China´s Impact on the Price of Oil:
An analysis in consideration of the New Normals

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Biographical Introduction

Charlotte Hoefner was born and raised in Germany. At the age of 16 she moved to Toronto, Canada, to attend the all-girls high school Branksome Hall. Over the two-year stay in the boarding school, she was the solely recipient of the school´s scholarship for academic excellence. In 2010, Charlotte graduated with High Honors in higher levels Mathematics, History and English. She proceeded her studies in Economics at the Free University of Berlin. During her studies, she concentrated on quantitative methods, which she later applied in her Bachelor thesis on foreign exchange forecasting techniques. In 2013, she graduated from the re-known university which has been awarded with the excellence certification by the German government. After travelling through North America, she spent the first half of 2014 employed in an internship at the Corporate and Investment Bank Société Généralé in Frankfurt. The internship followed many professional experiences made during her academic studies, which concentrated on financial markets and included HSBC Trinkaus & Burkhardt in Düsseldorf (2010), Conpair AG in Essen (2011), Warburg & CO in Hamburg (2012) and Bayern LB´s ThyssenKrupp Office in Essen (2013).

Her positive experience and passion for the financial markets led her to start her Master in Finance at the University of Porto in 2014. During her stay in Portugal, she integrated quickly, while learning Portuguese and actively participating at the University´s student organization FEP Finance Club. She held the position of the Director of Financial Markets and was leading the External Relations Department from 2015 to 2016. Charlotte highly contributed to the involvement and recognition of the Finance Club, in which she led a team of more than 30 members. Her expected graduation will be in the summer of 2016, after which Charlotte is moving to London to start her professional career in the Commodities Team of Global Markets at BNP Paribas.

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Abstract

The qualitative research of this paper covers the most recent structural changes in the oil market and the Chinese economy. Its econometric analysis, based on a structural dynamic linear regression model, shows Chinese GDP growth rates, the Shanghai Stock Index and the CNY/USD exchange rate to have a significant impact on the monthly spot price of Brent Crude oil and improve the explanatory value of the base specification including US and China´s crude oil imports and the historic prices of Brent Crude for the time period of 2000 to 2015. A structural break of the model is found to be significant in December 2008. The consideration of the structural specific variables Chinese industrial production, urban investments and energy intensity enhance the explanatory value of the model for the sub-samples 2000-2008 and 2009-2015 further. Its consideration of time lags and critical consideration of data allows for the confirmation of the observed fundamental changes in the oil market and China´s economy, which are change in the price elasticity of demand and supply, the strategic reserves of crude oil in China and the plateau of oil demand growth for urban areas. The analysis further finds, that the consideration of geopolitical events as dummy variables is not significant in most cases. The analysis confirms the observation by some studies, that China´s imports have no significant impact on oil prices, but found other explanatory variables to be significant. This result stresses the importance of an economic analysis to allow for a careful consideration of data and the awareness of their limitations.

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0. Introduction

In 2008, the international oil markets were strongly affected by the financial crisis. As the world economy only slowly recovered, oil prices did not reach the same price levels as before the crisis. Instead, oil prices fell to less than 30 USD/Barrel in 2016. This development was highly and controversially discussed in the media and eventually academic researchers joined the discussion. The main focus was to determine whether the decrease in prices was supply or demand driven, similar to the prior discussion on the rise of oil from 2000 to 2008. But different to the previous decade, the supply side as well as the demand side had undergone fundamental changes. The additional shale oil resources have restricted the, once dominant, power of the Organization of the Petroleum Exporting Countries (OPEC) and undermined the notion of imminent oil resource scarcity. On the demand side, it has triggered China to become the most important market for crude oil imports. Meanwhile, the growing dependency of China in the past decade has increased the concerns by Chinese authorities on energy security. In response and supported by the recent slowdown of economic growth, Chinese authorities changed their economic strategy from quantitative to qualitative growth targets. The new policies concentrate on less energy dependency as well as social stability within the country. Concerns on sustainable economic growth is addressed, while the Communist party is concerned to remain its legitimacy for power.

Both developments have been described with the term "New Normal" as the changes are considered structural and permanent. Although, this opinion seems to be shared by market observers as well as academic researchers, little literature has captured this change. The hypothesis of changing regimes, resulting in structural breaks, has been extensively discussed, however, often concentrating on geopolitical events, financial speculation and the financial crisis of 2008. Little quantitative academic research can be found on the "New Normals" in the oil market and the Chinese economy, whereas numerous business reports and articles have covered the matter.

This study fills the gap in existing academic literature and concentrates its evaluation on the observed structural changes in the oil markets and China´s economy. It successfully uses a dynamic multiple linear regression model to support arguments in favour of a structural break in 2008. Further, by doing so, it enables to observe changes in the importance of fundamental variables driving the market. More than the majority of the observed results considering significance level of past Brent Crude oil prices, US and Chinese oil imports, Chinese GDP growth, CNY/USD exchange rates, Shanghai Stock Index level, urban investments, energy intensity levels and the industrial production index support the qualitative observations of changes in the international oil market and China´s economy specifically. It is found, that a detailed specification of the model, considering economical and structural changes in China, describes better the price changes of Brent Crude in the sub-sample periods of 2000 to 2008 and 2009 to 2015 than the base model, which only considers historic Brent crude prices and imports. The consideration of economic variables further enhances the explanatory value over the entire period in comparison to the base specification. Previous studies (Mu and Ye 2011) have neglected such an extensive analysis, and restricted their study on imports which showed to be non-significant. Therefore, this paper considerably adds to existing literature, as it critically assesses whether China´s imports are the best measurement of its impact on oil prices.

The most important conclusion of this research is therefore, more than the specific regression results, that a detailed analysis of the oil market and China leads to a better understanding of econometric results and inherent data limitations. This is of high importance as changing oil prices have a large impact on oil importing as well as oil exporting countries. A close relationship between economic growth and oil prices has been agreed on and, after all, recent deflationary pressure has also been attributed to low oil prices. The effects on economic performance by the oil price are therefore apparent and observable. A better understanding of the fundamentals, that are driving the oil prices, supports the finding of reasonable economic targets as well as effective economic and energy policies.

This paper will proceed by presenting the qualitative analysis of the changes in the international oil market and the Chinese economy. It is followed by an overview of academic literature on international oil prices, economic and oil price relationships and the China Factor. The review includes a discussion of econometric techniques. In the third chapter, the method and data of the research is presented. It is followed by a discussion of the results and the conclusion.

1. The Time of New Normal*s*

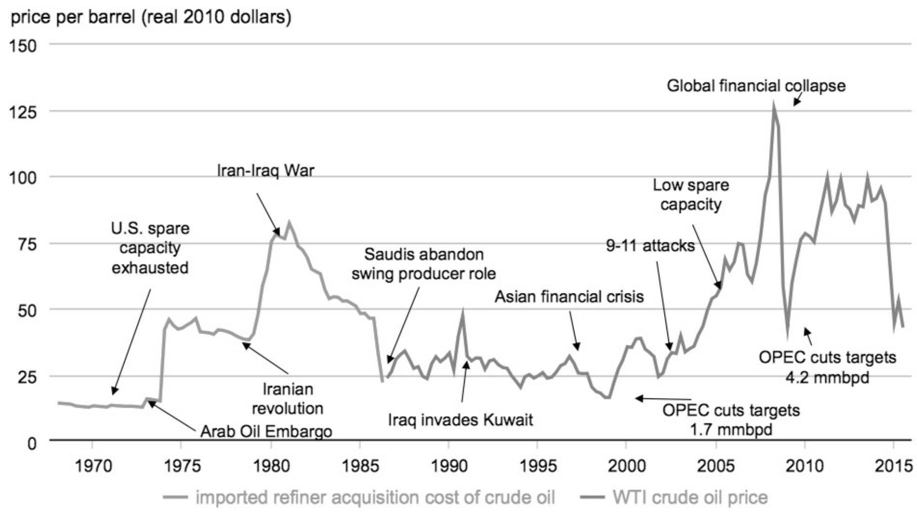
Since the financial crisis, important changes have taken place in the global oil market and in the Chinese economy. The shale oil revolution changed the dynamics of the international oil market. Meanwhile, China has targeted qualitative economic growth after economic growth rates were disappointing and concerns on the health of its economy were rising.

This chapter will provide the most important insights into the two markets. The changes observed in this context will argue in favour of new fundamentals driving the crude oil price. The analysis will provide a set of variables that are expected to contribute to the estimation of the impact on international oil prices by China´s oil demand and be used considered in the econometric analysis of this paper.

1.1. The New Normal in the Global Oil Markets – The Effects of the Shale Oil Revolution

The most recent decline in oil prices, starting in 2014, has caused many to reconsider the classical assumptions on the economics of oil. Today, it seems clear that the decline was caused by an unexpected increase in conventional oil (non-US production) and a decline in world economic growth (Badel and McGillicuddy 2015, Baumeister and Kilian 2015). The reason for why the market was not affected by prior decreases in conventional oil supply can be found in the shale oil revolution which started in 2009. The created additional shale oil output from the US did not disrupt the oil price and did not create a downward pressure on prices as it might be expected by economic theory, ceteris paribus. Instead, the additional output added to the stability of oil prices, as supply from traditional oil producers, such as Libya, was disrupted (Mănescu and Nuño 2015).

Figure 1: Crude Oil Price Evolution, 1970 - 2015



Source: Energy Information Administration (2015)

Figure 1 shows the evolution of the West Texas Intermediate (WTI) spot price and the acquisition cost of crude oil prior to 1986. Current oil price levels below 50 US-Dollar per Barrel (USD/barrel) are very low compared to the last decade, but oil prices have been at much lower levels in historical comparison (for examples prior to 2000 and prior to 1975).

The fast expansion of shale oil rigs in the US was supported by country specific advantages. After all, shale oil extraction is derived from shale gas extraction combining hydraulic fracturing with horizontal drilling. The procedure is, therefore, based on well-known principles and shale oil resources can be found numerously in other countries, with Russia holding the largest resources of shale oil reserves worldwide. But the US had the experience of extracting shale gas, legal incentives for landowners, including private ownership rights, existing infrastructure of pipelines that support the distribution of oil and easy access to global capital market funding (Mănescu and Nuño 2015). These advantages combined with high oil prices motivated the shale oil to take place in the US.

As a result, the US transformed from an oil importing country to a net oil exporting country and is expected to become energy self-sufficient by 2030. Whereas the shale oil rig count in the US has been rising until 2014, it began to decline once prices started to decrease in 2014. Even though break-even prices for shale oil extraction range from 30 USD/barrel to 100 USD/barrel, market observers estimate the average break even price to be at 50 USD/barrel (Rapier 2016). Once prices decreased in 2014, OPEC and especially Saudi Arabia was expected to cut production. However, they surprised markets when they did not do so and instead maintained production levels to force high-cost oil producers out of the market, including shale oil producers. The downward price trend continued and at the end of 2014 and a decline in US shale oil rigs was observed. Additional investments into the shale oil industry stayed absent causing maturing rigs not to be replaced. The short life-cycle of shale oil rigs contributed to this development. By 2016, the market observed a second development: debtor-in-possession financing allowed shale oil companies, who had filed for bankruptcy, to continue production and even invest in the productivity of existing rigs[1]. The strategy by shale oil producer was to stay in the market, until prices would increase again to the critical value of 50 USD/barrel (as they did in May 2016).

As soon as the critical price of 50 USD/barrel is reached, the market expects shale oil production to increase again[2]. This behaviour of shale oil producers defines them as swing producers and limits the price range of oil considerably (given constant demand). The previous market power of OPEC over oil price levels is hence restricted to levels below 50 USD/barrels and bears considerably high opportunity costs (Mănescu and Nuño 2015). Alternatively, the shale oil market could continue to evolve and enhance its technology to decrease production costs further, and become more competitive[3] at prices below 50 USD/barrel, further restricting OPECs market power.

The emergence of shale oil production has hence not only changed the role of the US in world oil markets, but also decreased the market power of OPEC. Furthermore, traditional theorems considering oil as a scarce resource and discussion on peak oil production have been muted to wide extent. Additionally, it is unlikely, that the market will evolve backwards, as shale reserves in China and Argentina are expected to be developed once the required infrastructure is developed. Therefore, the development can be considered of structural and sustainable nature, characterizing the shale oil revolution to have caused new market principles referred to new economics of oil.

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[1] See the articles by the market observers Rapier (2016) and Gopinath and Schneyer (2016) for a detailed discussion of the matter.

[2] Uncompleted wells, which are referred to as “fracklog”, can quickly start production within six months, requiring lower capital investments than conventional crude oil rivals.

