Fuller unit root test, which could reject the null hypothesis of a unit root at the 10%-level. For most of the subindices and the other sentiment indices the null hypothesis of a unit root could also be rejected at least at the 10%-level. For those, for which the unit root hypothesis could not be rejected, an analysis of the autocorrelation pattern showed that the time series are very persistent, but most likely do not contain a unit root, which is why all indices are used in levels.

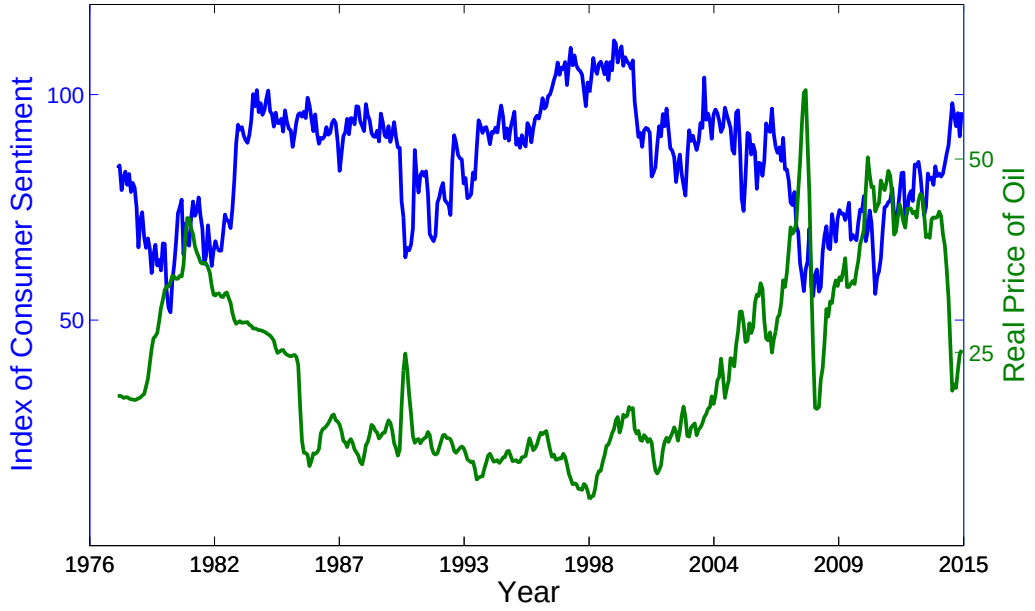
In order to get an impression of the potential comovement between the Index of Consumer Sentiment and the price of oil, Figure 1 provides a simple graphical depiction of the two variables. One can clearly see that in times of low oil prices consumers are more optimistic, whereas the Index of Consumer Sentiment drops in times of peaking oil prices. Of course, this does not mean that the real price of crude oil actually caused the increases and decreases in consumer sentiment in the US, as the oil price changes usually coincide with recessions or wars in the Middle East. Nevertheless, Figure 1 illustrates that the unconditional relationship between the two time series is likely to be negative.

3.3 Unit Root Tests

Table 2 summarizes the results of the conducted augmented Dickey-Fuller unit root tests. Under the null hypothesis that the time series contains a unit root, the coefficient

[6] For the exact calculation of the index as well as a detailed description of the survey see the Survey Information website of the Surveys of Consumers by the University of Michigan under `https://data.sca.isr.umich.edu/survey-info.php`.

Figure 1: A graphical analysis of the relationship between the real price of oil and consumer sentiment in the US



Note: The Index of Consumer Sentiment is expressed in index points. The real price of oil is expressed in dollars per barrel.

on the lagged dependent variable is zero. The relevant critical values of the t-statistic depend on the number of observations as well as on whether a constant and/or a linear time trend are included. Hence, a significant coefficient of the lagged dependent variable suggests that the null hypothesis of a unit root is rejected, which is the case for the real economic activity index and for the Index of Consumer Sentiment as well as for most of the other sentiment indices. As already mentioned above, for world crude oil production the null hypothesis of a unit root cannot be rejected whereas for the real price of oil the results are ambiguous. In addition to the augmented Dickey-Fuller unit root tests, the autocorrelation patterns of the time series were inspected. Even if the null hypothesis of a unit root could not be rejected by the statistical test, the time series was used in levels when the autocorrelation pattern suggested that it represents a very persistent stationary process rather than a process with a unit root.

4 Methodology

4.1 Identification Strategy and Specification of the SVAR Model

The empirical methodology of this thesis closely follows the SVAR model first developed in Kilian (2009) as well as the extension of this model by Kilian and Park (2009). It was

Table 2: Results of the augmented Dickey-Fuller unit root tests

	Time series													
Regressors	$lprod_t$	rea_t	$lrpo_t$	$senti_t$	$pago_t$	$pexp_t$	$bus12_t$	$bus5_t$	dur_t	$infl_t$	$ratex_t$	$rinc_t$	$umex_t$	veh_t
Lagged dependent variable	-0.038	-0.037***	-0.013	-0.041*	-0.046*	-0.047	-0.0513*	-0.063**	-0.053*	-0.062***	-0.076***	-0.035	-0.095***	-0.049
	(-2.750)	(-2.706)	(-2.262)	(-2.654)	(-2.651)	(-2.242)	(-2.819)	(-3.105)	(-2.823)	(-4.844)	(-3.603)	(-1.812)	(-3.968)	(-2.421)
Constant	0.410	-	0.038	3.568	4.929	5.836	5.228	5.760	7.729	0.193	4.911	2.781	7.798	6.437
	(2.748)	-	(2.250)	(2.684)	(2.665)	(2.270)	(2.767)	(3.102)	(2.834)	(3.966)	(3.391)	(1.831)	(3.960)	(2.440)
Linear time trend	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-
	(2.983)	-	-	-	-	-	-	-	-	-	-	-	-	-
Included lagged difference terms	6	4	2	12	13	5	8	3	13	20	4	5	13	5
Critical values for significance at the 10% level	-3.13	-1.62	-2.57	-2.57	-2.57	-2.57	-2.57	-2.57	-2.57	-2.57	-2.57	-2.57	-2.57	-2.57

H0: The series contains a unit root (coefficient of the lagged dependent variable is zero).
*, **, *** denote significance at the 10, 5 and 1% levels for the lagged dependent variable. t-statistics in parentheses.

already mentioned that the oil price has often been treated as exogenous with respect to other macroeconomic variables in the previous literature. Hence, studies investigated the effect of the oil price on some variables without accounting for the fact that these variables might in turn influence the oil price. Moreover, it was not distinguished what kind of shock led to an oil price increase or decrease. Kilian (2009) used a three-variable structural VAR model (see equations (1) and (2) below) to show that, by putting the variables in a specific order and imposing three restrictions on the inverse coefficient matrix $\mathbf{A_0^{-1}}$ equivalent to the Cholesky decomposition (orthogonalization), the three structural error terms of the vector $\varepsilon_\mathbf{t}$ can be recovered from the estimated reduced-form errors. This is important as only these structural shocks, each corresponding to one of the variables in the vector $\mathbf{z_t}$, have a causal interpretation. In other words, Kilian imposed a recursive structure on the relationship between the reduced-form error terms and the structural innovations within a given month to not only allow the oil price to respond to other macroeconomic variables, but also to identify the underlying causes of the shocks to the oil price. These shocks Kilian classifies as oil supply shocks, capturing the effect of disruptions in crude oil production on the oil price, aggregate demand shocks, which capture the impact of changes in world aggregate demand for all industrial commodities on the real price of crude oil as well as oil-market-specific demand shocks, which occur due to increased demand for crude oil because of uncertainty about its future price and availability. An economic justification for the validity of the imposed restrictions is given below. Kilian and Park (2009) extended this model by adding stock market returns as a fourth variable to the system of equations, where the vector of structural shocks contained a residual fourth component to capture all shocks to stock market returns not resulting from any of the three other sources. This extension further requires six rather than three restrictions on the inverse coefficient matrix to exactly identify the model. Note that the innovations to stock market returns are not given a structural interpretation.

In this thesis the equation for stock market returns is replaced by an equation for the Index of Consumer Sentiment, which is a measure for consumer expectations and uncertainty. The aim is to investigate the effect of oil demand and supply shocks, as defined by Kilian (2009), on consumer sentiment in the US since this relationship should give an idea of how oil price movements transmit to consumer behaviour. For this empirical investigation a four-variable structural vector autoregressive model as in Kilian and Park (2009) is estimated. The variables used in the model are the logarithmic change in world crude oil production $\Delta lprod_t$ in a certain period t, the real economic activity index by Lutz Kilian (compare Kilian, 2009) rea_t, the logarithmic real price of oil expressed in deviations from its mean $lrpo_t$ and the Index of Consumer Sentiment $senti_t$, which are summarized in the vector $\mathbf{z_t} = (\Delta lprod_t, rea_t, lrpo_t, senti_t)'$ with $t = 1, ..., 450$ denoting the monthly time periods. The estimated structural VAR system is then represented by

the following equation:

$$\mathbf{A_0 z_t} = \alpha + \sum_{i=1}^{24} \mathbf{A_i z_{t-i}} + \varepsilon_\mathbf{t}, \tag{1}$$

with α being a vector of constants, $\mathbf{A_0}$ and $\mathbf{A_i}$ being 4x4 coefficient matrices, the $\mathbf{z_{t-i}}$ being 4x1 vectors of the four lagged dependent variables and $\varepsilon_\mathbf{t}$ denoting the vector of structural shocks. Following the existing literature, especially Kilian (2009), Kilian and Park (2009) and Güntner (2014a), a lag length of 24 months was chosen. Empirical findings of the oil price shock literature suggest that at least 12 lagged observations of monthly data should be included to avoid problems with seasonal effects and also because the effects of oil price shocks on macroeconomic variables are highest after around 9 to 12 months (compare Hamilton and Herrera, 2004; Güntner, 2014a). In order to also identify possible long-run effects of oil price shocks on consumer sentiment, the suggested minimum lag length of 12 months was extended to 24 months.[7] Under the condition that $\mathbf{A_0^{-1}}$ is invertible, the corresponding reduced-form system can be written as

$$\mathbf{z_t} = \mathbf{A_0^{-1}}\alpha + \mathbf{A_0^{-1}} \sum_{i=1}^{24} \mathbf{A_i z_{t-i}} + \underbrace{\mathbf{A_0^{-1}}\varepsilon_\mathbf{t}}_{\mathbf{e_t}}. \tag{2}$$

In the following, the recursive structure of the contemporaneous relationship between the reduced-form and the structural innovations as well as the economic justification for the imposed restrictions are discussed in detail, applied to the research question of this thesis.