[3] See also The Economist (2014b) and Crooks (2015)

1.2. China´s Economic Development – A Path towards Qualitative Growth

The shale oil revolution might have just occurred at the right time. Due to the extensive growth of China´s economy, China´s demand for energy and specifically oil increased in the short run (Yuan et al. 2008) and long run (Zou and Chau 2006). As China transformed from an oil net-exporter into a net-importer in 1993, it had to consider new sources for crude oil. Oil sources came primarily from trading partners in the Middle East and Africa[4], sometimes competing for resource with the US or undermining international embargoes set by the US (Shinn 2010). Zweig (2005) underlined the growing tension, caused by the competition for future oil reserves and international secure transportation of oil. Referring to the power transition theorem[5], if not carefully managed, such a challenge to the power of the US could have resulted in severe suffering of international relations. To a great extent, the shale oil revolution hence eased the tensions over future oil reserves.

China has experienced an average economic growth rate of 10% between 2000 and 2011. The growing industry was motorized by the country´s industrialization. The growth resulted in rising demand for commodities, including oil. Since 2014, GDP growth rates have been disappointing market expectations and have, therefore, been observed closely by market participants. For the first time in 2012, the Chinese economy did not meet its target growth rate, when industrial production and exports started to decrease. Until the end of 2015, quarterly year-on-year (yoy) growth had slowed down to 6.8% in the last quarter.

The slowdown in economic growth reflects different economic developments and has been interpreted as the consequence of past political market interventions. As much as they are currently discussed in media, they were observable already in the aftermath of the financial crisis. Morrison (2009) reasons uneven economic growth and a high dependency on foreign trade to have made China subject to the financial crisis in 2008 in the first place. The importance of exports had previously motivated Chinese authorities to peg the Chinese Yuan (CNY) against the US Dollar until 2006. Eventually, the peg was restored after the financial crisis and, although, the Chinese government stressed

[4] The international trade flows of commodities to China are illustrated in Appendix 1.
[5] The power transition theorem states, that if the power of a nation is challenged by another nation, the nation in power will undermine (declare war on) the increase of the power by the challenging nation as long as it has an advantage.

internationalization efforts, the Yuan was recently devaluated in May 2016. This is interpreted to hinder future development and to undermine past internationalization efforts, such as the addition of the CNY into the IMF reserve currencies basket[6].

The pressure on the CNY increases, as the Federal Reserve Bank is planning to loosen its monetary policy further. This would force China to either spend additional foreign reserves on the devaluation of the CNY or allow the currency to appreciate. If Chinese authorities allow a free floating currency, the Yuan is expected to increase significantly, as the currency is considered to be undervalued (Balding 2015). The pessimism on the future development of the Chinese Yuan and the Chinese economy can be observed in the amount of capital outflow of the economy. The Chinese government reacted by implementing stricter capital controls and by increasing taxation on exchange transactions in 2015 and 2016. The trend of Chinese companies and households to rather invest in foreign assets reflects to a reasonable extent the distrust in future economic prospects. Eventually, any actions by the Chinese government to limit capital outflows would question their economic management skills (Balding 2015).

Besides net capital outflow, the devaluation of the Yuan has contributed to the evolvement of cheap credit (Morrison 2009). This resulted in oversupply capacities and bad loans, which impose today a severe problem for the Chinese economy. Most recently, Chinese debt is rising faster than economic growth and low interest rates have been used to re-leverage non-performing loans. Especially public debt, and more specifically debt levels of state-owned enterprises (SOE), are of concern. Gracie (2011) and Morrison (2009) argue the Chinese government to be the reason for the problem: Through continuously and unrestricted support for SOE, resources are diverted away from efficiently, profitable businesses and instead unprofitable SOEs, also referred to as *Zombie Companies*, are kept alive. Market observes do not agree, on whether the problem will self-correct itself or whether the conflict between economic and political objectives can be resolved by the Chinese government (Curran 2016, Gracie 2015). Lastly, however, capital requirements for Chinese banks have been lowered and the falling real estate market raises concerns over the highly leveraged economy, drawing similarities to the real estate market crisis in the US, which resulted in the financial crisis of 2008. In May 2016, Curran (2016) reported for Bloomberg, that Chinese authorities started to allow for

[6] An overview over internationalization efforts and time in which the CNY/USD was pegged or devalued, can be found in Appendix 2.

more defaults and that the Communist Party Newspapers reported China´s debt pile as the "original sin" which would not support long term economic health. This can be interpreted as a change in the government´s sentiment towards its rising debt levels and slowdown in economic growth. Alternatively, it can be interpreted that the circumstances forcing the Chinese government to act have harshened.

Meanwhile, business success in China has been traditionally tied to the relationship of business owners to the Communist Party. Corruption is an eminent problem in China and the regulatory environment is poor (Morrison 2009). Intellectual ownership rights are not well established and regulations are not transparent and found to be inconsistent. Additional to the inefficiencies created by the credit market, and decreasing economic growth, the Chinese stock market fell severely in the summer of 2015. It resulted in an additional increase of capital controls, to which the Chinese government reacted with additional government intervention in the financial markets. As Figure 4 shows, the different government interventions as well as currency policies could be observed in the Shanghai Composite Index.

Figure 2: Shanghai Composite Index, 2014-2016

Source: Curran (2016)

Most importantly, a growing economy is perceived by the Chinese government vital to secure social stability (Morrison 2009). Public unrest had been growing in 2005, when the Chinese population did not perceive to be benefitting from the rapid economic growth. Lately the income gap between the rural and urban area and environmental pollution had been of rising concern. Balding (2015) argues that the Chinese government will, therefore, more extreme than in Western countries, try to foreclose unemployment and hence mute possible protests. However, to target the economic problems and secure economic growth stability, Balding (2015) argues, no measures would be without negative consequences for at least some part of the population. One way the government is trying to achieve this balance is by increasing energy efficiency and decreasing energy intensity. A number of reforms and measure have set in place, to transform the economy and support qualitative growth. The set of rules has been referred to as China´s structural reforms and describe the transition from a manufacturing industry to a service oriented industry.

1.3. China´s Structural Reforms – The Impact on Oil Demand

Given the strategic value of oil, the commodity has been traditionally of high concern to oil importing and exporting nations. Therefore, many oil importing countries, including China, are targeting energy security as the dependency on oil imports is perceived risky (Roncaglia 2003). Energy security can either be accomplished by ensuring sufficient resources and safe transportation from the exploration side to industries and households or by reducing energy intensity and energy efficiency. Energy intensity in any country is expected to decrease over time, assuming economies to develop into service oriented industries and technology to allow increases in energy efficiency. China has targeted both options. This chapter will therefore examine policies specifically implemented to target energy efficiency and intensity as well as structural reforms changing the energy intensity and efficiency levels.

The imports of oil have been rising since 1993, as consumption levels exceeded production levels and oil reserves in China were declining[7]. The reserve to production ratio for oil (number of years until traditional oil reserves deplete) was estimated to be 12 years in 2007 by Pang et al. (2009). The peak of production might be delayed when energy efficiency is increased and energy intensity is reduced. The target rate of 16% less energy consumption per unit of GDP has been announced within the 12th Five-Year Plan (2011 – 2015) by the Chinese government. This implied a shift from an economy, based on manufacturing, to a service-industry. The IEA measures oil intensity as the amount of oil products used to generate Yuan 1 Billion of GDP (IEA 2015). In 2014, the oil intensity was measured to be at 0.54 kb/d for Yuan 1 Billion of GDP. Compared to levels when China was just entering the heavy industry sector in 2004, this is a 34% decreased. The

[7] Appendix 3 provides a short discussion on China´s Domestic oil fields.

IEA expects the oil intensity to decrease further to 0.43 kb/d in 2020. Besides energy intensity, other key targets covered lower carbon intensity and a higher share of non-fossil energy. On the other hand, Li (2007) points out the supremacy by Western countries over Asian countries in world-oil usage and the gap between them. If China was to reach the same per capita levels as Western countries, it would translate into for higher energy consumption and hence more oil demanded.

In 2015, a cap on total energy consumption (4 billion tons of coal equivalent) in 2015 was introduced. This gives reason for the industry (IEA 2015) and academics (Meidan, Sen and Campbell 2015) to reference the set of policies and the following changes in the Chinese energy market as the "new normal", adopting the term first used by Xi Jinping. In the 13th five-year plan (2016 – 2020), the Chinese government underlined to aim to aspire social inclusivity and environmental sustainability by decreasing manufacturing overcapacity and stimulating technological innovation. Technological innovation and private investments specifically apply to the energy sector (EIA 2015). The pricing schemes in the energy sector are increasingly determined by market forces and increased energy transmission infrastructure. Efficiency gains were recorded at 3.7% per annum between 2008 to 2014 and forecasted efficiency gains from 2015-2020 are expected to match these levels (IEA 2015).

The new strategy for economic growth concentrates on the quality of growth, accepting lower absolute economic growth rates between 6% and 7%. A sustainable growth is considered to be also socially stable and hence might diminish excessive social tensions (Roncaglia 2003). A matter, which is of constant concern for the Communist party, as its legitimacy is considered to be dependent on strong and sustained growth (Shinn 2010). Additionally, future economic growth should be driven by domestic consumption instead of net exports, investments or government spending. However, Gracie (2015) underlines that China´s demographic structure and debt problem have not been addressed to this point and that essential structural reforms have failed.

It is uncertain, whether the demand for oil by the manufacturing industry will be replaced by an other sector of the economy (Kawa 2016b). But although the times of extensive economic growth might be over, the demand for oil per person in China is still far below levels in America and Europe. Whereas China´s citizens only consume one ton oil equivalent per year (TOE/year), levels in Europe are at four TOE/year and eight TOE/year in the US (Anandan and Ramaswamy 2015).

The demand for diesel and gasoline products is decreasingly attributed to the industry sector. The percentage of diesel demand allocated to the industry sector has almost halved in 2014, compared to levels at almost 40% in 2002. A similar trend can be observed in the demand allocation for gasoline (Meidan, Sen and Campbell 2015). Meanwhile, the allocation of demand for gasoil and diesel to transportation has been rising compared to other sectors, while the demand for motor gasoline and jet fuel is expected to continue to grow further in absolute terms as well (IEA 2015). Therefore, it is likely, that the transportations sector in China will continue to its significant contribution to oil demand growth, as it has done since 2008 (Kawa 2016a).

China´s per capita vehicle ownership is much below the per capita vehicle ownership in developed countries, although, car ownership numbers have risen in the past years. Furthermore, although the populous country provides a large potential market, its urban density is self-limiting and road infrastructure is much less developed than in the US or Europe. Past and future environmental concerns have and will result in policies impacting the use and purchase of cars (McCracken 2010). Given the development of the oil use intensity of cars, the evolvement of electric cars and the state of China´s economic development, it might not be necessary that increased car ownership increases the China´s demand for oil.

The above argumentation may mislead to the assumption, that if a growth in oil demand from the transportation sector is observed, it would reflect economic growth. However, McCracken (2010) points out that an increase in domestic car sales, must not necessarily be in line with the China´s economic development. Instead, the government subsidised car sales in rural part of China and decreased taxes on newly purchased small vehicles. Car sales further might not indicate the number of people who are actively using the vehicles. Cars have been considered a status symbol for the middle and while car sales have been declining in 2015, car registrations increased (Kawa 2015).

2. Literature Review

The discussion in academic literature has been very controversial and not all authors agree on a demand driven oil price development, but rather consider crude oil supply changes[8], OPEC output restrictions[9], speculative behaviour by market participants and/or financial speculation[10] and inventory levels[11] as significant forces. Others have concentrated their studies on the macroeconomic affects of oil price shocks[12]. Given the number of research conducted, this literature review will concentrate only on a selection.

The selection will concentrate on econometric techniques used to study oil prices. The chapter will give an overview on different methods, the discussion of linearity and non-linearity between oil prices and the macro-economy and the importance of regime changes. The literature review will proceed with an overview on different results found in regards to the impact of China on the international oil prices.

2.1. Econometric Techniques

Reviewing literature on the oil price leads to the observation that studies either analyse the oil market movements and changing regimes in hindsight, or (more often) models are tested to forecast future oil prices. Generally, the benchmark crude oil prices, Brent Crude Oil or West Texas Intermediate are considered for such analysis.

Fattouh (2007) differs between non-structural models, demand supply models and informal models, and concludes none to provide sufficient forecasting power. Baumeister and Kilian (2016) argue that the reason for significant forecasting errors in the estimation of future crude oil markets might not be because of unknown determinants of the crude price, but rather because of forecasting errors in the estimation of explanatory variables. Furthermore, they observe forecasting errors to change in size depending on the nature of the demand or supply shock. Behmiri and Manso (2013) highlight that there is no consensus on which techniques are most reliable when forecasting crude oil prices. They differ between qualitative and quantitative methods. Qualitative methods would include approaches such as web text mining but are not considered in this review of existing

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[8] E.g. Gallo et al. (2010)
[9] E.g. King, Deng and Metz (2011)
[10] E.g. Fattouh, Kilian and Mahadeva (2012)
[11] E.g. Bern (2011), King, Deng and Metz (2011)
[12] E.g. Jones, Leiby and Paik (2004)

literature. Rather, econometric methods are concentrated on and more precisely structural models. Structural models are divided by Behmiri and Manso (2013) into OPEC behaviour models, inventory models, combination of OPEC behaviour models and inventory models and models based on supply and demand. Although, they find only little evidence for the forecasting power of structural models, they highlight their explanatory value for past price movements.

It can be observed in previous literature, that there has been a trend from using linear models to describe the relationship between economic growth and oil prices until the mid-1980s to non-linear specifications afterwards (Ghalayini 2011). The reason for the shift in the techniques is a study by Mork (1989) that showed that the US economic activity replied asymmetrically to real oil price changes: Whereas there was a significant impact by oil price increases on the economic activity, there was no significant impact observed when the oil price was declining. More recently Krugman (2016), reporting as a market observer for the *New York Times*, wrote that last decline in oil price did not have expected positive effects on the economy, but rather, the marginal size of change led to negative implications for world economic growth. Therefore, the traditional relationship between oil price declines and the economy, might not hold true anymore. Krugman (2016) argues the deleveraging effect by oil producers results in negative externalities for the global economy and the change in paradigm to be caused by the short cycle investments of the shale oil industry. In literature, Hamilton (2010) observes non-linearity of larger changes in oil prices using Kilian and Vigfusson (2010) as a reference paper. Ghalayini (2011) and Hamilton (2010) agree, that the review of literature conducted on the subject provides no clear answer.

Whether linearity is found or not often depends not only on the method (Ghalayini 2011), but also on the data sets used for the model (Hamilton 2009). Cong and Wei (2008) further underline the difference effects the stage of development of a country has on the linear or non-linear relationship between crude oil prices and economic growth. As a non-linear relationship might be apparent for OECD countries and developed countries, the same might not be true for developing countries such as China. Ghalayini (2011) underlines, that although the trend is apparent in empirical literature, the same trend cannot be observed in the theoretical literature. The exception she finds is based on the dispersion hypothesis developed by Lilien (1982), which is also considered by the analysis of Cong and Wei (2008) when studying the impacts of crude oil prices on the Chinese stock market. Lilien (1982) highlights the different effects oil crude price changes have on different sector, depending on whether they are energy efficient or energy intensive, and hence lead to readjustments across sectors which require different sets of time.

Once a relationship between economic growth and the oil prices is established, most academic papers agree that they might not be robust over time. Instead, it is usual to observe significant results for tests, that assess structural breaks in the models. Hamilton (2008) underlines that oil price changes are affected by different regimes at different times. Kilian and Hicks (2013) consider the period 2000 to 2008 without structural breaks, while Lechtahler and Leinert (2012) restrict the sample to 2003 to 2010 because of the observation of a structural break in 2003 in most time series, and criticize the results of studies not accounting for this specific break. Gallo et al. (2010) also find a structural break in March 2003 in the demand from China. They argue the Iraq war to be the reason for the structural break, while the increasing economic growth from China attributed in their opinion for the earlier structural break in their data set in 1991. Furthermore, they highlight that evidence for structural breaks differs between countries. Du, He and Wei (2010) confirm the existence of structural break in January 2002 (for the period between 1995 and 2008) and reason them with the changes in China´s oil pricing mechanism. Ji (2012) found a similar change in the impact of explanatory variables, assessing fundamental variables only to have a long run impact before the financial crisis, while short term oil price behaviour was explained by speculation. Such mechanisms were set off during the period of the financial crisis and fundamental explanatory power was re-established after the financial crisis.

2.2. The China Factor

The resulting increase in demand for crude oil from China is argued by Kilian and Hicks (2013) and Hamilton (2008) to have driven the international crude oil prices up from 2000 to 2008. Gallo et al. (2010) found the consecutive rise in oil prices from 2009 onwards caused by growing demand for oil from China. The latest decline in oil prices starting in 2014, was argued by Anandan and Ramaswamy (2015) to be due to low growth rates of China´s economy. Other, such as Bern (2011) highlights the many additional factors that determine the oil price besides supply and demand fundamentals. Explanatory variables could be expected to include stock markets and foreign exchange markets besides economic growth.

Beirne et al. (2013) analysed the China factor on the world economy through quantifying the influence of Chinese GDP growth on oil prices. Using a country-level demand model, based on 1965 to 2011, crude oil prices are estimated from 2010 to 2030. They find an increasing premium added to the price of oil by China. Kilian and Hicks (2013) stress the market´s underestimation of the respective growth rates and observe the real price of oil to react to unexpected growth in emerging in markets in a hump-shape, measured by revisions of professional GDP forecasts from 2000:12 to 2008:12. The measured surprises are observed to exist in a higher extent for Asian economies than for OECD economies[13], namely from China and Russia but also for OECD country Japan. Annual revisions of Chinese economic growth rates´ estimates by 0.1 percentage points led to a five percent increase of the crude oil price. Kilian and Hicks (2013)´ findings, based on a linear regression method and historical decomposition, confirm the results by Kilian (2009), who used a structural VAR model. The observation is contradicted by Lechtahler and Leinert (2012). Lechtahler and Leinert (2012) found that demand from emerging countries (India, Russia, South Africa, Indonesia and China) did not contributed additionally to the impact of the demand from OECD countries during the increase of oil prices from 2003 to 2008. Only during the peak of the oil price in 2008, a difference in the effect of cumulative demand and OECD demand was observed. Du, He and Wei (2010) find similar results as Lechtahler and Leinert (2012) for the period from 1995 and 2008, using a multivariate vector autoregressive model. They found no oil pricing power by China on the oil market.

Kilian (2009) differs between the effect of supply and demand shocks on the oil price. On the demand side, he differs between shocks specific to crude oil and demand shocks effecting global demand for all commodities. In his analysis of the real price of oil from 1975 to 2007, he found changes in expectations result in precautionary adjustments in demand, specifically effecting crude oil and resulting in a sustainable, immediate and large change in the real price of oil. Contrary, the effects by demand shocks on all commodities appear with a time lag but are also persistent. Kilian (2009) concludes most changes in the oil price to have resulted from demand side shocks and the increase in the real price of crude oil from 2003 to 2007 to have been driven by an increase in the

[13] The analysis concentrates only on the United States, Germany and Japan as OECD representatives, while non-OECD countries are represented by Brasil, Russia, India and China (BRICs).

aggregate demand for industrial commodities as well as specific increasing demand for crude oil.

Additional to the studies presented above, Kilian and Lee (2014), Fattouh, Kilian and Mahadeva (2012) and Smith (2009) support the impact by Chinese economic growth on the crude oil price. Mu and Ye (2011) found China´s imports not to significantly impact the oil price from 2002 to 2008 and conclude China not to have had a significant impact on the rising oil prices.

Whether the relationship between economic growth and the oil price is bilateral or unilateral is the subject of many additional studies. While some studies assume a bilateral relationship for which they make use of the vector autoregressive (forecasting) technique, other consider granger causality tests to identify the direction of a possible significant impact or calculate price elasticities. Ghalayini (2011) finds the impact of crude oil prices on economic growth to be dependent on the state of an oil net importer or oil net exporter. China, as a net importer of oil since 1993 is found to have a negative correlation between changes in oil prices and Chinese economic growth from 1986 to 2010. The economy can be affected by an oil price change through either the demand or supply side. Using the demand side channel, the disposable income of consumers is positively affected. When oil price rises, products derived from oil are expected to become more expensive and hence less income is available for other goods and services. As oil prices increase, the costs for producers using oil as an input factor increase as well and hence negatively impact investment decisions. The supply side channel considers the increase in production costs when oil is used as an input factor and hence can result in a reduction of the output by the firm.

Gallo et al. (2010) observe demand variables not to significantly impact oil prices, but changes in the oil prices to effect demand and supply variables from 1990 to 2009. Askari and Krichene (2010) find oil demand price elasticity very low and/or insignificant for the period from 1970 to 2008, confirming earlier results from Cooper (2003), who found no significant price elasticity of demand for China from 1979 to 2000. Instead Askari and Krichene (2010) found oil demand mainly responsive to income. Results by Hamilton (2008) contradict the study, when he observed that from 2002 to 2007 price elasticity of demand at lower levels than in 1980. He argues that this development is in line with the main demand for crude oil deriving from transportation which only has little substitution possibilities, compared to different uses of oil, demanded to a higher extent before, allowing more substitutions. Bern (2011) observes that the transportation sector was inelastic to the high prices of oil in 2008 but private consumers were outweighed by industrial users of crude oil, who cut production.

Behmiri and Manso (2013) underline the use of non-oil variables such as economic activity, interest rates, exchange rates and other commodity prices in structural models (see also Bern 2011). Although they criticize the forecasting performance, they observe fundamental variables to explain price movements well. However, the complexity of structural models and data limitations restricts their use for such purposes and therefore models using time-series techniques are used more frequently. Gallo et al. (2010) describe in their review of literature, economic growth, inflation and other economic indicators to provide inconclusive evidence. Ghalayini (2011) highlights that oil prices can also have a converse indirect effect on economic growth through influencing foreign exchange markets and inflation. The findings on whether the economic growth impact the oil price, vice versa, or whether there exists a bilateral relationship are not conclusive. Ghalayini (2011) reasons the difference to appear, as different models propose different results. If an increase in economic activity would lead to higher oil prices, then the effect of higher oil prices on the economy, described by Ghalayini (2011) as feedback relationship, can mitigate the direct impact.

Askari and Krichene (2010) and highlight furthermore, that the demand for crude oil depends besides economic activity also on demographic and technological factors. Urbanism and residential expansion will impact the demand for energy. In rural areas, vehicle substitutes are limited whereas the use of vehicles in large cities is limited. Additionally, rural areas might also not be connected as much as urban areas to the energy grid in developing nations. Crompton and Wu (2004) estimated the growth of energy consumption to decline by 2010, due to structural changes in the economy. Additionally, technological factors will impact energy intensity and energy efficiency of a country and for example, the loss of energy in the refining process of oil, or energy efficiency of vehicles. Not accounting for the complexities of the supply and demand determinants will increase the costs of misspecification and omission errors for econometric models (Askari and Krichene 2010).

3. Model and Data

This chapter explains the model used in the analysis, discusses the methodology applied as well as the choice of parameters based on the qualitative economic analysis provided in Chapter 1.

The analysis will consider the time period from 2000 to 2015. This time interval will include the industrialization of China´s economy as well as the financial crisis and the shale oil revolution. The data is limited to December 2015, as some economic indicators considered for this analysis have not been published for later period by mid-2016. Although a longer time series would increase the number of observations and hence enhance the asymptotic properties of estimators (Lechtahler and Leinert 2012), it also would lead to a higher probability of structural breaks in the time series describing the oil market. The monthly intervals are in line with most structural models reviewed by Behmiri and Manso (2013).

The explanatory variables considered in this analysis, are expected be to some extent endogenously defined. This is reasonable for the close interaction between oil prices and economies. To account for endogenous variables, co-integrated vector autoregressive (VAR) models have been applied in previous academic literature. The method is neglected for this analysis, for the same reasons as Askari and Krichene (2010). Co-integrated VAR models include the analysis of the co-integration factors of all variables which are numerous in this analysis. Furthermore, the model would have constraints in the identification of assigning values to parameters and whether their relation belongs to the vector space of co-integration vectors. Therefore, dynamic multiple regression model is estimated. The restriction on the interpretation of its coefficients is out-weighted by the possibility to consider different variables for the analysis of China´s impact on the oil price. The relationship between the economic indicators and the oil price is considered to be linear for developing countries (Cong and Wei 2008). China is categorized as a developing country, based on the low per capita levels of the economic indicators in international comparison (Li 2007).