The decomposition of the reduced-form error terms $\mathbf{e_t} \equiv \mathbf{A_0^{-1}}\varepsilon_\mathbf{t}$ as proposed by Kilian (2009) and Kilian and Park (2009) takes the following form:

$$\mathbf{e_t} \equiv \begin{pmatrix} e_t^{\Delta lprod} \\ e_t^{rea} \\ e_t^{lrpo} \\ e_t^{senti} \end{pmatrix} = \begin{pmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{oilsupply\ shock} \\ \varepsilon_t^{aggregate\ demand\ shock} \\ \varepsilon_t^{other\ oil\ demand\ shock} \\ \varepsilon_t^{other\ shock\ to\ consumer\ sentiment} \end{pmatrix} \tag{3}$$

As equation (3) shows, the imposed restrictions only allow shocks to the supply of crude oil to have an influence on crude oil production within the same month. It is assumed that changes in aggregate demand, changes in expectations about the future availability

[7] As a robustness test also estimations including 36 lags were conducted, which led to very similar results, although some of the estimated VAR models turned unstable. Hence, the model using 24 lags was preferred as it is also more parsimonious.

or price of crude oil (precautionary or speculative demand shocks) as well as shocks to consumer sentiment do not influence the supply of crude oil immediately but with a delay of at least one month. This assumption is economically justifiable when considering the high costs involved for oil companies in changing the volume of oil produced. Due to these high adjustment costs, it is unlikely that oil producers react to changes in demand within the same month, especially as there is uncertainty about whether demand changes are only temporary or permanent. This implies a vertical oil supply curve. The real price of oil is allowed to respond immediately to oil supply and both oil demand shocks. Hence, oil supply disruptions, shifts in global aggregate demand for industrial commodities as well as shifts in demand for crude oil that are independent of aggregate demand but specific to the oil market may result in an adjustment of the real price of crude oil within the same month. However, due to the slow response of global economic activity to oil price changes, it is assumed that oil-market-specific demand shocks do not lead to instantaneous adjustments of real economic activity, whereas shocks to oil supply and aggregate demand might lead to an immediate response of global real economic activity (compare Kilian, 2009; Kilian and Park, 2009; Güntner, 2014a, and others).

Moreover, the recursive structure of the model allows consumer sentiment, that is how consumers feel about their current and future economic situation, to respond immediately to oil supply and demand shocks. Yet, the shock $\varepsilon_t^{other\ shock\ to\ consumer\ sentiment}$ is assumed to have no instantaneous effect on the oil market block. This shock captures all shocks to the Index of Consumer Sentiment other than those explained by oil supply, global real economic activity and oil-specific demand shocks. These could be for example changes in political or environmental circumstances in the US that have an impact on consumers' confidence but not on the global oil market or on global real economic activity within the same month. On the one hand, it is plausible that such determinants of consumer sentiment in a single country are unlikely to affect the global market for crude oil or global real economic activity. On the other hand, as the US is a dominant player in the world economy, it may still be possible that domestic circumstances in the US are reflected in global activities and markets. However, as it is unlikely that these changes transmit immediately (within the same month), the imposed restrictions can still be justified. As mentioned, oil supply is unlikely to adapt quickly to changed demand conditions as adjustment costs are high, which justifies the zero restriction in the first row and fourth column. Furthermore, positive or negative shifts of the Index of Consumer Sentiment might reflect future changes in US demand for consumption goods, and further also in industrial commodities needed to produce final consumer goods, rather than immediate changes in demand. Thus, a response of global real economic activity in the same month is not plausible. The question that remains is whether the oil price responds instantaneously to shocks to consumer sentiment in the US, hence, whether the coefficient in the third row and fourth column is zero or not. Since oil prices

are determined by the supply and demand of crude oil, only events or developments immediately impacting on oil demand or supply will influence the real price of crude oil. These shocks, however, are already captured by the previously identified oil supply, aggregate demand and oil-market-specific demand shocks, which justifies the restriction that shocks to consumer sentiment other than oil demand and supply shocks do not influence the real price of oil instantly. With these assumptions, the global oil market and shocks to the oil market are contemporaneously predetermined with respect to consumer sentiment in the US, which makes it possible to evaluate the effect of oil supply and demand shocks on consumer sentiment without accounting for reverse causality within a given month. This identification strategy is used to estimate impulse response functions for the four variables in the VAR model to one standard-deviation oil demand and supply shocks. The theory behind estimating IRFs is explained in the next subsection.

The second research question in this thesis concerns the channels through which oil demand and supply shocks impact on consumer sentiment in the US. For this reason the above model is also estimated replacing the variable $senti_t$ by either one of the five subindices of the Index of Consumer Sentiment or another sentiment index based on one of the more specific questions of the Surveys of Consumers that is not part of the overall index. Hence, a range of impulse response functions are estimated, which show whether various disaggregates of the Index of Consumer Sentiment respond in the same way to oil supply and demand shocks or whether there are differences. The additional indices used represent feelings about the current personal financial conditions ($pago_t$), the expected future personal financial conditions ($pexp_t$), expected business conditions in the next 12 months ($bus12_t$), expected business conditions in the next 5 years ($bus5_t$), feelings about the conditions for buying major household durables (dur_t), inflation expectations ($infl_t$), interest rate expectations ($ratex_t$), expectations about real household income ($rinc_t$), unemployment expectations ($umex_t$) as well as expectations about vehicle buying conditions (veh_t). The exact definition of these indices is given in chapter 3.

4.2 Impulse Response Functions

As already mentioned, the aim of the described identification strategy is to estimate the three structural oil shocks in the SVAR model in order to be able to identify the response of the variables in the model to these structural shocks. The reduced-form error terms can simply be recovered from the estimated reduced-form VAR model. As equation (3) shows, the vector of reduced-form error terms $\mathbf{e_t}$ equals $\mathbf{A_0^{-1}}\varepsilon_\mathbf{t}$ and, hence, each component of $\mathbf{e_t}$ is a linear combination of the four structural shocks. To recover the structural shocks, the inverse coefficient matrix $\mathbf{A_0^{-1}}$ must be estimated. Since there are too many free parameters in this matrix to exactly identify it, the above

identification strategy is used, where the variables are first put into a specific order and then zero restrictions on the contemporaneous relationship between the reduced-form and the structural errors are imposed applying the Cholesky decomposition (this is called orthogonalization of the reduced-form error terms). With these restrictions the inverse coefficient matrix can be estimated from the variance of the reduced-form error terms, which is represented by[8]

$$E(\mathbf{e_t e_t'}) = \mathbf{A_0^{-1}} E(\varepsilon_\mathbf{t} \varepsilon_\mathbf{t}') \mathbf{A_0^{-1\prime}}. \tag{4}$$

The structural shocks are uncorrelated with each other. Hence, the variance-covariance matrix of the vector of structural error terms $E(\varepsilon_\mathbf{t} \varepsilon_\mathbf{t}')$ is diagonal. Moreover, to simplify the following analysis, the variance of the structural shocks is normalized to 1. The variance-covariance matrix can therefore be represented by an identity matrix of dimension $K = 4$:

$$E(\varepsilon_\mathbf{t} \varepsilon_\mathbf{t}') = \mathbf{I_K} \tag{5}$$

and, thus,

$$E(\mathbf{e_t e_t'}) = \mathbf{A_0^{-1}} \mathbf{I_K} \mathbf{A_0^{-1\prime}} = \mathbf{A_0^{-1}} \mathbf{A_0^{-1\prime}}. \tag{6}$$

As the variance-covariance matrix of the reduced-form error terms is symmetric about the main diagonal, with $K = 4$ it has 10 free parameters. Hence, 10 is also the maximum number of uniquely identifiable free parameters in the inverse coefficient matrix $\mathbf{A_0^{-1}}$, which is why the Cholesky decomposition is used to orthogonalize the matrix. More precisely, a matrix $\mathbf{P}$ is defined, which represents the lower triangular Cholesky decomposition of the variance-covariance matrix of the reduced form error terms $E(\mathbf{e_t e_t'})$. $\mathbf{P}$ is then used as one possible, economically justifiable solution for $\mathbf{A_0^{-1}}$. Hence,

$$\mathbf{P} = chol(E(\mathbf{e_t e_t'}))' = \mathbf{A_0^{-1}}. \tag{7}$$

As $E(\mathbf{e_t e_t'})$ is known, the parameters in $\mathbf{P}$ can be calculated by solving

$$vec(E(\mathbf{e_t e_t'}) - \mathbf{P P'}) = 0 \tag{8}$$

When $\mathbf{P}$ is known, the structural shocks in $\varepsilon_\mathbf{t}$ as well as the structural IRFs can be computed. The estimated structural IRFs represent the deviation of the variables in the vector from their long-run mean, which is caused by the structural shocks:

[8] Most of the rest of this subchapter is heavily based on unpublished lecture notes by Lutz Kilian.

$$\mathbf{z_t} - \mu = \sum_{i=0}^{\infty} \Phi_i \mathbf{e_{t-i}} = \sum_{i=0}^{\infty} \Phi_i \mathbf{P} \varepsilon_{\mathbf{t-i}} = \sum_{i=0}^{\infty} \Theta_i \varepsilon_{\mathbf{t-i}}. \tag{9}$$

where the matrix $\mathbf{\Phi_i}$ represents the responses to the reduced-form error terms and $\mathbf{\Theta_i}$ the responses to the structural shocks. All these components can be estimated and, hence, the IRFs of the variables in the vector $\mathbf{z_t}$ can be calculated accordingly.

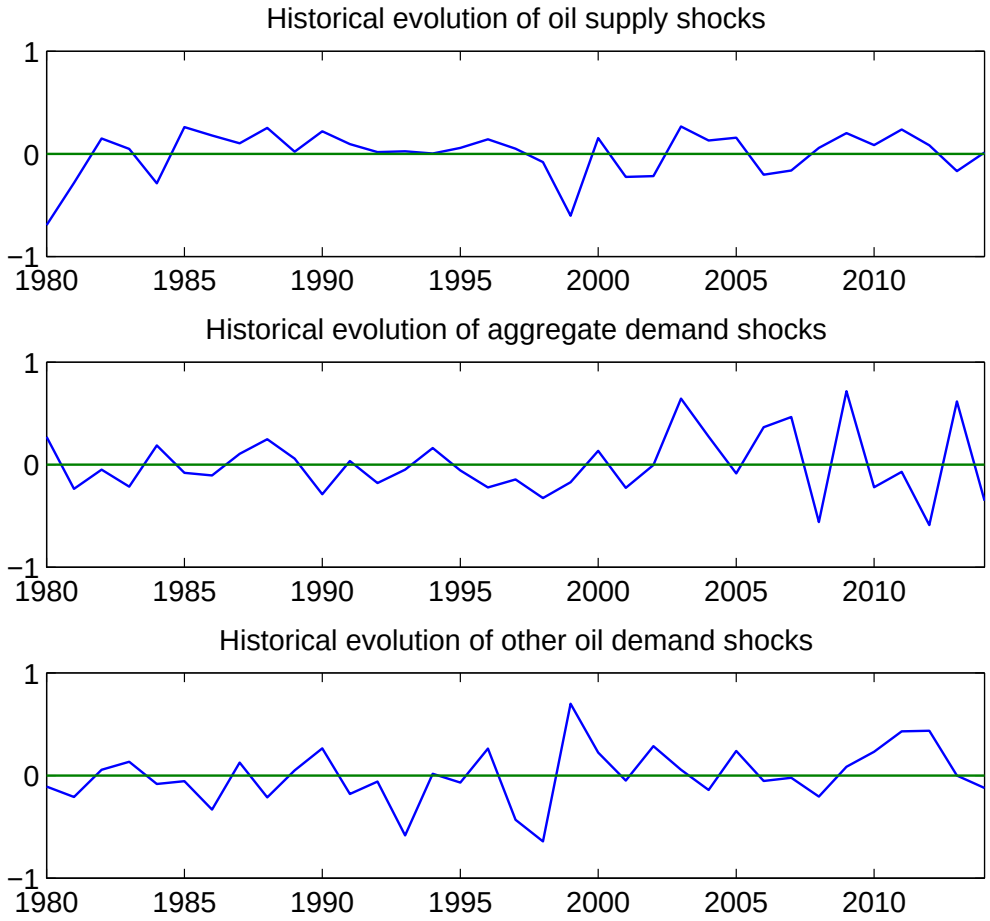
Although the estimated reduced-form residuals are uncorrelated, there is autoregressive conditional heteroskedasticity (ARCH) in the residuals, as is confirmed by a conducted Engel's ARCH test. The null hypothesis of no conditional heteroskedasticity can be rejected for the residual series of the world crude oil production equation as well as for the real economic activity index equation and, depending on the included lag length, also for the residuals of the real oil price equation. For the residual series of the equation for the Index of Consumer Sentiment no conditional heteroskedasticity can be found. As a consequence, standard confidence intervals around the impulse response functions are not applicable. Instead, a recursive-design wild bootstrap method is used for calculating the confidence intervals, as proposed by Gonçalves and Kilian (2004). According to Gonçalves and Kilian (2004), this method is very well-suited for empirical macroeconomics and it performs well, whether the error terms are conditionally heteroskedastic or i.i.d. I construct one- and two-standard-deviation confidence bands, which approximately represent 68% and 95% confidence intervals. Furthermore, 5,000 replications are used for the wild bootstrap.

5 Empirical Results

5.1 Historical Evolution of the Structural Shocks

It is always helpful to start with an evaluation of the time path of the structural shocks as illustrated in Figure 2. The monthly structural oil demand and supply shocks have been aggregated to annual averages for the years 1980 to 2014 for better readability. Figure 2 shows that observed movements in the oil price from one period to the next are never caused by a single shock alone, but that various shocks impact simultaneously on the price of oil at a specific point in time. At the beginning of the 1980s a large negative oil supply shock was observed, which is consistent with the outbreak of the First Gulf War between Iran and Iraq during that time. At the same time, a positive shock to aggregate demand might have further contributed to the increase in the oil price, whereas a small decrease in precautionary demand counteracted this trend. This does not mean, however, that the First Gulf War did not affect uncertainty about future oil availability. Kilian (2009) concluded that there was an unanticipated rise in other oil demand in the year 1979, which suggests that oil-specific demand probably increased in

Figure 2: Historical evolution of oil supply, aggregate demand and other oil demand shocks from 1980 to 2014



Note: The monthly structural shocks have been annualized (annual average) for ease of interpretation.

anticipation of the upcoming war.[9] The oil price peak around the year 1990 seems to have been solely caused by a rise in precautionary demand associated with the Second Gulf War between Kuwait and Iraq, whereas at the same time oil production increased and aggregate demand for crude oil decreased.

The largest movement of other oil demand shocks was observed in the years before and after the Asian Financial Crisis. While negative shocks to other oil demand as well as to aggregate demand are consistent with the fall in the oil price to historically low values until 1998, afterwards a combination of a surge in precautionary demand, recovering real economic activity as well as a drop in oil production may have contributed to the subsequent substantial rise of the oil price level. Since the year 2000 large fluctuations

[9] Of course, other political developments in the Middle East might have also contributed to the shock to other oil demand in 1979.

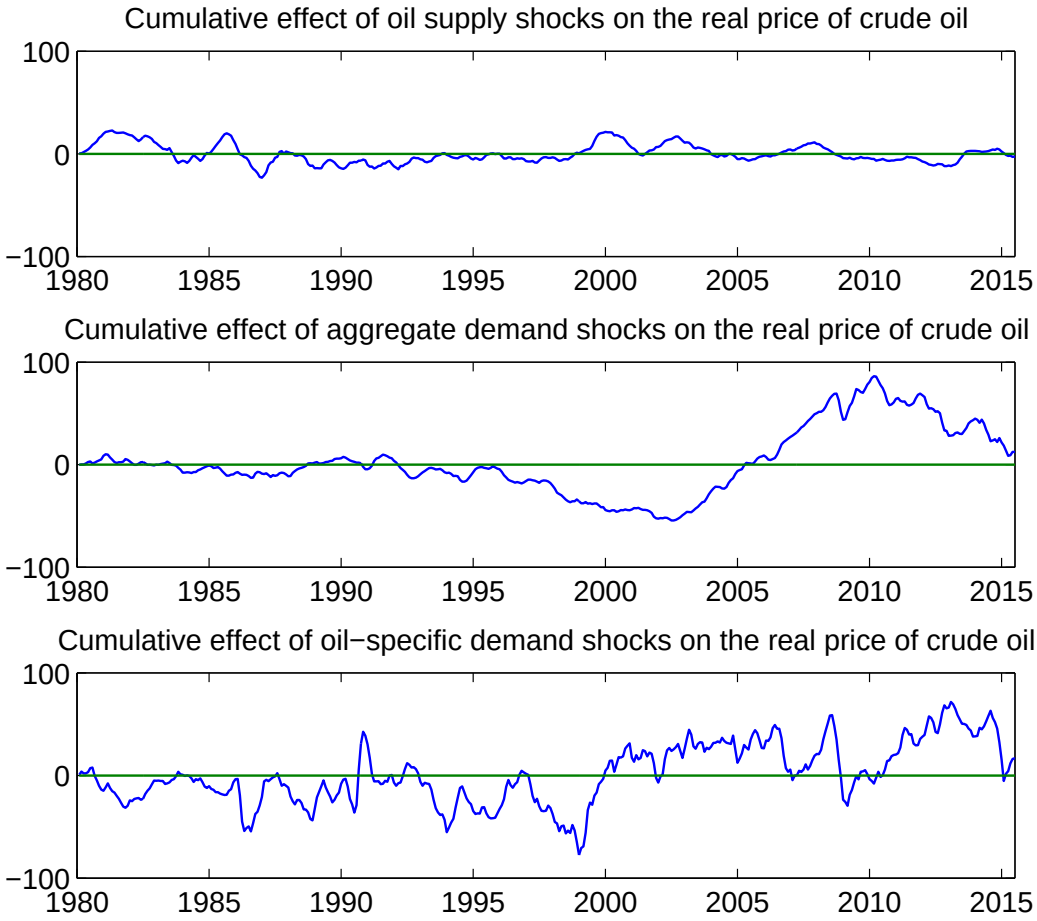
in world aggregate demand occurred. Strong demand in the first years of the new millennium coincide with significant oil price hikes during that time. Also the drop in the oil price during the Global Financial Crisis and its subsequent recovery seem to be primarily attributable to shocks to world aggregate demand. Surprisingly, the recent oil price decline seems to be caused by a combination of the two oil demand shocks and not so much by oil supply shocks. One might have expected that the use of hydraulic fracturing (fracking) in the US combined with stable or increasing production of the rest of the oil producing countries must have caused substantial positive shocks to oil supply. But this cannot be seen from Figure 2, hardly any shock to oil supply occurred in 2013 and 2014.

5.2 Historical Variance Decomposition

In order to evaluate the relevance of the analysis conducted in this thesis, a historical decomposition of the fluctuations in the real price of crude oil and the Index of Consumer Sentiment over the sample period is undertaken. Whereas impulse response functions show the response of a variable to a specific one-time and one-standard-deviation shock, the historical variance decomposition illustrates the cumulative effect of a sequence of these shocks of different magnitude and sign that occurred during the sample period. Hence, it is analysed how much the three identified oil demand and supply shocks contributed to the historical evolution of the real price of crude oil and the Index of Consumer Sentiment.

Figure 3 presents the cumulative effect of oil supply, aggregate demand and oil-specific demand shocks on the real price of oil over the period 1980:01 to 2015:06. To a large extent the results coincide with those of previous studies (compare Güntner, 2014a; Kilian, 2009; Kilian and Park, 2009). Innovations to oil supply explain comparatively little of the development of the oil price. While shocks to global real economic activity generate large and long-term swings in the oil price after 1995, other oil demand shocks, like shocks to precautionary or speculative demand, are responsible for substantial sudden oil price fluctuations. However, as the structural model underlying the historical decomposition in this thesis is a different one than in earlier studies, the findings also deviate in some points. Compared to e.g. Güntner (2014a), in the 1980s the model in this thesis attributes a much higher proportion of real oil price fluctuations to oil supply shocks. During the First Gulf War between Iran and Iraq in the 1980s shortfalls in oil supply triggered increases in the oil price, especially in the earlier years. Moreover, no substantial cumulative effect of global aggregate demand on the real oil price could be found during this time, whereas contrary to the findings of Güntner (2014a), precautionary demand for oil declined and had a depressing effect on the oil price in the early 1980s. Hence, my results suggest that it is indeed reduced oil supply that contributed

Figure 3: Historical decomposition of the fluctuations in the real price of crude oil from 1980:01 to 2015:06, percentage share explained by oil demand and supply shocks



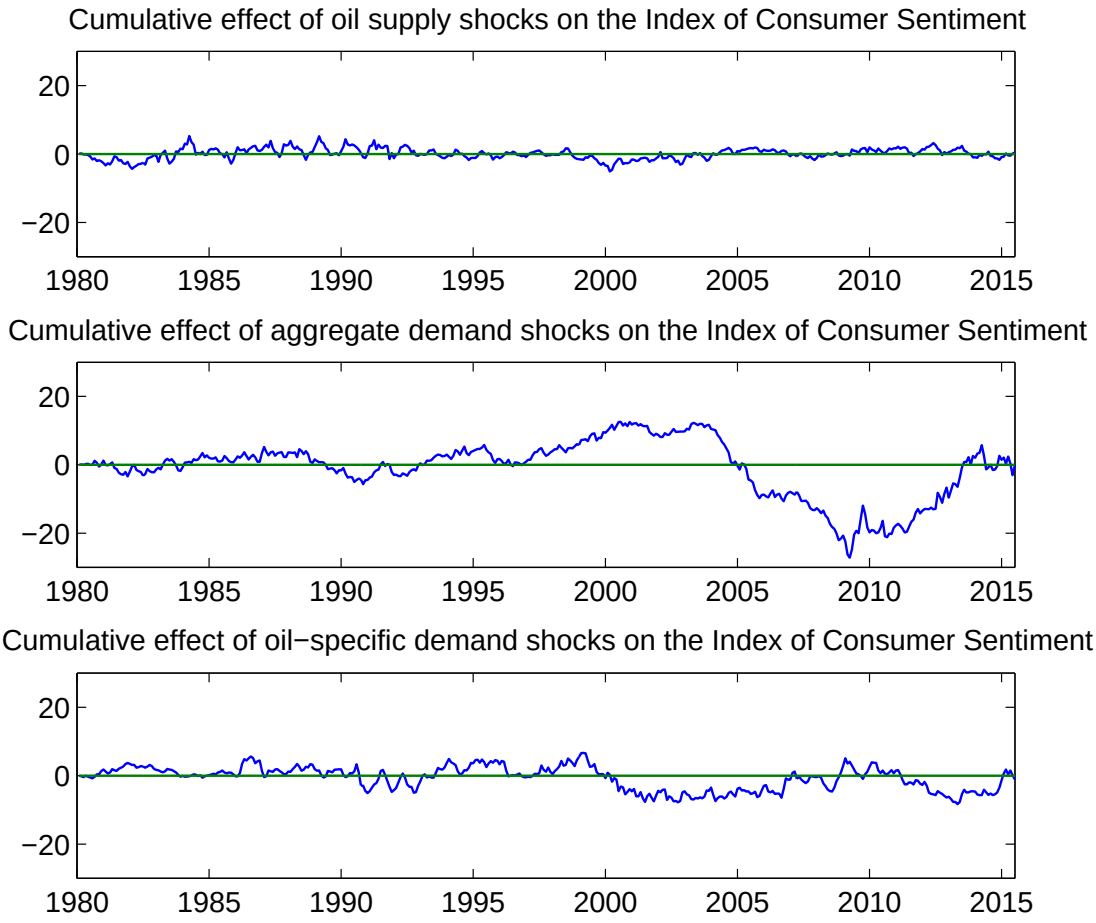
most to the oil price increase in the early 1980s during the First Gulf War and not a surge in precautionary demand for oil. During the whole 1980s the cumulative effect of precautionary oil demand on the oil price was fluctuating quite strongly but it was always negative, until it sharply increased during the Second Gulf War in 1990/1991. So in contrast to the episode of the First Gulf War, during the Second Gulf War the rise in precautionary demand for oil was mainly responsible for the rise in the oil price.