3.1. Model

The oil price is assumed to be based on supply and demand, which through market clearing fulfils an equilibrium condition in each month. In equilibrium the quantity demanded (Q_D) is equal to the quantity supplied (Q_s), equation 1.0.

$$Q_D = Q_S \tag{1.0}$$

$$Q_S = c_S + \beta_{SP}\, p_t + \beta_{S(j)}\, p_{t-j} + u_{S,t} \qquad j = 1,2, \ldots, 12 \tag{2.0}$$

$$Q_D = c_D + \beta_{DChina}\, Q_{Dchina,\,t} + \beta_{DChina(i)}\, Q_{DChina,\,t\text{-}I} + \beta_{DC}\, Q_{DC,\,t} + \beta_{DC\,(i)}\, Q_{DC,\,t\text{-}I} + \beta_{DChinaIV}\, p_t\, Q_{DChina,\,t} + \beta_{IVChina(i)}\, p_{t-i}\, Q_{DChina,\,t-i} + \beta_{DUS}\, Q_{DUS,\,t} + \beta_{DUS(i)}\, Q_{DUS,\,t-i} + \beta_{IVDUS}\, p_t\, Q_{DUS,\,t} + \beta_{IVDUS(i)}\, p_{t-i}\, Q_{DUS,\,t-i} + u_{D,t} \qquad i = 1, \ldots, 6 \tag{3.0}$$

The world aggregate supplied (2.0) is defined by a dynamic model, assuming production to be supplied by residual producers whose price setting decision is simulated recursively by current and past oil prices (Stevens 1995). The quantity demanded (3.0) is dynamically modelled by considering the demand from China (Q_{DChina}) and the US ($Q_{DUS)}$), who are the biggest consumers of energy and the biggest importers of crude oil in the time period from 2000 to 2015. The different economic structures lead to different impacts on oil demand in response to changes in the oil price (Askari and Krichene 2010). The difference is accounted for through interaction variables ($p_t\ Q_{DChina}$ and $p_t\ Q_{DUS}$).. In addition, explanatory variables can be included to describe the Chinese economic development and structural changes more accurately, which will take the place of Q_{DC}. The intuition for equation 2.0 and equation 3.0 is described in more detail in Appendix 4. The equations presented above are simultaneously solved for p_t , which results after simplification of the coefficient representation in equation 4.0[14].

$$p_t = c_p + b\, Q_{Dchina,\,t} + b_{(1+i)}\, Q_{DChina,\,t\text{-}I} + \gamma_t + \gamma_{t-i} + b_{IV,\,China)}\, p_{t-i}\, Q_{DChina,\,t-i} + b_{US}\, Q_{DUS,\,t} + b_{US,\,(1+i)}\, p_{t-j}\, Q_{DUS,\,t-j} + \beta_{IVDUS(i)}\, p_{t-i}\, Q_{DUS,\,t-i} - b_{supply}\, p_{t-j} + u_{p,t} \qquad j = 1, 2, \ldots, 12 \quad i = 1, \ldots, 6 \tag{4.0}$$

$$c_p = \frac{c_D}{\lambda} - \frac{c_S}{\lambda} \qquad u_{p,t} = \frac{1}{\lambda}(u_{D,t} - u_{S,t})$$

$$b = \frac{\beta_{DChina}}{\lambda} \qquad b_{,\,(i)} = \frac{\beta_{DChina,(i)}}{\lambda}$$

$$b_{IV,\,China} = \frac{\beta_{IVChina(i)}}{\lambda} \qquad b_{IV,\,DUS} = \frac{\beta_{IVDUS(i)}}{\lambda}$$

$$b_{US} = \frac{\beta_{DUS}}{\lambda} \qquad b_{US,\,(i)} = \frac{\beta_{DUS,(i)}}{\lambda}$$

$$b_{supply} = \frac{\beta_{S,(1+j)}}{\lambda}$$

[14] The calculations used to solve equation 3.0 and 4.0 simultaneously is presented in Appendix 4.

3.2. Methodology

The base case is Specification 1 which accounts for China´s imports, US imports, their respective interaction variables and lagged oil prices. Specification 2 will add additional explanatory variables to the model, representing more strongly the changes in the Chinese economic development and the overall sentiment on the Chinese economy. Specification 3 considers variables that are reflecting the structural changes in the Chinese economy. Before Specification 2 and Specification 3 add their explanatory variables, the previous Specification is reduced in its from using the stepwise backwards elimination process.

Table 1: Methodology

$$p_t = c\ c_p + b\ Q_{DChina,\ t} + b_{(1+i)}\ Q_{DChina,\ t-I} + \gamma_t + \gamma_{t-i} + b_{IV,\ China)}\ p_{t-i}\ Q_{DChina,\ t-i} + b_{US}\ Q_{DUS,\ t} + b_{US,\ (1+i)}\ p_{t-j}\ Q_{DUS,\ t-j} + \beta_{IVDUS(i)}\ p_{t-i}\ Q_{DUS,\ t-i} - b_{supply}\ p_{t-j} + u_{p,t}$$

$$j = 1, 2, \dots, 12$$

$$i = 1, \dots, 6$$

Specification 1	Specification 2	Specification 3
p_t – Brent Crude Price Q_{Dchina} - Chinese Imports Q_{DUS} –US Imports	$\gamma_{GDP,\ t}$ – Gross Domestic Product $\gamma_{CNY/USD,\ t}$ – CNY/USD $\gamma_{Equity,\ t}$ – Stock Market Index	$\gamma_{Industry,\ t}$ – Industrial Production Index $\gamma_{Urban,\ t}$ – Urban Investments γ_{TOE} – Energy intensity

Source: Author´s Table

The results are expected to show, i) whether oil demand from China is significant during 2000 and 2015, ii) if structural changes can be observed in the model by testing for structural breaks, iii) if during the different regimes, indicated by structural breaks, the significance of the explanatory values changes, and if so iv) if such changes can be explained through the previous economic analysis on China and the oil market. Finally, v) the different variables considered in each specification allow to observe, if such variables add to the explanatory power of the model and vi) if the results confirm or oppose previous findings discussed in the Literature Review.

The large set of independent variables and their lagged equivalents limit the model in the statistical tests that can be conducted. Therefore, especially concerning heteroskedasticity and autocorrelation, the calibration of the model is specifically considered. For example, instead of the White Test, the Breusch-Pagan Godfrey test is consulted to test for heteroskedasticity. Additionally, multicollinearity will be analysed in more detail, given the increased likelihood of such by the included lagged explanatory variables.

Given the previously discussed likelihood of endogeneity in the different specifications and the complex nature of the parameter coefficients in 4.0, the analysis will neglect to comment on the coefficient estimates and rather concentrates on the test statistics.

3.3. Data

The monthly averages of Brent Crude oil spot prices are published by the Energy Information Administration. The nominal price of the Brent Crude Oil price is used instead of the real price which would be adjusted for inflation over time. Fan and Xu (2011) highlight the advantage of the nominal price to be more sensitive to short term impacts on the oil price from other markets. The time series starts in 1999 to allow the regression modelling in 2000, given the consideration of lagged Brent Crude oil prices.

To reflect China´s and US´ demand for oil, the official import levels are chosen. The import data, differently to consumption data, reflects the transition by the US from the world´s biggest crude oil importer to a temporary net-exporter after the shale oil revolution. The US imports of crude oil were taken from the Energy Information Administration as monthly data and was recorded in thousand barrels. China´s crude oil and refined petroleum products (liquid products only, measured in metric tons) imports are published by General Administration of Customs of China on a monthly basis with a two-week time lag. The series is considered by Mu and Ye (2011) the “single most important barometer” to present China´s oil demand. The rising oil imports in 2015 can be explained by the increases in strategic oil reserves (Meidan, Sen and Campbell 2015) and reflect the rising concerns over energy security by the Chinese authorities (Zweig 2005). It is to highlight, that different units for oil imports are considered. A transformation is not attempted, as such would only consider a rough estimate. The conversion between barrels and metric tonnes required the knowledge of the specific gravity level of the oil product considered and the official imports published by the Chinese authorities refer to refined petroleum products as well. This increases the likelihood of heteroskedasticity in the regression model. Both time series start in July 1999, to allow for the consideration of six lagged variables in the modelling of the regression from 2000 to 2015.

For Specification 2, the CNY/USD and the Shanghai Stock Index monthly average values are taken from the National Bureau of Statistics of China. The GDP growth data is also published by National Bureau of Statistics of China, but as it is only available on a quarterly basis, the missing values are created using linear interpolation. Market observers have often highlighted the limitation of the opaque techniques used by China´s authorities, however, this observation will not be controlled for in the further analysis. For Specification 3, the manufacturing index and urban investments are considered, which are also published by the National Bureau of Statistics of China as well. They are available on a monthly basis but only from mid-1999. Therefore, the time interval for Specification 3 will be restricted from April 2000 to December 2015. The energy intensity level of primary energy for China are taken from the databank of the World Bank. It is only available on an annual basis, for which the missing values are created by linear interpolation. The manufacturing index as well as the Shanghai Stock Index are both considered as indicators for China´s stability in the transition period from quantitative to qualitative growth (Preston et al 2016). They reflect not only economic stability, but given the previously discussed link between economic development and government performance, they also reflect political stability.

Almost all time series are found to be non-stationary, using the augmented Dickey Fuller (ADF) test and therefore are transformed into their first difference to achieve stationarity of the variables. The exception are the interaction variables and urban investments. The difference of the energy intensity level remains non-stationary, for which the second difference is considered. The respective descriptive statistics are presented in the Table 2.

Table 2: Descriptive Statistics Main Variables, 2000-2015

	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.	Observations
BRENT_D	0.07	13.73	-25.65	5.84	-1.0999	5.6686	95.68	0.0000	192
CHINA_IMPORTS_D	15.33	624.70	-703.52	221.69	-0.2813	3.6877	6.31	0.0425	192
CNYUSD_D	-0.01	0.19	-0.13	0.03	0.7155	16.5923	1494.38	0.0000	192
GDP_D	0.00	0.80	-0.83	0.35	0.1297	2.9792	0.54	0.7628	192
INDUSTRIAL_INDEX_D	-0.01	16.70	-15.90	3.18	0.3378	15.0137	1158.29	0.0000	192
SHANGHAI_INDEX_D	11.32	747.83	-1082.99	240.77	-0.8275	7.6986	198.53	0.0000	192
TOE_CAPITA_DD	0.02	6.89	-5.04	1.06	1.0362	23.0724	3257.56	0.0000	192
URBAN_INVESTMENTS	93016.91	501445.50	954.87	109422.70	1.6582	5.1287	124.24	0.0000	192
US_IMPORTS_D	-54.62	91809.00	-84041.00	25278.51	-0.0452	4.6286	21.28	0.0000	192
VI_CHINA_1	-73.69	5707.68	-8484.85	1355.08	-0.5216	13.5305	895.84	0.0000	192
VI_US_1	-6740.24	957157.80	-1600817.00	180538.50	-2.6132	38.8506	10500.63	0.0000	192

Data obtained using Eviews Package
Source: Author´s Table

Considering a model concentrating on supply and demand fundamentals alone, it is likely to be underspecified. Therefore, as suggested by Fan and Xu (2011), dummy variables for important political events are added. Such consider in their analysis the collapse of the World Trade Centres on 9/11 and the invasion of Iraq in 2003. For this analysis, the method is replicated and extended to account for the effect of Hurricane Katrina in 2005, tensions in Gaza in 2008 and 2009, the revolution in Libya in 2011, the revolution in

Egypt in 2013 and the annexation of Crimea by Russia in 2013. Kilian (2009) argues that the consideration of exogenous political events covers to a high extent supply side shocks, as precautionary demand adjustments consider the uncertainty concerning future oil supply shortages.

4. Results & Discussion

In this chapter the results of the econometric analysis are presented and observations put into context with the prior economic analysis undertaken in Chapter 1. The interpretation of the results will be compared to previous results in literature and finally the validity of the model, its observations and interpretation discussed.

4.1. Specification 1

The Breusch-Pagan test for heteroskedasticity is non-significant at 10% but the LM-Test indicates significant autocorrelation (10%) in the first lag. For this reason, the Newey-West robust estimation technique is used to obtain the regression results. Specification 1 is further found to have a structural break in December 2008, indicated by the Chow test.

The null hypothesis of no structural break cannot be rejected at 10%, different to the remaining month of 2008. The breakpoint indicates with a time lag the financial crisis and its impact on the global demand for commodities, including oil. However, it does also indicate the start of the shale oil production in the US, which would later lead the US to transform from the biggest oil imported into a temporary net-oil exporter. Therefore, two sub periods are compared to each other from 2000 to 2008 (108 observations) and from 2009 to 2015 (84 observations). The observation confirms Hamilton´s (2008) expectation to find different regimes during different times.

Table 3 shows the added dummy variables for geopolitical events do not to add explanatory value to Specification 1, but decrease the Akaike Information Criterion in the time period from 2000 to 2015. However, considering the two sub-samples created by the structural break, the dummy variables add explanatory value to Specification 1 in the post-2008 period. The statistical insignificance of the Iraq war, opposing results by Gallo et al. (2010) could be explained by the fact, that the political and geopolitical event pre-2008 were all related to the US[15] and hence their impact is likely to be reflected in the US import variables. However, the variables Libya, Crimea and Egypt describe geopolitical

[15] The Iraqi war was initiated by a coalition, led by the United States and a (partial) result of the 9/11 terror attacks in New York. Hurricane Katrina hit the US in 2005, especially the region of New Orleans. The US had (has) strong interest in the Middle East and Israel, making the Gaza War from 2008 to 2009 a direct concern.

events with no involvement or strong ties to the US. Therefore, it can be argued, that the consideration of such separately, increases the explanatory value of the model.