From the early 2000s until the Global Financial Crisis in 2008 the price for crude oil soared rapidly. This development is driven by rapidly rising world aggregate demand starting around the year 2003 as well as a jump in precautionary demand in the late 1990s, which remained high until the crisis. The cumulative effect of oil supply shocks in the early 2000s amplified these two effects. After the crisis hit in 2008/2009, the oil price fell sharply, which is mainly due to a decline in precautionary demand and less global aggregate demand. But the oil price recovered again quickly since oil-specific demand rose again after 2009 and also aggregate demand further increased until 2010. The drop in the oil price to historically low values after 2014 is again mainly attributed to reduced

precautionary demand and constantly falling world aggregate demand and not to a rise in oil supply. This finding is consistent with the historical evolution of the structural shocks in Figure 2, where no major positive shocks to world crude oil production could be detected for the last two years. Both results are somewhat surprising as during this period global production levels of oil should have increased due to the use of fracking in the US and a fight for market shares amongst oil producing countries, which is not at all reflected in a sequence of positive oil supply shocks as well as in a negative cumulative effect of oil supply shocks on the price for crude oil. It seems that the combination of lower aggregate demand and higher oil supply influences the real oil price mainly through a resulting lower precautionary demand for oil, which somehow contradicts the estimated IRFs in the next subsection. The IRF of the real oil price demonstrates a significant positive response to negative oil supply shocks, which was not found in the existing literature. I attributed this to the longer sample used in this thesis including the recent period of low oil prices. But it seems that, compared to oil demand shocks, oil supply shocks still contributed little to the historical evolution of the oil price also in recent years.

Figure 4 shows the same analysis for the Index of Consumer Sentiment. Oil supply shocks contributed very little to the historical evolution of this index. At the beginning of the 1980s, during the first years of the Iran-Iraq war, oil supply shocks contributed to a reduction in consumer sentiment. Moreover, in the year 2000, when oil supply shocks added to an increase in the oil price, they added to a decrease in the Index of Consumer Sentiment as well. Yet, the cumulative effect is very small and moves erratically. This suggests that oil supply disruptions do not worry consumers too much, probably because they rely on oil reserves or expect them to be only temporary. Also precautionary or speculative demand shocks have historically not been a major driver of the Index of Consumer Sentiment. Other oil demand seems to have lowered the Index of Consumer Sentiment in the early 2000s, which is probably due to the rapidly increasing oil price during that time. Also the rising oil price due to other oil demand after the Global Financial Crisis has burdened consumers in the US with higher energy prices, which made them think more pessimistically about the future. However, in the last months of the sample which are marked by relatively low oil prices and decreasing precautionary demand, oil-market-specific demand shocks contributed to a recovery of consumer sentiment in the US. What can also be clearly seen is that the negative precautionary demand shocks during and before the Asian Financial Crisis in the late 1990s also added to an increase in consumer sentiment in the US and not only to a fall in the oil price. A much larger cumulative effect on consumer sentiment results from aggregate demand shocks. Whereas before 1995 their impact is small, from the mid 1990s onwards they raise consumer sentiment in the US. However, from 2005 to 2010, aggregate demand shocks have contributed to a considerable decline in the index. One reason for this is

Figure 4: Historical decomposition of the fluctuations in the Index of Consumer Sentiment from 1980:01 to 2015:06, percentage share explained by oil demand and supply shocks



of course the Global Financial Crisis in 2008/2009. Moreover, consumers might have already seen the crisis coming or at least expected an economic downturn, which might explain the negative effect starting three years earlier. Additionally, the movements in the oil price caused by aggregate demand shocks most likely also contributed to the positive effect of the latter on consumer sentiment until 2005 and their subsequent negative effect. After the crisis, aggregate demand shocks are the main reason for the recovery of the index to previous levels.

It can be seen from Figure 4 that the wars in the Middle East at the beginning of the sample period, like the First and Second Gulf Wars, which dramatically influenced the oil price, did not lead to increased pessimism amongst US consumers. Only during the Second Gulf War in 1990/1991 adverse precautionary and aggregate demand shocks contributed to a fall in the index. The decade before the Global Financial Crisis as well as the crisis and after-crisis periods are, however, marked episodes in the historical evolution of the Index of Consumer Sentiment with oil demand and supply shocks being

major drivers.

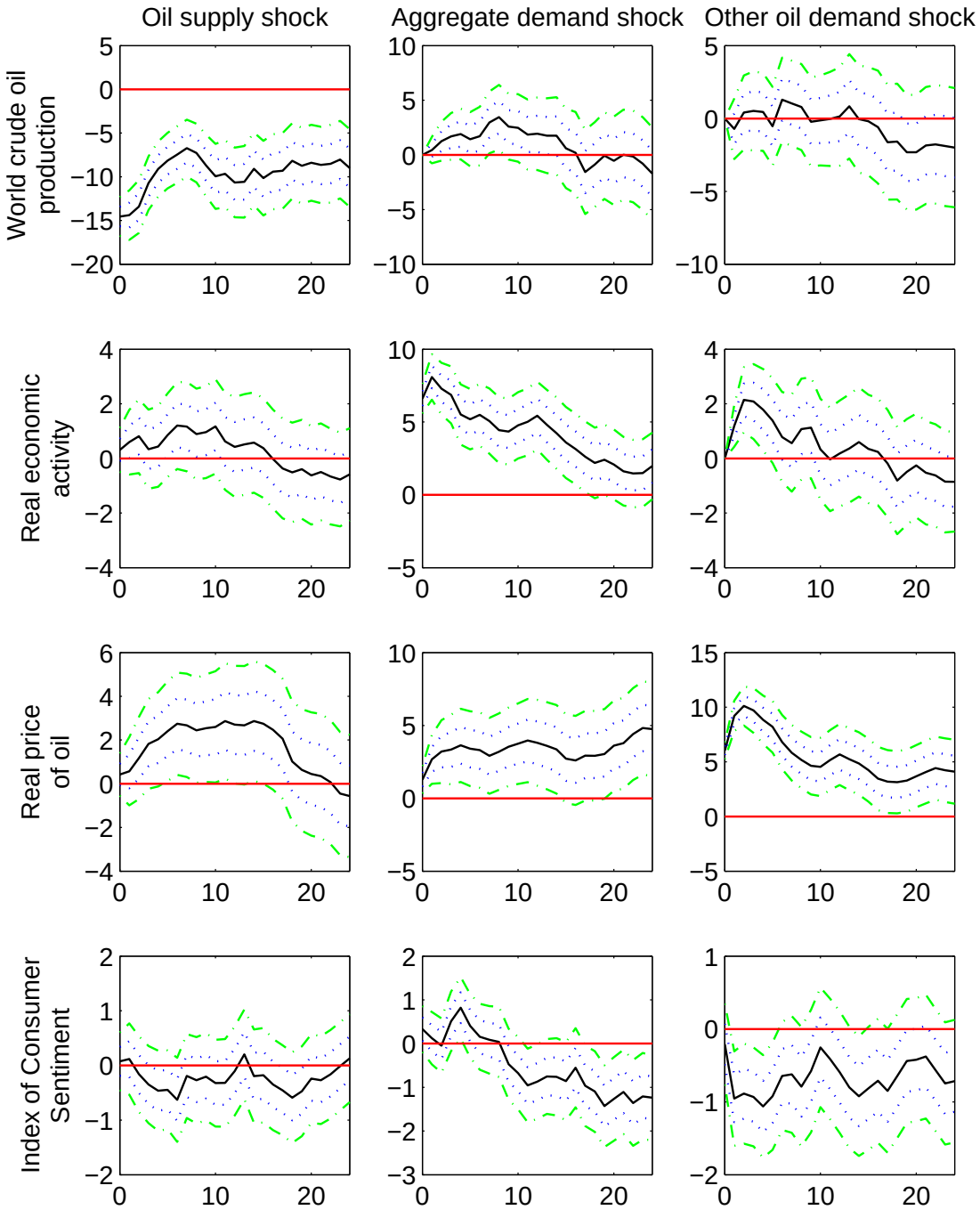
5.3 Structural Impulse Responses

From the SVAR model given in equation (1), the responses of the four variables in the model to the individual structural shocks were estimated using the identification strategy discussed in the previous chapter. Figure 5 illustrates the estimated impulse response functions for the three oil-market variables as well as the overall Index of Consumer Sentiment. Each shock represents a one-standard-deviation structural innovation. In contrast to the shocks associated with the oil-market block of the model, shocks to the Index of Consumer Sentiment do not represent structural shocks in the sense that one could identify a specific source for an observed innovation. Accordingly, the responses of the variables in the model to this type of shock are not considered. Whereas positive aggregate demand and oil-market-specific demand shocks tend to raise oil prices, a positive oil supply shock is expected to decrease the oil price. Hence, in order to be better able to compare the effects of the three different shocks, the impulse response functions represent the responses to negative oil supply shocks, but to positive aggregate demand and other oil demand shocks, so that all shocks are expected to trigger an oil price increase. The one- and two-standard-error confidence bands are calculated using a recursive-design wild bootstrap technique with 5,000 replications (compare Gonçalves and Kilian, 2004), which correspond to approximate 68% and 95% confidence intervals under the assumption of a standard normal distribution.

5.3.1 Oil Market Variables

Starting with the results for the three variables representing the oil market in Figure 5, the results are comparable to those in Güntner (2014a), Kilian (2009) and Kilian and Park (2009), but differ to some degree in magnitude and direction. A one-standard-deviation negative oil supply shock leads to an immediate reduction in oil production of up to 15.0%. This large initial negative effect approximately halves during the next months until it stabilizes around -10.0% after 10 months for the rest of the horizon of 24 months. There is some evidence that global real economic activity slightly increases in response to an oil production shortfall. For around 10 months this effect is partly marginally significant. This result contradicts the findings of previous studies which, if at all, find evidence for a temporary decrease in real economic activity. One possible reason for the difference in results is the longer sample period, including the recent crisis and post-crisis years, in this thesis. The observations at the end of this sample are characterized by relatively generous oil supply, whereas the world economy was in a recession with economically powerful countries like China slowing down in growth. Yet, it contradicts theoretical reasoning that lower oil production should lead to increased

Figure 5: Structural impulse responses to one-standard-deviation oil supply, aggregate demand and oil-specific demand shocks over a two-year horizon



Note: One- and two-standard-deviation confidence bands are constructed using a recursive-design wild bootstrap with 5,000 replications.

global economic activity, which makes it more plausible that the estimated relationship is due to the specific sample and that there is no impact at all, especially since the impulse responses are only marginally significant as well. The real price of oil increases by up to 3.0% relative to its mean following an oil supply disruption. The response is delayed for about 2 months and significant up to month 17. After about one and a half years, the positive effect on the oil price vanishes. This result is more significant and more persistent than the responses found in previous studies, which may again be due to the different sample period used in the investigation. The estimation in this thesis includes the year 2014 and the first half year of 2015, which are marked by a strong increase in oil production and a significant drop of the oil price. The increase in the supply of oil was mainly driven by the advent of hydraulic fracturing (or fracking) in oil production in the US. With this technology US oil companies boosted their production. Subsequently OPEC countries increased production as well in order not to lose market share. Moreover, political issues in the Arab region also led Saudi Arabia to produce more oil. These developments had a strong effect on the real oil price, which might explain why the impact of oil supply shocks on the price of oil found in this thesis is stronger than in previous studies using a shorter sample period. While theoretically this is the most plausible explanation for the difference in results between this thesis and earlier studies, the findings in Figures 2 and 3 provide no evidence for a recent surge in oil production and a significant cumulative effect of oil supply shocks on the oil price. However, the different sample and the slightly different model applied in this analysis may still be the major reasons for the discrepancy in the results.

Shocks to global real aggregate demand for all industrial commodities cause a marginally significant, positive cumulated percentage change in world crude oil production. Production of oil slowly starts rising 1 month after the shock and this production increase peaks with around +3.5% after 8 months. Then the cumulative effect of the shock slowly starts to decline and becomes insignificant after 14 months. This finding provides evidence for the view that oil producing countries do not fully accommodate the demand for oil but follow their own price and market-share goals when setting production volumes. Moreover, real economic activity immediately increases by more than 6.0 index points in case of a positive aggregate demand shock. The effect is largest after 1 month with nearly +8.0 index points, before it slowly declines until it becomes only marginally significant around one and a half years later. The impact of this type of oil shock on the price of oil is positive, significant and very persistent. Over a horizon of 24 months the effect of increased aggregate demand on the price of oil becomes larger and larger. The reason for this probably is that oil producers do not fully adjust production and, hence, oil demand rises faster than production, which raises the price.

Other oil demand shocks, like increased precautionary or speculative demand for oil, do not have an impact on world crude oil production. Most likely, this finding is the

result of aggregation bias, as Güntner (2014b) concluded from his empirical analysis that some months after a precautionary/speculative oil demand shock OPEC countries curtailed production, whereas non-OPEC producers expanded their oil production. In the short-run, oil production of neither of the two groups responded to this type of demand shock. Hence, although on average world crude oil production does not seem to react to an oil-market-specific demand shock, individual oil producers might indeed show a significant response. Surprisingly, oil-market-specific demand shocks have a short-run positive impact on real economic activity. A similar effect was found by Kilian (2009) and Güntner (2014a). This is difficult to explain, as one would assume that increased uncertainty about the future availability of oil would reduce economic activity. One can only speculate about the reasons for this finding. A possible explanation is that precautionary demand shocks are often associated with exogenous political events and especially with the outbreak of wars in the Middle East or terrorist attacks. The outbreak of a war can stimulate global economic activity when weapons and other military equipment are needed, which are often supplied to the fighting countries from abroad. Hence, when oil-producing countries prepare for a war or when Western nations plan to attack a country in the Middle East to fight terrorism, the global economy benefits from increased demand for steel, weapons, fighter jets and other equipment, while uncertainty about the availability of secured supplies of crude oil rises. As already mentioned, the effect of oil-specific demand shocks on the real price of oil is substantial and has the expected direction. At the time of the shock, the price of crude oil deviates from its mean by around +6.0% and after 2 months this effect peaks with +10.0%. Subsequently, the impact of the shock slowly dies out, fluctuating between +3.0% and +6.0% relative to the mean oil price, but remains highly statistically significant up to at least 24 months after the shock.

5.3.2 The Index of Consumer Sentiment

In the following the response of the Index of Consumer Sentiment to structural oil demand and supply shocks is analysed. This is a new result, which to the best of my knowledge has not been investigated so far. It should give an idea of how US consumers' expectations about current and future economic and personal financial conditions change in response to disruptions in the oil market. The impulse response function in the fourth row and first column of Figure 5 suggests that decreased crude oil production has a small, negative, but only marginally significant impact on consumer sentiment in the US during the second quarter after a shock. Therefore, reduced oil production does not worry consumers immediately but with a delay of a few months. A possible explanation is that in the short-run existing stocks of oil are depleted, so that consumers are not hurt by the production shortfall immediately. Another reason could be that consumers expect the reduced production of oil in one country, whatever reason it has, to be quickly

compensated by increased production elsewhere in the world and only start to worry in case this does not happen. Yet, as this negative effect is only marginally significant and vanishes after three months, the perceived adverse effects on consumers seem to be eliminated soon, e.g. because indeed the production shortfall is compensated by other oil producing countries. 17 to 19 months after the shock the negative effect becomes marginally significant again, although there is no sound economic explanation for that.

The estimated response of consumer sentiment to a positive aggregate demand shock is quite interesting and also a bit surprising. At the time of the shock and then again 3 months after the shock consumers are more optimistic about economic and business conditions. However, this effect is very temporary and completely vanishes 5 months after the shock. Subsequently, consumer sentiment declines by up to 1.5 index points and three quarters after the shock this effect becomes more and more statistically significant. Hence, after a positive impulse to the world economy and initial optimism, consumers in the US seem to expect a reversal of the positive trend and become more pessimistic about the future. A similar pattern has been found for the response of US cumulative real stock returns to a positive aggregate demand shock (compare e.g., Güntner, 2014a; Kilian and Park, 2009). US real stock returns also rise initially due to the booming economy, whereas the effect turns negative a few months after the shock. This subsequent decline in stock market returns might of course also influence the Index of Consumer Sentiment and could be one reason for its observed decline three quarters after a positive aggregate demand shock. Another reason might be the usual business cycle, which suggests that economic booms are followed by downturns more or less quickly. This is also what one can observe in the more recent economic history, where crises like the Global Financial Crisis and the Dotcom Crisis could be observed. Households may anticipate the end of the boom and start of the recessionary phase after some months. Moreover, increased inflation during economic upswings, which decreases real incomes, might also be a reason for the response of consumer sentiment. In a booming economy inflation rises and nominal incomes may not adjust accordingly, which worsens the households' income situation. Thus, consumers expect that the upswing might soon be reversed or even experience the downturn already, which is also suggested by the effect on the Index of Consumer Sentiment becoming more and more negative, peaking at nearly -1.5 index points approximately one and a half years later. Finally, a continually rising oil price due to increased global demand for raw materials might further contribute to the fall in consumer sentiment in the longer-run.

The impact of an oil-specific demand shock on consumer sentiment in the US is as predicted. It has an immediate and persistent negative influence on consumer sentiment. The effect is largest in the first 4 months, where it reaches up to -1.0 points. After that it becomes less negative and also less significant, but remains mostly marginally significant for the rest of the horizon of two years. Therefore, if consumers fear future supply

shortfalls of crude oil, they become more pessimistic about future economic conditions.

The results in this subchapter confirm *Hypothesis 1* that the Index of Consumer Sentiment responds differently to oil price shocks depending on the underlying cause of the shock. Without further analysis, we can only conjecture the underlying reasons for the behaviour of the structural impulse response functions. Hence, the possible explanations given above are only suggestions. In the next subchapter, the responses of the five subindices of the Index of Consumer Sentiment as well as of five other sentiment indices constructed from more detailed survey questions to the same shocks are evaluated, from which we gain additional insights into the question of how and why consumers react to oil demand and supply shocks.

5.4 Transmission Channels of Oil Demand and Supply Shocks to Consumer Sentiment

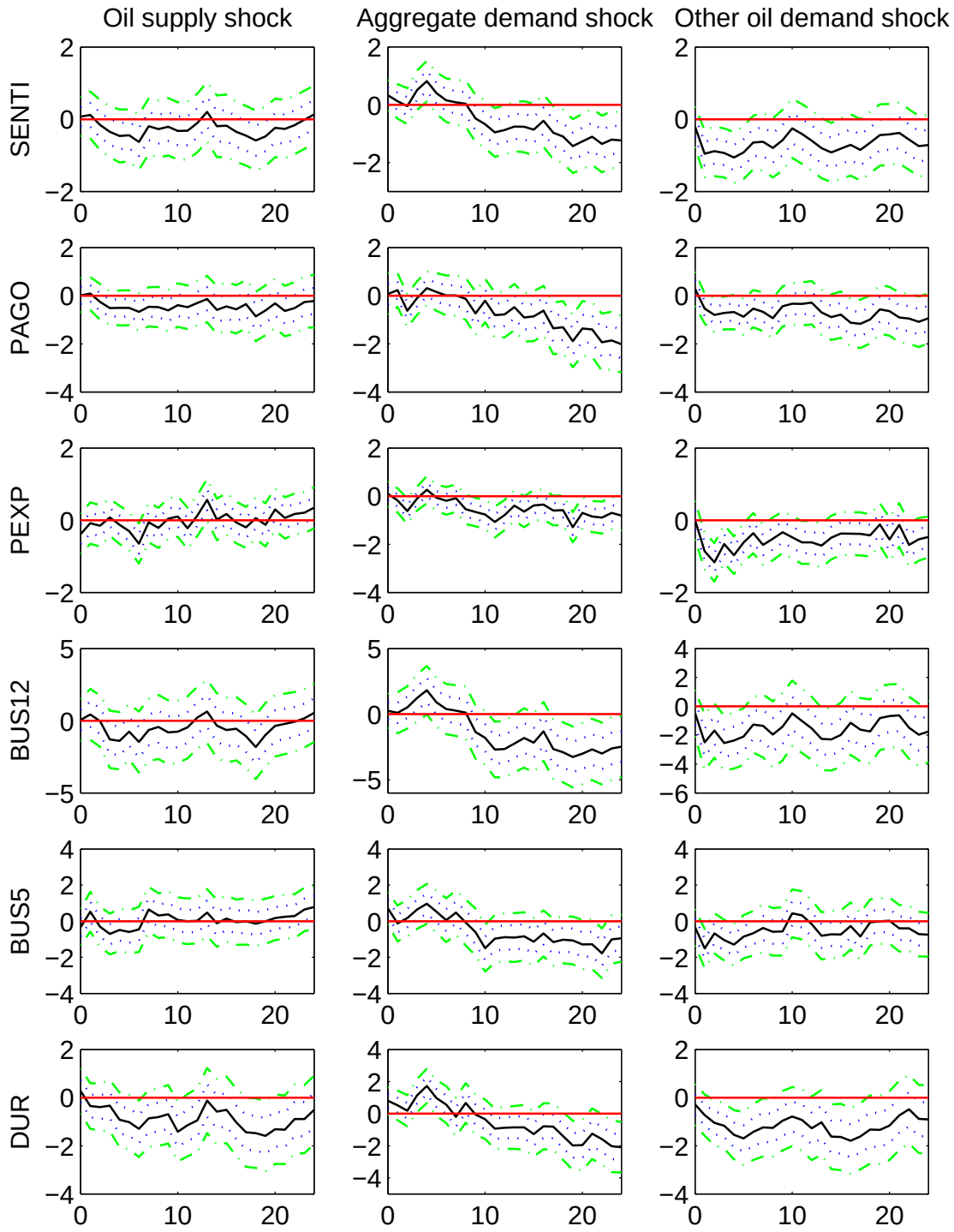
5.4.1 Current and Expected Personal Financial and Economic Conditions