Table 3: Regression Results Specification 1

	2000-2015				2000-2008				2009-2015			
C	-0.2102		0.3254		1.2902		1.5912		-0.1142		0.0700	
BRENT_D_1	3.3567	***	3.1518	***	3.1200	***	2.7742	***	2.1383	**	2.2889	**
BRENT_D_2	1.9827	**	1.8671	*	0.7055		0.6244		0.8601		1.0382	
BRENT_D_3	-0.7066		-0.9266		-0.3658		-0.6025		-0.1522		-0.3091	
BRENT_D_4	0.6674		0.1722		-0.8748		-1.0068		-0.6563		-0.6528	
BRENT_D_5	-0.1793		-0.4975		-0.5599		-0.5395		0.9874		0.9642	
BRENT_D_6	-2.4252	**	-2.3344	**	-1.2180		-1.0379		-2.1126	**	-2.1947	**
BRENT_D_7	1.4175		1.5686		0.3740		0.5699		1.0083		0.6898	
BRENT_D_8	-0.5263		-0.1887		0.0698		0.0472		-0.4725		-0.3862	
BRENT_D_9	-0.6494		-0.7550		-1.5663		-1.7019	*	-0.1359		-0.2847	
BRENT_D_10	1.3428		1.3141		0.1394		0.1986		-0.1233		0.1404	
BRENT_D_11	1.4819		1.4334		1.5091		0.8254		2.2570	**	2.2663	**
BRENT_D_12	-1.2789		-1.4786		-1.8223	*	-1.4804		-1.0325		-1.5733	
CHINA_IMPORTS_D	-0.8851		-1.0605		-0.2511		-0.2799		0.0393		-0.3448	
CHINA_IMPORTS_D_1	0.8389		0.4978		0.4687		0.0506		0.2834		-0.3121	
CHINA_IMPORTS_D_2	1.0416		0.8262		0.7658		0.5313		0.1025		-0.5057	
CHINA_IMPORTS_D_3	1.2919		1.0811		2.2456	**	1.9559	*	-0.4595		-0.8865	
CHINA_IMPORTS_D_4	1.4126		1.2006		1.1652		1.1492		-0.0610		-0.3195	
CHINA_IMPORTS_D_5	0.2130		0.0734		-0.3673		-0.5657		-0.0429		-0.1334	
CHINA_IMPORTS_D_6	0.2407		0.1009		-0.1570		-0.3317		-0.0410		-0.0054	
US_IMPORTS_D	-2.4858	**	-2.2042	**	-0.8880		-0.8678		-1.6881	*	-2.0094	*
US_IMPORTS_D_1	-1.1593		-1.0934		-0.8133		-0.8073		-1.0200		-1.2258	
US_IMPORTS_D_2	0.2244		0.3400		0.7544		0.8216		0.1449		-0.0703	
US_IMPORTS_D_3	1.1294		0.8008		0.7642		0.2868		0.8577		0.1812	
US_IMPORTS_D_4	-1.0060		-1.6078		-1.4069		-1.4750		-1.0522		-1.7489	*
US_IMPORTS_D_5	-0.8133		-1.0632		0.6651		0.4341		-1.3385		-1.4982	
US_IMPORTS_D_6	-0.1011		-0.0653		0.0284		0.1721		-1.1055		-1.2202	
VI_CHINA_1	4.4528	***	4.3605	***	2.4034	**	2.5372	**	4.3741	***	3.5335	***
VI_CHINA_2	0.3684		0.7097		1.3622		1.5169		-0.0015		-0.1614	
VI_CHINA_3	0.3232		0.5219		-1.0676		-0.9103		0.2833		0.1132	
VI_CHINA_4	1.2885		1.1465		1.5139		1.3760		-0.0951		-0.2689	
VI_CHINA_5	-0.6621		-0.6177		-0.5003		-0.5437		0.1094		-0.0290	
VI_CHINA_6	0.3971		0.4262		0.2817		0.4816		-0.2295		-0.5025	
VI_US_1	-2.3586	**	-1.8886	*	-0.9706		-0.9731		-0.5578		-0.3796	
VI_US_2	-2.1374	**	-3.0718	***	-1.3176		-1.9567		-2.4014	**	-2.1994	**
VI_US_3	-1.1383		-1.2521		-1.3801		-0.5477		-0.2449		0.3693	
VI_US_4	0.8184		1.5778		2.4966	**	2.2974	**	1.2880		1.9172	*
VI_US_5	0.2714		0.9612		-0.5195		-0.2244		0.7686		1.5901	
VI_US_6	1.1798		1.1799		0.9003		0.7143		1.1068		1.4221	
CRIMEA			-1.2672								-0.4144	
EGYPT			1.9772	**							2.4001	**
GAZA			-2.1785	**			-1.1552					
HURRICANE_KATRINA			0.4599				-0.2611					
IRAQUE			-0.0773				-0.1234					
LIBYA			-0.4083								-0.9042	
NINEELEVEN			-1.3049				-1.5030					
R^2	0.4126		0.4374		0.5672		0.5814		0.5589		0.5954	
Adjusted R^2	0.2667		0.2639		0.3289		0.3109		0.1864		0.2004	
Akaike Info Criterion	6.2367		6.2666		6.2270		6.2679		6.4977		6.4828	
Schwarz Criterion	6.8984		7.0471		7.1956		7.3358		7.6263		7.6982	
Hannan-Quinn Criterion	6.5047		6.5827		6.6197		6.7009		6.9514		6.9714	

**** The test statistic is significant at 1%, ** The test statistic is significant at 5% , * The test statistic is significant at 10%*

Data obtained using Eviews Package
Source: Author´s Table

Considering the specific variables, it is first to highlight, that the Variance Inflation Vectors indicate multicollinearity among the variables. As the variables reflect international macroeconomic relations, this is reasonable and not corrected for. Instead, the analysis of the significant variables is undertaken with caution, as multicollinearity can lead to a bias in the test-statistic by artificially lowering the p-value.

The lagged Brent price for one, two and six months are found to be significant for the entire period from 2000 to 2015. However, the lagged variables are differently significant for the two time periods. Whereas from 2000 to 2008 the most immediate Brent Crude prices are significant (Brent_D_1), the half-year lagged variable (Brent_D_6) becomes significant from 2008 to 2015. As discussed earlier, the price elasticity of supply enhanced after the shale oil revolution, which, maybe by coincidence, requires on average six month to set up production.

The oil imports by China are not found to be significant for the entire period. but only the three month lagged variable (China_Imports_D_3) is significant for the time prior to 2009. The bias of Chinese imported oil data has been highlighted in the previous discussion and could be interpreted to be validated by these results. The increase in official strategic reserves over time could be an explanation for no significance of import data for the time past 2008. Also, the three month lagged import data would be six weeks old after it has been published. This could possibly indicate the time, that the market needs to interpret the data, or on the other hand, be considered spurious.

The analysis undertaken in Chapter 1 is validated, as US Imports became more important after 2008. Reflecting the change of the US from a net oil importer to a net oil exporter, the data becomes more influential in the expectation setting of the market participants. Considering the significance of the current data, which would not be published in the current month, point towards the market transparency given by the number of agencies estimating and publishing reports on the US oil market.

The interaction variables were considered to highlight the change in imports given price changes. Especially for China this is crucial, as one might expect strategic reserves not to change in response to market price movements and instead to be strictly and continuously increased by the Chinese government. Also, infrastructure projects supported by the government are likely to increase oil demand. This demand would only show little sensibility towards price changes and the oil required could be more easily estimated by the market. Therefore, the change of oil imports that is due to price changes is likely to reflect to a better extent the price elasticity of demand. The sensibility might be more difficult to estimate and hence has a higher impact on the changes in the Brent Crude price, also in regards to the market participants. This is in line with the observations made by Kilian and Hicks (2009) who found underestimation of Chinese economic growth rates to significantly drive the oil price. Although the interaction variables do not represent GDP, they do to some extent reflect unanticipated changes in crude oil imports. A change in the responsiveness of oil imports to price changes over time cannot be confirmed by the results and hence does not support the trend highlighted by Hamilton (2008) of decreasing price elasticity of demand. Meanwhile, the observation of Bern (2011) on differences between price elasticity of demand for private consumers and industrial producers can be somehow interpreted in the different significant levels of lagged variables between interaction variables representing China´s imports and US´ imports.

As for the US, the change in imports upon price changes also reflect to some extent the price elasticity of demand and price elasticity of supply. As the four months lag (VI_US_4) is found to be significant for the period prior to 2009, the change of significance to the two months lag (VI_US_2) for the period after 2008, could indicate the increase of substitutes available for oil consumers. However, the interpretation is of assumptive nature, as a precise relationship cannot be described from the analysis undertaken in this paper. In regards to the price elasticity of supply. the time oil production can change in the US decreased after the shale oil revolution, as shale rigs are set up much faster. Hence, a decrease in the time lag could also indicate the changing US production levels and hence directly impact the level of imports required to meet US demand.

4.2. Specification 2

For Specification 2, Specification 1 is reduced by stepwise backward elimination of the most insignificant variables until the adjusted R^2 and the Akaike Information Criterion cannot be improved. Afterwards. the variables for GDP growth, CNY/USD and Shanghai Index are added to create Specification 2.

The Breusch-Pagan test for heteroskedasticity is significant at 5%, whereas the LM-Test shows no significant level for autocorrelation. Therefore, the Newey-West method is applied to estimates heteroskedastic robust regression results. Although the explanatory variables show high levels of multicollinearity in the Vector Inflation Factors (Appendix 5), the test statistics indicate sufficient significant explanatory variables. Results from

Specification 1 are confirmed, as the significance of the previous explanatory variables are robust (Appendix 6). Similar to Specification 1, the dummy variables do not add value to the explanatory power of Specification 2 for the time from 2000 to 2015. The R^2 decreases and the Akaike Information Criterion increases from 6.10 to 6.15 (Table 4). Specification 2 has a considerably higher explanatory value than Specification 1 and the reduced form of Specification 1. Although the regression model is increased by 17 explanatory variables, reducing the degrees of freedom, the Akaike Information Criterion improves. Meanwhile, the first difference of the additional explanatory variables CNY/USD and the Shanghai Index show to be significant at 5% in their non-lagged form (confirming Behmiri and Manso 2013). Depending on the interpretation of such variables as speculative or fundamental, the long (short) run relationships between fundamental (speculative) variables and oil by Ji (2012) is opposed (confirmed). The change in GDP growth is found to be significant at 1%, also in line with results by Kilian and Lee (2014), Fattough, Kilian and Mahadeva (2012) and Smith (2009). All of these results remain robust when the dummy variables are added (Appendix 6).

Table 4: Explanatory Value of Specification 2

	2000-2015		
	Specification 1 (reduced form)	Specification 2	Specification 2 (incl. Dummy Variables)
R^2	0.4044	0.5035	0.5137
Adjusted R^2	0.3188	0.3678	0.3505
Akaike Info Criterion	6.1047	6.0999	6.1521
Schwarz Criterion	6.5289	6.8125	6.9834
Hannan-Quinn Criterion	6.2765	6.3885	6.4888

Data obtained using Eviews Package
Source: Author´s Table

An analysis of the sub-samples is omitted, as the correlation between the variables of GDP growth, the Shanghai Stock Index and CNY/USD are too high (Appendix 5) and results in no significant variables in the sub sample.

4.3. Specification 3

In the same way as before, Specification 2 is reduced using the stepwise backward elimination technique. Once neither the adjusted R^2 nor the Akaike Information Criterion can be improved by omitting explanatory variables, the additional variables representing the Industrial Production Index, Investments in Urban Areas and Energy Intensity levels are added.

Specification 3 does not perform significant in the Breusch-Pagan test for heteroskedasticity and shows no significant level of autocorrelation for the tested lags. Multicollinearity is not apparent in most Vector Inflation Factors (Appendix 7), but for urban investments.

There is no additional value added to the explanatory power of Specification 2 and its reduced form by the Specification 3. Instead the adjusted R^2 decreases from 0.41 in the reduced form of Specification 2 to 0.35 in Specification 3 (Table 5). The Akaike Information Criterion increases as well, which means that the penalty value for additional variables added is higher that the explanation of the development in the change of Brent Crude prices.

Table 5: Regression Results Specification 3

	2000-2015			2000-2008		2009-2015	
BRENT_D_1	3.3843 ***	4.5786 ***	4.2893 ***	2.0958 **	2.0083 **	1.9623 *	1.7960 *
BRENT_D_2	1.1960	0.8822	0.8283	-0.1554	-0.2390	0.6665	0.6236
BRENT_D_3	-1.1211	-1.3638	-1.3103	0.5469	0.3994	-0.5045	-0.3176
BRENT_D_6	-3.5594 ***	-3.0587 ***	-2.8097 ***	-1.4012	-1.3209	-0.0211	0.0875
BRENT_D_7	1.6845	1.2387	1.2372	1.4235	1.3255	1.2900	0.8834
BRENT_D_9	-1.0374	-1.0119	-1.0610	-1.4317	-1.3302	0.2393	0.3187
BRENT_D_10	2.1657 **	1.9410 *	1.9372 *	-0.1794	-0.0409	0.1874	0.2699
BRENT_D_11	1.8364 *	1.4202	1.4175	-0.6130	-0.6937	2.2952 **	2.1981 **
CHINA_IMPORTS_D	-2.3178 **	-2.6887 ***	-2.6161 ***	-1.4534	-1.3795	-1.3318	-1.0254
CHINA_IMPORTS_D_2	1.2528	0.8394	0.8998	1.3158	1.2874	0.3930	0.4871
CHINA_IMPORTS_D_3	2.2647 **	1.9065 *	1.9369 *	2.2862 **	2.2526 **	0.6840	0.7277
CHINA_IMPORTS_D_4	2.6366 ***	2.5913 **	2.4528 **	1.8126 *	1.8180 *	0.0177	-0.0356
US_IMPORTS_D	-2.0452 **	-1.1742	-1.1857	-1.8694 *	-1.7460 *	-1.0865	-1.2509
US_IMPORTS_D_3	1.6503	1.7042 *	1.5755	0.2315	0.0352	-0.4422	-0.5087
VI_CHINA_1	5.3998 ***	3.9949 ***	3.8213 ***	0.4547	0.4662	3.9019 ***	3.2629 ***
VI_CHINA_4	2.1659 **	2.2169 **	1.9374 *	1.6181	1.3149	-0.4798	-0.4713
VI_US_1	-2.1129 **	-1.6807 *	-1.8116 *	-0.4853	-0.4869	-2.4780 **	-2.8032 ***
VI_US_2	-2.8026 ***	-2.1971 **	-2.3634 **	-2.0196 **	-1.4304	-3.6045 ***	-3.5811 ***
VI_US_3	-1.4874	-1.2706	-1.3933	0.2572	0.3457	-1.9004 *	-1.8017 *
VI_US_4	1.5094	0.6471	0.8923	0.8388	0.7659	0.2137	0.2219
VI_US_6	2.3440 **	2.0176 **	1.7828 *	0.5558	0.5010	1.8915 *	1.9207 *
CNYUSD_D	-2.6711 ***	-1.7255 *	-1.7478 *	-1.8101 *	-1.6143	-0.1421	-0.2869
CNYUSD_D_2	-1.2173	-0.9730	-0.9443	-0.8117	-0.8045	0.1774	0.4700
CNYUSD_D_3	1.9324 *	1.0430	1.0747	2.3916 **	2.3223 **	-0.3738	-0.2464
CNYUSD_D_4	-1.2271	-1.1777	-1.0503	-1.8256 *	-1.6781 *	0.1219	0.2644
CNYUSD_D_6	1.7485 *	1.8105 *	1.5380	1.6566	1.6458	-2.4045 **	-2.5302 **
GDP_D	3.5037 ***	3.0425 ***	2.9173 ***	1.6544	1.4504	2.9490 ***	2.6568 **
SHANGHAI_INDEX_D	-2.3607 **	-2.2422 **	-2.2996 **	-1.2914	-1.2381	-2.9942 ***	-3.1855 ***
SHANGHAI_INDEX_D_5	2.8047 ***	2.9079 ***	2.8574 ***	1.7799 *	1.6614	-0.8829	-0.6411
INDUS_INDEX_D		0.6116	0.4135	1.7729 *	1.4625	-1.1696	-1.1430
INDUS_INDEX_D_1		0.6279	0.3513	1.5984	1.1396	-0.9088	-0.8023
INDUS_INDEX_D_2		-0.4738	-0.6656	0.6997	0.4434	-0.3390	-0.5409
INDUS_INDEX_D_3		0.1409	-0.0474	1.1081	0.7418	-0.6370	-0.4816
INDUS_INDEX_D_4		0.4221	0.2497	1.1465	0.8131	-0.5597	-0.6164
INDUS_INDEX_D_5		0.1135	-0.0013	0.9279	0.8213	0.0646	0.1308
INDUS_INDEX_D_6		0.4235	0.3588	0.8178	0.7962	-0.3934	-0.4844
URBAN_INVEST		0.8066	0.7829	-2.1850 **	-2.0178 **	-0.1093	-0.1348
URBAN_INVEST_1		-0.9779	-0.9069	1.9078 *	1.7007 *	0.1336	0.0905
URBAN_INVEST_2		1.0731	0.9528	-1.2112	-1.1268	-0.0597	0.0012
URBAN_INVEST_3		-1.0806	-0.9119	1.2867	1.2116	-0.0753	0.0401
URBAN_INVEST_4		1.0830	1.0889	-1.3224	-1.2449	-0.0090	-0.0028
URBAN_INVEST_5		-0.5256	-0.6314	1.5154	1.4460	-0.1853	-0.4319

URBAN_INVEST_6		-0.2538	-0.3032	-1.6816 *	-1.4540	-0.3752	-0.4393
TOE_CAPITA_DD		0.3498	0.6737	1.6005	1.3262	-0.7746	-0.5718
TOE_CAPITA_DD_1		-0.7224	-0.3721	-0.4683	-0.1761	0.2539	0.1617
TOE_CAPITA_DD_2		0.3572	0.5553	-1.2225	-0.6988	1.4379	1.5217
TOE_CAPITA_DD_3		-0.0063	0.0000	-2.1666 **	-2.1088 **	2.4912 **	2.4562 **
TOE_CAPITA_DD_4		0.0596	0.1369	0.4234	0.3586	0.1962	0.1848
TOE_CAPITA_DD_5		0.7780	0.7913	0.0331	0.0711	3.3427 ***	3.6115 ***
TOE_CAPITA_DD_6		-0.9894	-0.6990	1.3872	1.3079	0.4685	0.9122
CRIMEA			0.1407				0.0581
EGYPT			0.6193				1.2913
GAZA			-0.7714		-0.3292		
HURRICANE_KATRINA			-0.0893		0.1650		
IRAQUE			-0.6694		-0.4717		
LIBYA			-0.2643				-0.0424
NINEELEVEN			-0.3918		-0.6067		
R^2	0.4926	0.5224	0.5282	0.7541	0.7558	0.7468	0.7541
Adjusted R^2	0.4055	0.3540	0.3280	0.5349	0.5020	0.3820	0.3418
Akaike Info Criterion	5.9862	6.1677	6.2296	5.9189	5.9880	6.2043	6.2465
Schwarz Criterion	6.4782	7.0253	7.2073	7.1827	7.3529	7.6512	7.7802
Hannan-Quinn Criterion	6.1854	6.5152	6.6257	6.4311	6.5410	6.7860	6.8630

**** The test statistic is significant at 1%, ** The test statistic is significant at 5% , * The test statistic is significant at 10%*

Data obtained using Eviews Package
Source: Author´s Table

The significance of past Brent Crude prices stays robust in Specification 3 and the importance of the lagged 1 (Brent_D_1) and lagged 6 (Brent_D_6) oil price is to highlight. China Imports (China_Imports_D) become more significant in Specification 3, after they showed no significance in Specification 1 and Specification 2. This therefore confirms the observations by Mu and Ye (2011) but limits their conclusion considerably, as the analysis finds China to have a significant impact on oil prices. Contrary, the variable for US Imports (US_Imports_D) becomes insignificant for Specification 3. The same is to observe for the currency variables (CNYUSD_D), whose test statistic becomes less significant compared to Specification 2. The explanatory variables for Chinese GDP growth (GDP_D) and the Shanghai Stock Index (Shanghai_Index_D) show robust results compared to Specification 2. However, the stepwise reduction of Specification 2 to Specification 2 –reduced has eliminated most of their lagged variables.

The structural break in December 2008 holds true for Specification 3 at 1% (Chow Test). Similar to Specification 1, the dummy variables do not add to the explanatory value of the model in any (sub-)sample. The significant levels of the explanatory values added in Specification 2 changes between the two sub-samples, which is interesting to observe, as an analysis for Specification had to be omitted. CNY/USD shows to be significant only prior to 2009, whereas GDP growth and the Shanghai Stock Index became significant only after 2008. Whereas the CNY/USD was pegged the majority of time before 2009, the Chinese currency was mostly unpegged, although not freely floating, in the time afterwards. The significance of Chinese GDP growth on the oil prices developments confirms the results by Beirne et al. (2013). The industrial index (Indus_Index_D) and the urban investments (Urban_Invest, Urban_Invest_1) are also shown to be only significant in the time prior to 2009. Industrial production was the driving force of China´s economic growth until 2008, but the change towards qualitative growth reduces the importance of the sector. The observed econometric results support the qualitative observation of structural economic change in China. Urban investments would increase the demand for oil until further expansion, for example infrastructure, limit additional consumption of energy (Askari and Krichene 2010). Given the high growth of Chinese urban areas before 2009, the change in significance levels indicates that such a plateau has been reached. Energy intensity (TOE_CAPITA), shows to partly change the significant time lags in the sub-samples. The lagged variable of 3 months is significant in both samples, whereas lag 5 becomes significant only past 2008. A possible explanation for why changes in China´s energy intensity impacts oil after 2008 with a longer delay could be found in the time the market needs to observe and interpret the new information. The efforts by the Chinese government to improve energy intensity and the new policies to support such a development might motivate bias in the reported data, for which the market could require additional information to verify the reported statistics.

The added variables of Specification 3 add to explanatory value to the results from Specification 1 for the sub-samples. This comparison is restricted, as Specification 2 has not been regressed over the sub-samples. Over the entire period from 2000 to 2015, Specification 2 performs better than Specification 1 and 3. In all combinations, the dummy variables, reflecting geopolitical events, do not improve the explanatory value and are mostly not significant. The only exception is to be observed in Specification 1 for the time interval from 2009 to 2015. The Specification 1 and Specification 3 both perform better from 2000 to 2008 than from 2009 to 2015. Given the concentration on variables representing the demand from China, this supports the findings by Kilian and Hicks (2009) who conclude China´s demand for crude oil to have driven prices until 2008.

The regression output shows some robust and some mixed results. The interpretation of the specific variables must be considered with caution, as multicollinearity exists to some extent in all specifications. Furthermore, most explanatory variables are defined endogenously in economic theory, which limits the conclusion to the extent, that results need to be confirmed in further studies.

5. Conclusion

In this analysis the changes in the oil market, and the undergoing changes in the economy of one of its biggest consumers, China, were analysed over the past 15 years. The changes have in common that both are referred to as the “New Normal”, describing a sustainable, different state compared to market conditions ten years ago. The shale oil revolution has been the reason for important structural changes in the crude oil market. On the supply side, the power of OPEC has been restricted by shale oil producers and transformed the US from the biggest net oil importer to a temporary net oil exporter. It impacted the demand side directly, as the place of the biggest oil importer was then taken by China. For this reason, China´s demand for oil becomes of high interest. However, the demand for oil by China has considerably changed over the past. After the industrialization of its economy until 2008, the new scope of the government is to introduce qualitative growth rates, while transforming the economy into a service driven industry. This requires less oil and therefore changes the outlook for future demand growth significantly.