In order to be able to identify the transmission channels of oil demand and supply shocks to consumer sentiment, the reduced-form VAR model in equation (2) is estimated repeatedly, each time replacing $senti_t$ in the vector $\mathbf{z_t}$ by one of the five subindices of the Index of Consumer Sentiment, $pago_t$ (evaluation of current personal finances), $pexp_t$ (expectations about future personal finances), $bus12_t$ (expectations about business conditions in the next 12 months), $bus5_t$ (expectations about business conditions in the next 5 years) and dur_t (evaluation of buying conditions for major household durables).[10] In a further step, the structural impulse response functions of the five subindices to the three oil demand and supply shocks are calculated and compared to those of the overall Index of Consumer Sentiment. The results are given in Figure 6.

Oil supply shocks do not have a significant effect on the Index of Consumer Sentiment, except for a very small, marginally significant negative effect 4 to 6 months after the shock. From Figure 6 it can be seen that this result is mainly driven by the responses of the indices $pago_t$ and dur_t. After 3 months, there is a statistically significant decline in the index $pago_t$ of about half an index point up to month 9 and then again for some individual months after that. Further, with a delay of 4 months the index dur_t decreases by around 0.7 to 1.5 points for up to 12 months after the shock. From month 16 to 23 this effect still has the same magnitude and becomes marginally statistically significant again. A similar but much less significant response is shown by the subindex $bus12_t$. The sentiment indices $pexp_t$ and $bus5_t$ are not affected by oil supply shocks. Hence, two main transmission channels of oil supply shocks to the Index of Consumer Sentiment are that US consumers feel it is not a good time to buy major household

[10] For an exact definition of the indices see chapter 3.

Figure 6: Structural impulse responses of the Index of Consumer Sentiment and its five subindices to one-standard-deviation oil supply, aggregate demand and oil-specific demand shocks over a two-year horizon



Note: One- and two-standard-deviation confidence bands are constructed using a recursive-design wild bootstrap with 5,000 replications.

items like refrigerators or furniture and that they feel worse off financially than a year ago if oil supply falls. Both effects are delayed by about 3 to 4 months. Possible reasons for this have already been discussed when interpreting the response of the Index of Consumer Sentiment: Consumers either expect production shortfalls to be compensated soon and/or trust that there are sufficiently large stocks of oil that can be depleted. The observed impact on the two subindices is probably caused by the rise in the price of oil after a negative oil supply shock. When the supply of oil falls, the price of crude oil increases and US consumers feel worse off financially and have less money available to undertake major purchases for their homes. This is then also reflected in a declining Index of Consumer Sentiment, indicating increased pessimism amongst consumers. On the contrary, expectations about future financial and business conditions, personally as well as in the country as a whole, are hardly affected.

With respect to aggregate demand shocks, all five subindices more or less closely mimic the path of the Index of Consumer Sentiment after a positive impulse to the global economy. The $bus12_t$ index shows the most significant response to an aggregate demand shock. 3 to 4 months after the shock, this index rises by up to 1.8 index points. Thus, the initial effect of a world aggregate demand shock on this subindex is even larger than it is on the overall sentiment index. Then the effect turns negative, as it is also the case for the Index of Consumer Sentiment, and is significant from month 9 to the end of the investigated horizon of 24 months. Again, the magnitude is much larger, the index decreases by up to 3.3 points. The $bus5_t$ variable behaves similarly, but the observed response is less significant and of the magnitude of the response of the Index of Consumer Sentiment. Therefore, in contrast to oil supply shocks, aggregate demand shocks affect consumers' expectations about future economic conditions. More precisely, around 9 to 10 months after a positive impulse to the economy consumers expect a reversal of the trend, which is again consistent with the response of US real stock returns to an aggregate demand shock (Güntner, 2014a; Kilian and Park, 2009). The observed positive response of the Index of Consumer Sentiment in the first months following an aggregate demand shock is further caused by the index for buying major household items, dur_t, as this index increases by up to 1.7 index points for 5 months after the shock. This effect is partly highly statistically significant. Yet, also the response of this index becomes negative after 10 months with a magnitude of up to -2.0 points and marginal significance. There is hardly any initial response of the $pago_t$ index to an aggregate demand shock except for a small negative one in month 2. Around 9 months after the aggregate demand shock the impact on $pago_t$ becomes more and more negative and statistically significant. Hence, due to higher world aggregate demand consumers feel worse off financially compared to a year ago three quarters after the shock as well as, although with less statistical significance, 2 months after the boom. This finding is difficult to explain as one would expect consumers to feel better off if the world economy is stimulated. The reasons

may be diverse, as already discussed above. Consumers may suffer from rising inflation, soaring real estate prices and/or higher energy and commodity (especially oil) prices. Lastly, the response of the index $pexp_t$ to an aggregate demand shock is quite erratic. It basically follows the same path as the index $pago_t$ but the fluctuations of the impulse response function are much larger. In the second month after an increase in world aggregate demand the index drops by about 0.6 points and after month 8 it falls by up to 1.3 points, an effect that is partly highly statistically significant. To summarize, about three quarters after a positive aggregate demand shock and modest initial optimism, consumers feel worse off financially than a year ago, do not dare so much to make large purchases and they are pessimistic about their own and their country's economic future. The rise in the Index of Consumer Sentiment in the first months is driven by increased optimism about future business conditions in the country as a whole as well as about durables buying conditions. Interestingly, households in the US do not expect their personal finances to be influenced positively by a favourable aggregate demand shock. These results, however, do not give much additional insight into the question why in fact pessimism amongst consumers rises some months after the shock. The results in Figure 6 do not offer specific causes but only indicate that feelings about the current situation as well as expectations of consumers are affected. In the next subsection, where consumer responses to more specific survey questions, e.g. about unemployment and inflation expectations, are analysed, some explanations may be found.

Finally, the response of the five subindices to other oil demand shocks, like precautionary or speculative oil shocks, is discussed. The overall Index of Consumer Sentiment declines permanently due to a shock specific to the oil market. For most horizons the effect is at least marginally significant and has a magnitude of between -0.5 and -1.0 index points. The index $pago_t$, an indication for how consumers evaluate their financial condition compared to a year ago, responds in the same way and with a similar magnitude, however, the effect is less statistically significant. Moreover, the index dur_t, an index for how consumers evaluate current buying conditions for large household goods, follows a similar path in response to this type of oil price shock. 1 month after the shock the index starts declining by up to 1.8 points and this effect is significant for almost 24 months. Expectations about future personal financial conditions ($pexp_t$) become more gloomy after an oil-specific demand shock. The $pexp_t$ index falls by up to 1.2 points for around one and a half years after the shock. In contrast, the drop of the indices reflecting short-run and long-run expectations about business conditions in the whole country, $bus12_t$ as well as $bus5_t$, is less statistically significant. Short-run expectations ($bus12_t$) decrease by up to 3.5 index points, which is very large compared to the response of the other indices, yet, the effect is insignificant for some months. The fall of the index for long-run expectations about future business conditions ($bus5_t$) is smaller and only significant for the first half year after an oil-specific demand shock. To sum up these

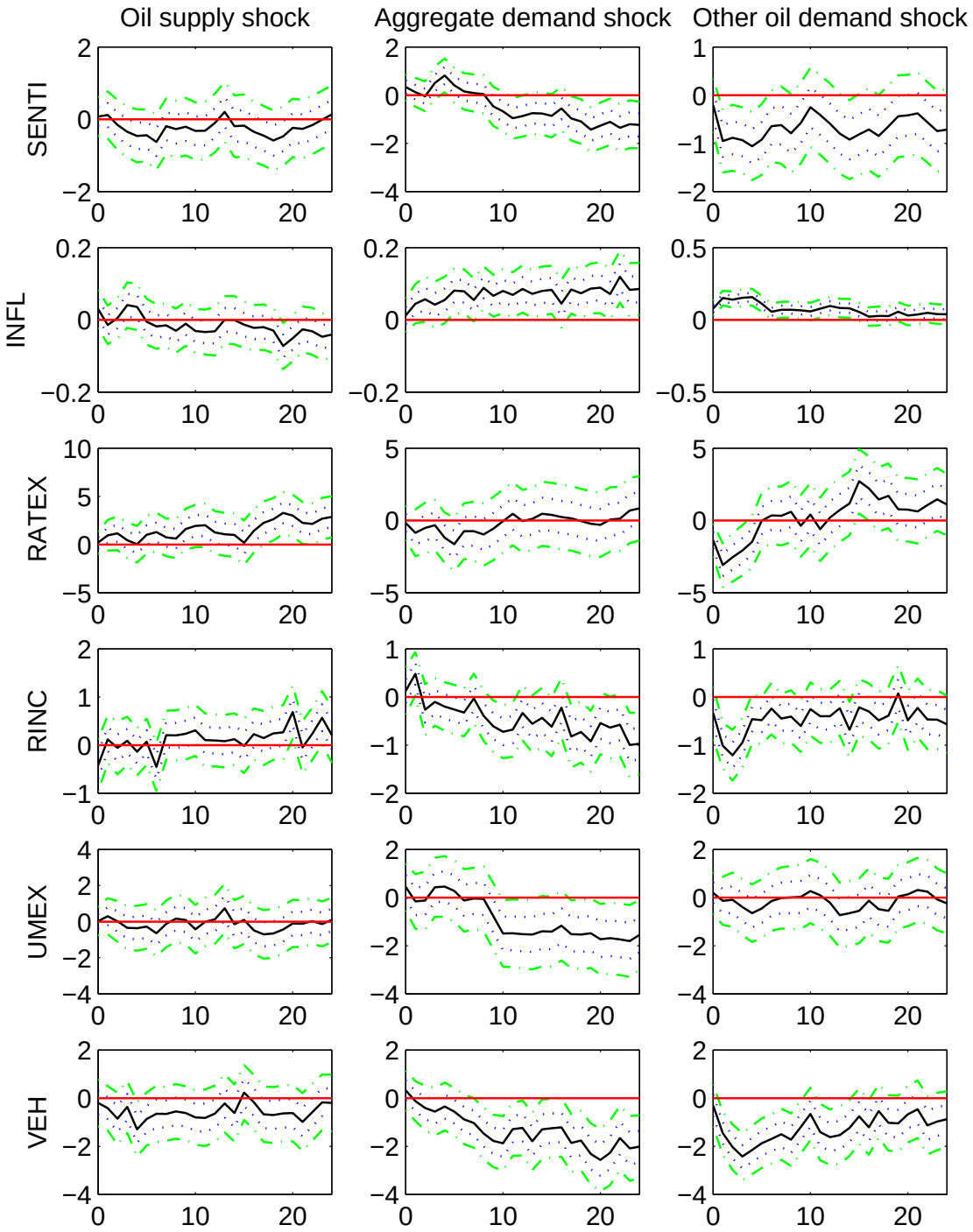
results, one can say that oil-market-specific demand shocks cause increased pessimism about current personal financial conditions amongst US consumers as well as about the suitability to spend a lot of money on major purchases, the reason of which probably being the substantial rise in the oil price, raising the price of gasoline and energy for consumers. Increased uncertainty about political conditions, terrorism and wars with a US involvement may also play a role. But also expectations about future personal and economic conditions become less optimistic. In the first months after a shock, consumers even expect a worsening of business conditions for up to five years. After some time, however, only a short-run depression of economic and business conditions in the US is expected.