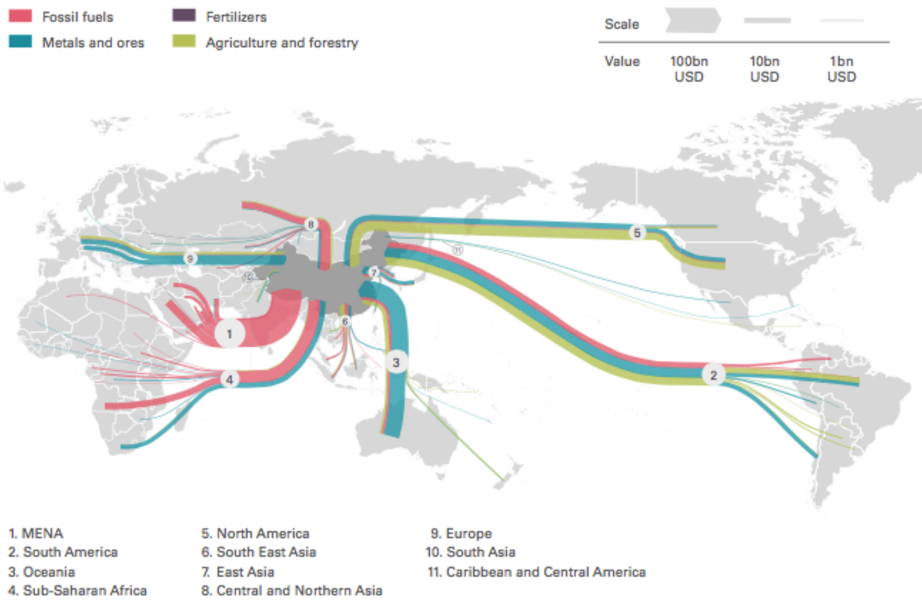
The changes observed in the qualitative analysis have been studied quantitatively only to a limited extent in previous literature. The results obtained for the importance of China have been mixed and the findings of this paper support the argument that this is largely due to the data sets and variables used. The case has been made that the Chinese demand for oil is complex and therefore the variables need to be chosen with caution and awareness of their limitations. The approach has been used by providing a detailed econometric analysis of the subject and a critical review of the data to obtain valuable results. The methodology allows to compare the importance of different variables and model specification considering general economic indicators but also specific variables that reflect the structural changes taking place in China. The linear multiple regression based on a structural model provides a first analysis of the topic at the expense of the interpretation of parameters coefficients.

It was found that a detailed approach can improve the explanatory power of the structural model that only considers import data. Additional variables considered, besides the classical import data of the US and China and GDP growth rates, are the Shanghai Stock Market Index, the CNY/USD exchange rate, energy intensity, urban investments and the industrial production index. Additionally, interaction variables of oil imports and oil prices were created to reflect country specific changes in oil imports. The study observes the change of regimes in 2008, not only caused by the financial crisis, but also caused by the shale oil revolution. Besides changing significance level, the importance of lagged variables confirms observations of the qualitative analysis of higher levels of price elasticities of supply and demand. The econometric results allow for an analysis of the significance level of different demand variables from 2000 to 2015 and the change of their significance for the time period before and after December 2008. The qualitative observations can be observed and arguments on structural changes supported. Besides the actual results of the regressions, the main conclusion therefore is, that the method applied leads to a valuable econometric analysis of complex changes in the international oil market and the Chinese economy. Studies, such as Mu and Ye (2011), that consider net oil imports and found no significant impact by China on the oil price, might observe a significant impact, when considering alternative variables such as presented in this study.

Therefore, the research in the field should be continued and future studies should try to estimate non-bias parameter coefficients which could then more specifically analyse obtained results in this study. Whereas in past literature the changes in the oil market and the specific and complex economic and political state of China have been considered to a limited extend, this research presents a method to account for the different characteristics. An application of the analysis to a two-stage least square estimation method and/or a structural vector autoregressive model would enhance the validity of the obtained results. In another step, the robustness of the results could be tested by comparing the added explanatory value when the demand by other countries is considered more explicitly.

Appendix 1: International Flow of Commodities

Figure 3: Resource Flows into China, 2014

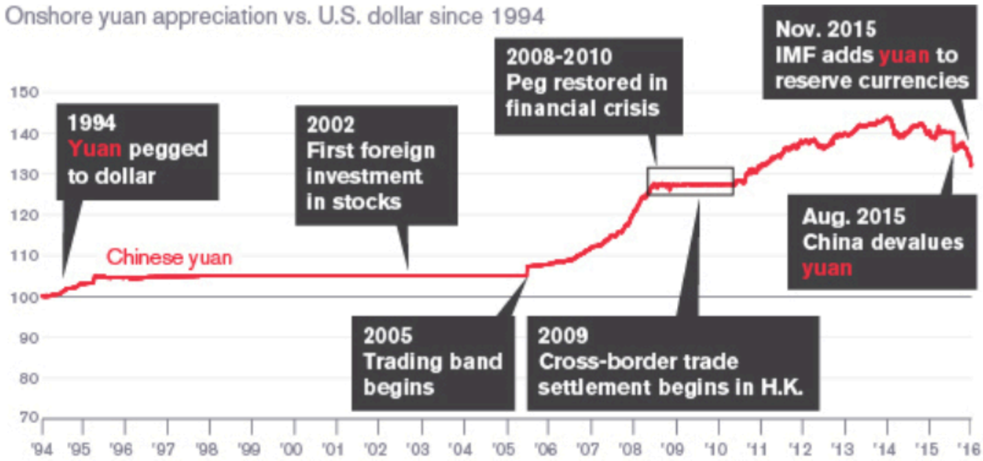


Source: Preston et al. (2016), p.9

Figure 8 shows the global resources flows equal to or greater than $1 billion. Of all worldwide resource, 98.3% flow into China. It is of apparent concern to China, to diversify the export countries it conducts business with. Nevertheless, regional interdependencies are created and natural resources are sometimes competed for.

Appendix 2: CNY/ USD Development

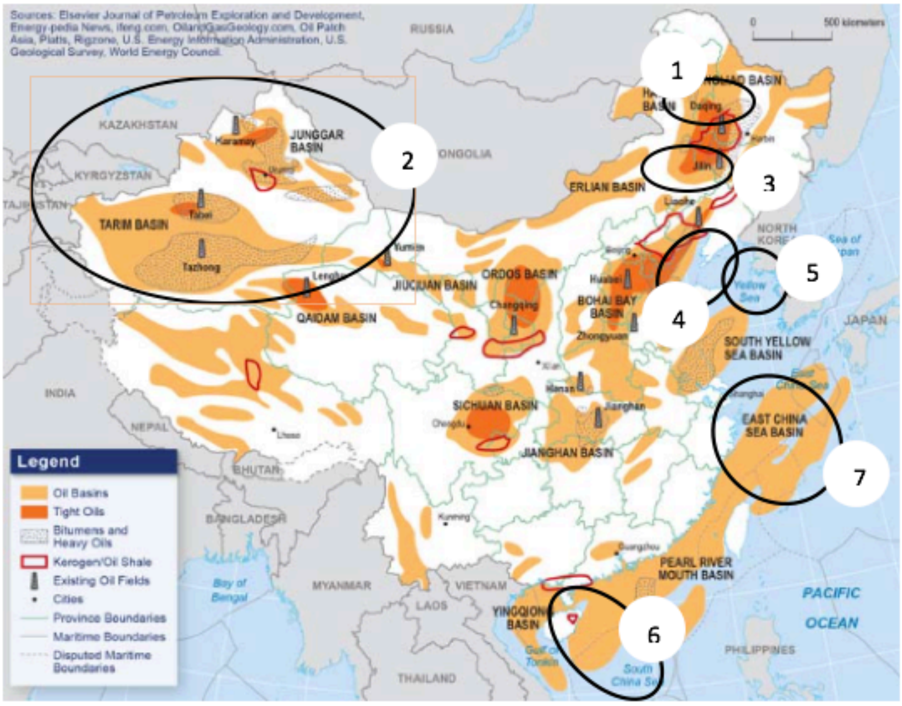
Figure 4: History of Internationalization efforts of the Yuan, 1994-2016



Source: Li (2016)

Appendix 3: China´s Oil Production

Figure 5: China´s largest oil fields



Source: EIA (2015), p. 8; Highlighted and additional legend added by author

1: Daqing	*4: Bohai Bay*
2: Tarim Basin and Junggar Basin	*5: Yellow Sea*
	6: South China Sea
3: Jilin	*7: East China Sea*

Most crude oil production is placed onshore (80%) but recent extraction and production strategies have concentrated on offshore fields, while China´s energy policy also aims at additional investments in tight oil extraction. Incremental production increases are achieved by the new offshore fields as well as enhance oil recovery techniques used for mature onshore fields. The oldest onshore field is Daqing (northeast China, highlighted "1" on Figure 10) which contributes 19% of China´s total crude oil production (EIA 2015). Daqing is exploited since the 1960s and is expected to produce 640,000 bbl/d by 2020 compared to 800,000 bbl/d in 2014. Besides the limited reserves which require enhanced oil recovery techniques and hence translate into higher production costs, the lower international oil prices support the development. Production growth can only be observed in interior provinces, such as the Tarim Basin or Junggar Basin (northwest China, highlighted "2" on Figure 10), achieved by advanced oil extraction and improved drilling techniques to access more complex geological reserves. Hydraulic fracturing (fracking), targeted by the Chinese government to be extended, is existing in the onshore field Jilin to mitigate declining outputs of the field (northeast China, south of Daqing, highlighted “3” on Figure 10).

China´s offshore reserves are smaller than its onshore reserves and hence mature at a faster rate. Therefore, mostly deep-water fields are currently explored in Bohai Bay, Yellow Sea and South China Sea (highlighted “4”, “5” and “6” respectively on Figure 10). Developments in the East China Sea (highlighted “7” respectively on Figure 10) are restricted due to territorial disputes with Japan, which are ongoing since 2009. Similar rising disagreements can also be observed on territorial claims in the South China Sea (“6”) between China and Vietnam and China and the Philippines.

Given the limited onshore reserves, resulting in declining production growth rates compared to increasing production outputs until 2010, China must either access technological more advanced oil fields more profitable, extract more oil from shale oil reserves or concentrate and resolve territorial disputes in offshore locations to keep up its production levels. The challenges are mostly and especially faced by the national oil companies.

Appendix 4: Derivation of Structural Model

For the analysis, quantity supplied is simplified by a function of past oil prices. The reasoning is based on the assumption, that historical prices reflect past equilibria of supply and demand. Hence, swing producers can extract required information on past demand from prices in order to anticipate current and future demand. Residual producers react directly to price levels and adjust their production (Stevens 1995). Time lags of the price are included to allow for a delayed reaction by oil producers. The time delay may not only result from time consuming changes in the production volumes[16], but also result from temporary unchanged production levels due to hedging strategies or debt-in-possession financing. For this analysis, historical oil prices of one year are considered. Given the monthly calibration, the time lags include 12 historical crude oil prices in equation (0.2)[17]. Oil supply is specified in a world aggregated form. Therefor, Q_s considers oil producing companies and countries, OPEC members and non-members. Whereas oil supply can be affected by many country specific variable such as interest, exchange rates and technological factors, the aggregate world specification does not account for these country-specific variables (Askari and Krichene 2010). The parameter β_{SP} describes the coefficient of the current oil price level explaining the changes in quantity supplied, whereas the "S"-index indicates the supply side and the "P"-index indicates the affiliation to the current oil price level.

On the other hand, the demand function will be defined by the demand from China and the US. Previous to China, the US was the net largest oil importer of crude oil and therefore, the demand by both countries will also be considered in equation (0.3)[18]. In order not to propose a tautology and define the equation by definition (Halcoussis 2005), the demand from other countries is neglected. Considering the literature reviewed on demand price elasticities, one can conclude that the impact of oil prices on oil demand is different between households and industries. While households tend to be rather inelastic

[16] The understanding that oil extraction, once the oil field is established, can vary relies on the theory of real options. Hence, the producer might pause production or reduce the output to make use of the time value, possibly allowing a future higher price to start production again or enhanced technology to produce at lower costs. Although, once fields are exploited, the establishment of new traditional oil reserves is very time costly (up to 5 years), the shale oil revolution allows for a quick set up of rigs (as fast as 6 months) with little to no costs of pausing production output.

[17] Equation 0.2. states: $Q_S = c_S + \beta_{SP}\, p_t + \beta_{S(j)}\, p_{t-j} + u_{S,t}\,;_{\ j= 1,2, \ldots, 12}$

[18] Equation 0.3. states: $Q_D = c_D + \beta_{DChina}\, Q_{Dchina,\ t} + \beta_{DChina(i)}\, Q_{DChina,\ t-I} + \beta_{DC}\, Q_{DC,\ t} + \beta_{DC\ (i)}\, Q_{DC,\ t-I} + \beta_{DChinaIV}\, p_t\, Q_{DChina,\ t} + \beta_{IVChina(i)}\, p_{t-i}\, Q_{DChina,\ t-i} + \beta_{DUS}\, Q_{DUS,\ t} + \beta_{DUS(i)}\, Q_{DUS,\ t-i} + \beta_{IVDUS}\, p_t\, Q_{DUS,\ t} + \beta_{IVDUS(i)}\, p_{t-i}\, Q_{DUS,\ t-i} + u_{D,t}\,;_{\ i= 1, \ldots, 6}$

to price changes, industries relocate the costs or cut production. Considering for the difference between China and the US, also in terms of energy use by households and importance of manufacturing versus service industries, interaction variables are included in the demand equation. The interaction variables reflect, how the price of oil determines differently the quantity demanded by China and the US. Considering, that adjustments in the industry and households take time, time lags are included for both interaction variables. Considering the nature of many contracts, determining future quantity of sales, but also the semi-annual publication of performances by public companies, six lags for the price of crude are included, representing half-a-year.