From the results in Figure 6 one realizes that oil supply shocks mainly influence the Index of Consumer Sentiment through making US consumers feel worse about the current personal financial and business situation, whereas aggregate demand and oil-market specific demand shocks impact negatively on current feelings as well as on future expectations of households in the US. As already mentioned, these results give little insight into the underlying reasons for the observed responses of consumers. Hence, in the next subsection the expectations of consumers concerning macroeconomic variables like inflation, interest rates, real income, unemployment and vehicle purchasing conditions are analysed.

5.4.2 Expectations about Macroeconomic Variables and Vehicle Buying Conditions

The Surveys of Consumers by the University of Michigan contains around 50 questions. Besides the five quite broadly-formulated questions forming the Index of Consumer Sentiment, also various more detailed questions concerning inflation and unemployment expectations, gasoline price expectations, buying conditions for cars and houses, etc. are asked. For each of these questions again an index is formed or, in case of inflation expectations, the median expected inflation rate is calculated. Investigating the response of these indices to structural oil demand and supply shocks may be helpful for identifying the underlying reasons for the estimated effects on the Index of Consumer Sentiment and its subindices. While investigating all 50 indices constructed from the survey is beyond the scope of this thesis, five very important areas are selected and discussed in greater detail. These are expectations about inflation ($infl_t$), interest rates ($ratex_t$), real income ($rinc_t$), unemployment ($umex_t$) as well as about vehicle buying conditions (veh_t). The exact formulation of the survey questions is stated in chapter 3. Figure 7 presents the estimated structural IRFs for these five indices compared to the response of the Index of Consumer Sentiment ($senti_t$). The results have been obtained in the same way as explained in the previous subsection for the five subindices.

Figure 7: Structural impulse responses of the Index of Consumer Sentiment and five other more detailed sentiment indices to one-standard-deviation oil supply, aggregate demand and oil-specific demand shocks over a two-year horizon



Note: One- and two-standard-deviation confidence bands are constructed using a recursive-design wild bootstrap with 5,000 replications.

First, again the results for oil supply shocks are discussed. Whereas a supply shock causes only a small, temporary and marginally significant decline in overall consumer sentiment in the second quarter after a shock, there is a larger impact of this type of shock on some of the more detailed indices. Like the overall index, expectations about inflation ($infl_t$) are hardly affected. The point estimate of the median expected inflation rate rises a little bit on impact as well as in months 3 and 4. Afterwards the movement is irregular and points to a decrease in expected inflation in the long-run. Also the index for interest rate expectations ($ratex_t$) moves quite irregularly in the first months after a shock, indicating that people expect declining interest rates but only with, if at all, marginal significance. Yet, after month 16 the index rises by up to 3.3 index points per month and this effect is even highly statistically significant. Therefore, oil supply shocks lead consumers to expect lower interest rates for the future. This result is consistent with the view that oil supply shocks lead consumers to expect a contraction in demand, which is evident from the responses of the durables and vehicle buying condition indices (dur_t and veh_t) to an oil supply shock, as well as a subsequent expansion of monetary policy in order to counteract the fall in demand. Consumers' beliefs about their real household income ($rinc_t$) do not change considerably. There is a small drop in the index $rinc_t$ immediately after the shock and then again half a year later, probably due to the rising oil price. People's expectations about vehicle buying conditions (veh_t) are negatively affected by a decrease in oil production, but the magnitude of the effect is much lower than for oil demand shocks. From month 2 on, the index falls by up to 1.3 points, but this decline remains only marginally significant for 12 months. Expected unemployment ($umex_t$) is not affected by oil supply shocks. Hence, when looking at these five indices, the small drop in the Index of Consumer Sentiment after an oil supply shock seems to be mainly caused by the perception that due to the shock it is not a good time to buy a car. Although the index for interest rate expectations is significantly affected by oil supply shocks in the longer run, this is not reflected in the overall Index of Consumer Sentiment.

The impact of aggregate demand shocks on the investigated indices is, with the exception of interest rate expectations ($ratex_t$), quite substantial and mostly statistically significant. 1 month after an aggregate demand shock people expect prices in the US to rise by an additional 0.05% to 0.12% over the next year due to the shock. This effect is highly statistically significant and very persistent. Moreover, 4 to 5 months after the shock consumers in the US expect interest rates to go up. However, from month 6 on this effect becomes statistically insignificant. Despite higher expected inflation and the tendency to expect rising interest rates, the Index of Consumer Sentiment responds positively to an aggregate demand shock within the first months, since no major drops in employment or real income are expected and also there are no reservations against purchasing a vehicle. Hence, in the first months after a positive impulse to the economy

the expected improvement in future business conditions and buying conditions for major household durables dominates the negative influence from rising expected inflation and oil prices. Yet, as the IRFs of the indices for short-run and long-run expectations about business conditions ($bus12_t$ and $bus5_t$) in the previous subchapter indicate, 9 months after an aggregate demand shock this positive effect is reversed and consumers become increasingly pessimistic about general business conditions, which is also reflected in the Index of Consumer Sentiment ($senti_t$). The reason is a sudden and large increase in expected unemployment ($umex_t$) after 8 months. In the first three quarters the aggregate demand shock does not change expectations about unemployment, but after this period consumers suddenly expect employment opportunities to deteriorate and the index falls by about 1.5 to 1.8 index points (meaning that an increasing number of consumers answered that they think that there will be more unemployment over the next year). Furthermore, real household income ($rinc_t$) is expected to decrease. Whereas in the first months the anticipated negative development of real income is very imprecisely measured, after month 8 it becomes statistically significant. This is consistent with the persistent rise of the price of oil and expected inflation. In addition, perceived buying conditions for vehicles (veh_t) deteriorate due to an aggregate demand shock and after 20 months a low point with a drop of the index by 2.6 points is reached. At the same time, expected inflation fluctuates within a constant band over the whole two-year horizon, so no major sudden increases in inflation expectations further contribute to the drop in consumer sentiment. To summarize, whereas initially the boom in the world economy leads to increased optimism, around 9 months after an aggregate demand shock rising expected inflation, expectations about a surge in unemployment, a perceived worsening of vehicle buying conditions due to a high oil price and decreasing real income cause a drop in consumer sentiment in the US. Thus, the observed pessimism might indeed be explained with consumers expecting an economic downturn after a boom phase, which might be reinforced by declining stock market returns some months after an aggregate demand shock (compare Güntner, 2014a; Kilian and Park, 2009).

When looking at the response of the indices to other oil demand shocks, it becomes obvious that this type of shock does not change expectations about unemployment amongst US consumers ($umex_t$). This result is not too surprising as other oil demand shocks mainly represent wars and political unrest in oil producing countries in the Middle East or terrorist attacks. These events are quite unlikely to disturb the job market in the US. On the contrary, real income is expected to drop on impact: The index for real income expectations ($rinc_t$) drops immediately by up to 1.2 points after two months and although the magnitude decreases in the following months, for most of the two-year horizon the effect remains at least marginally significant. Partly this may be caused by the immediate jump in inflation expectations ($infl_t$) to up to 0.15%, which is reversed to about half its size approximately at the same time when also the negative response

of the real income index loses in magnitude. But also the soaring oil price after an oil-market-specific demand shock probably contributes to the drop in real income expectations. In addition, after an other oil demand shock people immediately feel that it is not a good time to buy a car (veh_t). The corresponding index drops by up to 2.4 index points in month 3 and remains negative and (marginally) statistically significant for two years. These three developments seem to be the major reasons for the observed persistent drop in the Index of Consumer Sentiment after an oil-market-specific demand shock. In the first 4 months after the shock also higher expected interest rates ($ratex_t$) contribute to the drop in consumer sentiment. The corresponding index falls by up to 3.0 points 1 month after the shock. After 4 months, however, the effect becomes insignificant and in the long run consumers expect interest rates to fall again. This finding may be driven by the expected monetary policy response to an other oil demand shock. Due to the immediate jump in the oil price and in expected inflation consumers might expect tighter monetary policy to dampen inflation. In the longer run, however, policy makers might switch to a more expansionary monetary policy to stimulate the economy after a period of high oil prices. To summarize it can be noted that a bad outlook for vehicle purchasing, the fear of losing household income due to inflation and high oil prices as well as a perceived rise in future interest rates are the main reasons for the negative impact of oil-specific demand shocks on the Index of Consumer Sentiment.

The analysis of these five additional indices considerably contributes to a better understanding of the response of the Index of Consumer Sentiment to the three identified oil demand and supply shocks. The results show that these shocks affect not only the Index of Consumer Sentiment in different ways, but indeed also consumer expectations about the development of various economic variables and conditions. This confirms *Hypotheses 2* that the transmission channels of oil demand and supply shocks to consumer sentiment differ depending on the nature of the underlying shock. Hence, as Kilian (2009) stated: Not all oil price shocks are alike; and also consumers see it like that.

5.5 Comparison of Results

As already mentioned, Edelstein and Kilian (2007, 2009) compute impulse response functions for the Index of Consumer Sentiment as well as for other consumer expectation indices to one standard-deviation purchasing power shocks arising due to a change in energy prices. In this subchapter the results of these two authors are briefly compared to the findings of this thesis. Even though the results cannot be compared directly as they apply a bivariate SVAR model, identifying shocks to the consumers' purchasing power due to changes in the price of various energy goods rather than oil price shocks, with a lag length of 18 months, a comparison might yield insights into how stable the results are. When first looking at the response of the overall Index of Consumer Sentiment in

Edelstein and Kilian (2007, 2009), it drops on impact by up to 1.6 index points and the effect remains negative and statistically significant for 18 months. This pattern looks similar to the estimated response of the Index of Consumer Sentiment to an oil-market-specific demand shock. In general it can be concluded that the IRFs of Edelstein and Kilian (2007, 2009) are best comparable to the IRFs for the oil-market-specific demand shock in this thesis.

This is also true for the index of the expected change in one's personal financial situation ($pexp_t$) and for the index of the expected change in business conditions ($bus12_t$). However, a significant immediate drop of the two indices as observed by the two authors was not found in this thesis, where both indices respond with a lag of at least 1 month. Moreover, the negative effect for the $bus12_t$ index is more persistent than in Edelstein and Kilian (2007, 2009). For the durables consumption index (dur_t) both the consequences of oil-supply shocks and other oil demand shocks are similar in magnitude as well as in direction to the estimated effects of energy-price-related purchasing power shocks. Whereas the responses of the indices of expected vehicle buying conditions (veh_t) and real income expectations ($rinc_t$) to purchasing power shocks are again somehow comparable to the IRFs for oil-specific demand shocks, the estimated structural impulse responses for expected unemployment ($umex_t$) and expected interest rate changes ($ratex_t$) do not coincide. Edelstein and Kilian (2007, 2009) did not find an effect of purchasing power shocks caused by higher energy prices on expected interest rates, whereas in this thesis evidence for a relationship between consumers' interest rate expectations and oil supply as well as other oil demand shocks was shown. One reason could be that a shock to purchasing power is not considered by consumers to change interest rates in the market, while rising uncertainty about future oil supply and demand conditions or actual physical supply disruptions may indeed be perceived to also disturb financial markets. With regard to unemployment expectations, Edelstein and Kilian (2007, 2009) estimated a rather large negative response of the index in the first months after the shock which remains at least marginally significant for 18 months. In this thesis no initial pessimism about future unemployment could be detected. Only aggregate demand shocks had an effect on unemployment expectations which, however, became significant only after around 9 months.

Additionally, whereas the IRFs of Edelstein and Kilian seem to be quite "smooth" (meaning that there are no large fluctuations from month to month), the respective IRFs estimated in this thesis show quite a lot of ups and downs. The initial rise in some of the consumer sentiment indices after aggregate demand shocks is not represented in any of the IRFs of Edelstein and Kilian (2007, 2009), since they only measure the effects of purchasing power changes due to higher prices for energy goods and do not consider possible positive effects on a household's budget because of higher aggregate demand. Yet, one very important aspect of the results of Edelstein and Kilian (2007, 2009) and

the results of this thesis is comparable, and this is the magnitude of the estimated impulse responses. The size of the estimated effects of energy-related purchasing power as well as of oil demand and supply shocks on the Index of Consumer Sentiment and its disaggregates is similar, which at least partly confirms the plausibility of the estimated IRFs in this thesis. As the IRFs in Figures 5 to 7 show, the estimated effects are rather small when compared to the mean values of the various indices (compare Table 1). But as Edelstein and Kilian (2007, 2009) note in their studies, repeated shocks will add up over time and will generate substantial responses of consumer sentiment to oil/energy price changes. To sum up, a comparison of my results with those of Edelstein and Kilian (2007, 2009) shows that the estimated responses of consumer sentiment in this thesis are quite plausible with respect to both magnitude and direction.

5.6 Possible Limitations of the Empirical Analysis

In this subchapter two possible limitations of the empirical analysis undertaken in this thesis are discussed. Firstly, in the existing literature the possibility of asymmetric responses of economic variables to positive and negative oil price shocks has been discussed. If asymmetries are indeed present, a VAR model, which imposes symmetry on the effects of oil price increases and decreases, does not correctly analyse the effects of oil price shocks. However, there is no consensus in the literature on this issue. On the one hand, Hamilton (2003) and Cuñado and Pérez De Gracia (2003) provided evidence for asymmetric responses of GDP and industrial production indices to oil price shocks in various countries. Both studies found that oil price increases have significant negative effects while a decline in the oil price is far less important or has no effect. Baghestani (2016) came to the same conclusion when investigating the effect of gasoline price changes on the Index of Consumer Expectations in the US. On the other hand, Edelstein and Kilian (2007) found no evidence for asymmetries in the response of consumption aggregates and consumer expectations to energy-price-related purchasing power changes. Additionally, a quite recent study by Kilian and Vigfusson (2011) challenges the previous findings of asymmetries in the relationship between energy price shocks and US GDP. This discussion shows that an asymmetric response of the Index of Consumer Sentiment and its disaggregates to oil price shocks is possible. However, as Edelstein and Kilian (2007) tested a very similar hypothesis for various subindices of the Index of Consumer Sentiment as well as for other sentiment indices and did not find evidence for asymmetries, I follow their results and use an SVAR model, which imposes symmetry, in the empirical analysis of this thesis. How one can test for asymmetric effects is not further discussed at this point, the interested reader is referred to the quoted references.

Secondly, the SVAR model employed in this thesis does not allow the estimated coefficients to change over time. Many researchers have suggested that the relationship

between the oil price and the macroeconomy has become much weaker over time. For example, Hooker (1996) found robust evidence that after 1973 the oil price no longer Granger-caused certain economic variables in the US. However, he was not able to confirm his three possible explanations for this break. He neither found support for an asymmetric response of the macroeconomy to oil price increases and decreases, nor for a structural break in the data or that the oil price has become endogenous. Also Edelstein and Kilian (2007, 2009) investigated this question. They split their sample into the two periods 1970:2-1987:12 and 1988:1-2006:7 and estimated the same SVAR model for various US consumption aggregates for both shorter samples. They found a significant reduction of the effect of purchasing power shocks due to higher prices for energy goods on different consumption aggregates in the US, e.g. for total consumption from -0.46% in the first half to -0.12% in the second half of the sample. They mainly explained their findings with a change in the structure of the US automobile market, switching from producing only large and inefficient cars to also offering smaller cars that consume less energy, which made the automobile industry and consequently also the US economy less vulnerable to energy price shocks. A very recent paper by Kang et al. (2015) used Bayesian estimation of a time-varying structural VAR model to determine whether the response of US stock markets to structural oil shocks changed over time. They found that the coefficients as well as the variance-covariance matrix vary with time. Especially, the coefficients of aggregate demand shocks and other oil demand shocks in the stock return equation have been lower since the 1990s. Blanchard and Riggi (2013) investigated three possible explanations for the declining effect of the oil price on the US macroeconomy, for all of which they found evidence. They argued that the observed change is due to the decreasing importance of oil in production and consumption, the lower rigidity of real wages as well as better monetary policy. Hence, the literature shows that the relationship between macroeconomic variables and the oil price altered over time, which could also be the case for the relation between US consumer sentiment and the oil price. This could quite easily be tested by following Edelstein and Kilian (2007, 2009) in splitting the sample and repeating the same estimation for both shorter samples.

6 Summary and Conclusions

The majority of the scientific studies dealing with the effect of oil price shocks on economic variables concentrates on investigating the response of variables like GDP, inflation and industrial production. Although private households are directly affected by an increase in the price of crude oil as well, a comparatively small share of the literature analyses how consumer behaviour changes in response to a major shift in the oil price. This is a major shortcoming when considering the fact that consumption accounts for a large part of US GDP and that oil price shocks mainly transmit to the economy through

the demand channel. The aim of this thesis is thus to fill a major gap in the oil price literature, namely to answer the question of how the feelings and expectations of US households, expressed by the Index of Consumer Sentiment, react to oil supply shocks, aggregate demand shocks and oil-market-specific demand shocks.

The results of this thesis show that shocks to the price of crude oil significantly affect consumers' expectations about future economic and business conditions in the US as well as their feelings about their financial situation and buying conditions. As was expected from the findings of the existing literature, the path of consumer sentiment after an oil price shock as well as the magnitude of the effect significantly depends on the underlying cause of the shock. Whereas shocks to the physical supply of crude oil only have a very limited perceived impact on US households, both aggregate demand shocks as well as oil-market-specific demand shocks that raise the oil price make consumers feel more pessimistic about their personal and their country's economic future. Most likely, the reason for the minor importance of oil supply changes is that they are perceived by consumers to be only temporary, as production shortfalls in one country are likely to be compensated by other oil producers. On the contrary, precautionary or speculative oil demand shocks are expected to be longer-lasting, which arouses scepticism amongst consumers whether current economic standards can be met in the future if the oil price remains high or increases even further due to these shocks. My findings for the effects of aggregate demand shocks are more difficult to interpret as two counteracting effects are at work. On the one hand, higher world aggregate demand raises the price of oil and other commodities, which hurts consumers. On the other hand, consumers might benefit from higher global demand for all industrial commodities as job opportunities and income might improve. However, the estimated IRFs show that the perceived positive impulse of higher aggregate demand is very short-lived and rather small. In the long run consumer sentiment declines after a positive aggregate demand shock due to higher inflation and commodity prices, especially a higher oil price, and because consumers expect a subsequent economic downturn.

Additional insights into the specific reasons for what makes consumers feel worse off are gained by an analysis of various disaggregates of the Index of Consumer Sentiment, e.g. regarding unemployment and inflation expectations or expectations about conditions for buying vehicles. Oil supply shocks neither significantly affect expectations about future personal financial conditions nor expectations about general business conditions in the future, whereas other oil demand shocks impact on short-term (1-year-ahead) expectations and aggregate demand shocks even influence 5-year-ahead evaluations of business conditions by US consumers. Opinions about vehicle purchasing conditions and buying conditions for major household durables are significantly affected by all three kinds of shocks and, hence, are major drivers of the response of the overall Index of Consumer Sentiment. The response of the overall consumer sentiment index to aggregate demand

shocks seems to be further determined by inflation, real income and unemployment expectations, whereas unemployment expectations are not affected by oil supply and other oil demand shocks. From these results one realizes that different oil shocks do not only have different effects on the Index of Consumer Sentiment, but that their transmission channels differ, as well.

What can be concluded from these findings? Firstly, the empirical estimations confirm that the effect of repeated oil price shocks on consumers in the US is quite sizeable and should not be neglected by decision makers trying to limit the economic consequences of oil price fluctuations. Even though the effect on consumer sentiment and not on actual consumption expenditures is estimated, this might nonetheless give important insights into how consumer spending will evolve in the two years after a shock, as sentiment is an important predictor of expenditures. Consumption expenditures make up a large part of GDP and rising uncertainty and pessimism amongst consumers in the US, leading to lower spending, might therefore severely hurt the US economy and amplify the direct negative effects high oil prices have on firms and asset markets. Pessimistic consumers do not only spend less, but also firms curtail investment if they are uncertain about future demand for their goods and services. The results of this thesis demonstrate that oil supply and demand shocks indeed have the power to make consumers in the US feel worse off. Hence, if policy makers want to limit the adverse economic consequences of oil price shocks, one possibility is to use policies aimed at stimulating consumer confidence.

7 References

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