As the purpose of this analysis is to find the impact on the oil price, the two equations are solved simultaneously for the price of oil. To simplify the equation for further usage, lambda (λ) is introduced in equation 0.8.

$$c_S + \beta_{SP}\, p_t + \beta_{S(j)}\, p_{t-j} + u_{S,t} = c_D + \beta_{DChina}\, Q_{Dchina,\,t} + \beta_{DChina(i)}\, Q_{DChina,\,t-I} + \beta_{DC}\, Q_{DC,\,t} + \beta_{DC\,(i)}\, Q_{DC,\,t-I} + \beta_{DChinaIV}\, p_t\, Q_{DChina,\,t} + \beta_{IVChina(i)}\, p_{t-i}\, Q_{DChina,\,t-i} + \beta_{DUS}\, Q_{DUS,\,t} + \beta_{DUS(i)}\, Q_{DUS,\,t-i} + \beta_{IVDUS}\, p_t\, Q_{DUS,\,t} + \beta_{IVDUS(i)}\, p_{t-i}\, Q_{DUS,\,t-i} + u_{D,t} \tag{1.1}$$

$$j = 1, 2, \dots, 12 \qquad i = 1, \dots, 6$$

$$\beta_{SP}\, p_t + \beta_{DChinaIV}\, p_t\, Q_{DChina,\,t} + \beta_{IVDUS}\, p_t\, Q_{DUS,\,t} = c_D + \beta_{DChina}\, Q_{Dchina,\,t} + \beta_{DChina(i)}\, Q_{DChina,\,t-I} + \beta_{DC}\, Q_{DC,\,t} + \beta_{DC\,(i)}\, Q_{DC,\,t-I} + \beta_{IVChina(i)}\, p_{t-i}\, Q_{DChina,\,t-i} + \beta_{DUS}\, Q_{DUS,\,t} + \beta_{DUS(i)}\, Q_{DUS,\,t-i} + \beta_{IVDUS(i)}\, p_{t-i}\, Q_{DUS,\,t-i} + u_{D,t} - (c_S + \beta_{S(j+1)}\, p_{t-j} + u_{S,t}) \tag{1.2}$$

$$j = 1, 2, \dots, 12 \qquad i = 1, \dots, 6$$

$$(\beta_{SP} + \beta_{DChinaIV}\, Q_{DChina,\,t} + \beta_{IVDUS}\, Q_{DUS,\,t})\, p_t = c_D + \beta_{DChina}\, Q_{Dchina,\,t} + \beta_{DChina(i)}\, Q_{DChina,\,t-I} + \beta_{DC}\, Q_{DC,\,t} + \beta_{DC\,(i)}\, Q_{DC,\,t-I} + \beta_{IVChina(i)}\, p_{t-i}\, Q_{DChina,\,t-i} + \beta_{DUS}\, Q_{DUS,\,t} + \beta_{DUS(i)}\, Q_{DUS,\,t-i} + \beta_{IVDUS(i)}\, p_{t-i}\, Q_{DUS,\,t-i} + u_{D,t} - (c_S + \beta_{S(j+1)}\, p_{t-j} + u_{S,t}) \tag{1.3}$$

$$j = 1, 2, \dots, 12 \qquad i = 1, \dots, 6$$

$$\lambda\, p_t = c_D + \beta_{DChina}\, Q_{Dchina,\,t} + \beta_{DChina(i)}\, Q_{DChina,\,t-I} + \gamma_t + \gamma_{t-i} + \beta_{IVChina(i)}\, p_{t-i}\, Q_{DChina,\,t-i} + \beta_{DUS}\, Q_{DUS,\,t} + \beta_{DUS(i)}\, Q_{DUS,\,t-i} + \beta_{IVDUS(i)}\, p_{t-i}\, Q_{DUS,\,t-i} + u_{D,t} - (c_S + \beta_{S(j+1)}\, p_{t-j} + u_{S,t}) \tag{1.4}$$

$$j = 1, 2, \dots, 12 \qquad i = 1, \dots, 6$$

$$\lambda = \beta_{SP} + \beta_{DChinaIV}\, Q_{DChina,\,t} + \beta_{IVDUS}\, Q_{DUS,\,t}$$

$$\gamma_t = \beta_{DC}\, Q_{DC,\,t}$$

$$\gamma_{t-i} = \beta_{DC\,(i)}\, Q_{DC,\,t-i}$$

Gamma (γ) is also introduced in equation 1.4 to outline the demanded crude oil from China specifically, as the analysis will concentrate on the significance of this parameter. The remaining coefficients are generously simplified in the next equation. Given the complexity, their value will not be analyzed, but the test statistics on the significance of the parameter is still of value and is the center of this analysis.

$$p_t = c_p + b\, Q_{Dchina,\, t} + b_{(1+i)}\, Q_{DChina,\, t-I} + \gamma_t + \gamma_{t-i} + b_{IV,\, China)}\, p_{t-i}\, Q_{DChina,\, t-i} + b_{US}\, Q_{DUS,\, t} + b_{US,\, (1+i)}\, p_{t-j}\, Q_{DUS,\, t-j} + \beta_{IVDUS(i)}\, p_{t-i}\, Q_{DUS,\, t-i} - b_{supply}\, p_{t-j} + u_{p,t} \tag{1.5}$$

j= 1, 2, … , 12

i= 1, …, 6

$$c_p = \frac{c_D}{\lambda} - \frac{c_S}{\lambda} \qquad u_{p,t} = \frac{1}{\lambda}(u_{D,t} - u_{S,t})$$

$$b = \frac{\beta_{DChina}}{\lambda} \qquad b_{,(i)} = \frac{\beta_{DChina,(i)}}{\lambda}$$

$$b_{IV,\, China} = \frac{\beta_{IVChina(i)}}{\lambda} \qquad b_{IV,\, DUS} = \frac{\beta_{IVDUS(i)}}{\lambda}$$

$$b_{US} = \frac{\beta_{DUS}}{\lambda} \qquad b_{US,\,(i)} = \frac{\beta_{DUS,(i)}}{\lambda}$$

$$b_{supply} = \frac{\beta_{S,(1+j)}}{\lambda}$$

Appendix 5: Multicollinearity - Specification 2

Table 6: Vector Inflation Factors Specification 2

	2000-2015	2000-2008	2009-2015
BRENT_D_1	3.24	7.37	3.93
BRENT_D_2	3.75	3.40	8.13
BRENT_D_3	4.00	8.16	4.14
BRENT_D_6	4.47	5.72	10.99
BRENT_D_7	5.01	7.91	13.54
BRENT_D_9	2.80	5.10	9.29
BRENT_D_10	4.72	4.10	15.75
BRENT_D_11	3.99	6.51	10.15
BRENT_D_12	4.29	6.50	8.86
CHINA_IMPORTS_D	6.91	10.92	26.85
CHINA_IMPORTS_D_1	11.65	15.06	33.82
CHINA_IMPORTS_D_2	8.35	18.01	20.23
CHINA_IMPORTS_D_3	10.02	22.17	18.27
CHINA_IMPORTS_D_4	8.75	12.58	24.01
CNYUSD	2.19	42.57	5.72
CNYUSD_D	4.77	7.14	8.71
CNYUSD_D_1	3.89	8.52	7.88
CNYUSD_D_2	2.56	6.33	12.05
CNYUSD_D_3	3.09	25.04	8.96
CNYUSD_D_4	5.00	6.98	14.55
CNYUSD_D_5	3.77	16.61	4.26
CNYUSD_D_6	4.02	8.62	5.46
GDP_D	5.66	16.63	27.34
GDP_D_1	9.32	18.96	52.24
GDP_D_2	11.39	13.32	67.66
GDP_D_3	17.95	49.82	31.66
GDP_D_4	18.09	33.88	47.21
GDP_D_5	14.62	15.13	34.85
GDP_D_6	8.42	13.48	16.90

Data obtained using Eviews Package
Source: Author´s Table

Appendix 5: Regression Results Specification 2

Table 7: Test Statistics Specification 2, 2000 - 2015

	Specification 1 (reduced)		Specification 2		Specification 2 (incl. Dummy Variables)	
BRENT_D_1	3.5908	***	3.4362	***	3.2044	***
BRENT_D_2	2.1849	**	1.0922		0.9335	
BRENT_D_3	-0.7062		-1.0875		-1.1423	
BRENT_D_6	-2.6275	***	-3.4979	***	-3.5812	***
BRENT_D_7	1.5468		1.4469		1.6008	
BRENT_D_9	-1.2245		-0.9938		-1.0014	
BRENT_D_10	1.3878		2.0462	**	1.9008	*
BRENT_D_11	2.0735	**	1.4827		1.4932	
BRENT_D_12	-1.5441		-0.5418		-0.7079	
CHINA_IMPORTS_D	-1.2085		-1.1681		-1.2602	
CHINA_IMPORTS_D_1	0.9991		0.5954		0.3692	
CHINA_IMPORTS_D_2	1.5136		0.9052		0.7700	
CHINA_IMPORTS_D_3	1.8198	*	1.5656		1.4721	
CHINA_IMPORTS_D_4	2.0655	**	2.1633	**	1.9986	**
US_IMPORTS_D	-3.0948	***	-2.4095	**	-2.4255	**
US_IMPORTS_D_1	-1.5747		-0.8482		-0.9016	
US_IMPORTS_D_3	1.1033		1.4674		1.1895	
US_IMPORTS_D_4	-0.8051		-0.2979		-0.7458	
VI_CHINA_1	4.3867	***	4.2789	***	4.1112	***
VI_CHINA_4	1.0988		1.9517	*	1.7273	*
VI_US_1	-2.9792	***	-2.1753	**	-1.9690	*
VI_US_2	-2.2576	**	-2.2748	**	-2.8060	***
VI_US_3	-1.5155		-1.1980		-1.2678	
VI_US_4	1.3984		1.3909		1.5512	
VI_US_6	1.6687	*	2.1246	**	2.2762	**
CNYUSD_D			-2.3084	**	-2.2040	**
CNYUSD_D_1			-0.4088		-0.4786	
CNYUSD_D_2			-1.0913		-1.0342	
CNYUSD_D_3			1.1017		1.1590	
CNYUSD_D_4			-1.1121		-0.9959	
CNYUSD_D_5			-0.0005		-0.0004	
CNYUSD_D_6			1.6236		1.3514	
GDP_D			2.8284	***	2.6663	***
GDP_D_3			0.3379		0.2647	
GDP_D_6			0.7143		0.8899	
SHANGHAI_INDEX_D			-2.1217	**	-2.2168	**
SHANGHAI_INDEX_D_1			0.7306		0.7375	
SHANGHAI_INDEX_D_2			-0.5343		-0.4506	
SHANGHAI_INDEX_D_3			-0.5060		-0.7093	
SHANGHAI_INDEX_D_4			-0.2465		-0.0178	
SHANGHAI_INDEX_D_5			2.0732	**	1.9751	*
SHANGHAI_INDEX_D_6			-0.1217		-0.3590	
CRIMEA					-1.1034	
EGYPT					1.4647	
GAZA					-1.1440	
HURRICANE_KATRINA					-0.3875	
IRAQUE					-0.9707	
LIBYA					-0.4689	
NINEELEVEN					-0.8625	
R^2	0.4044		0.5035		0.5137	
Adjusted R^2	0.3188		0.3678		0.3505	
Akaike Info Criterion	6.1047		6.0999		6.1521	
Schwarz Criterion	6.5289		6.8125		6.9834	
Hannan-Quinn Criterion	6.2765		6.3885		6.4888	

**** The test statistic is significant at 1%, ** The test statistic is significant at 5% , * The test statistic is significant at 10%*

Data obtained using Eviews Package
Source: Author´s Table

Appendix 6: Multicollinearity - Specification 3

Table 8: Vector Inflation Factors Specification 3, 2000 - 2015

	VIF		VIF
BRENT_D_1	1.76	GDP_D	1.38
BRENT_D_2	2.08	SHANGHAI_INDEX_D	1.56
BRENT_D_3	2.17	SHANGHAI_INDEX_D_5	1.36
BRENT_D_6	1.90	INDUSTRIAL_INDEX_D	1.86
BRENT_D_7	1.74	INDUSTRIAL_INDEX_D_1	3.04
BRENT_D_9	1.81	INDUSTRIAL_INDEX_D_2	3.37
BRENT_D_10	1.91	INDUSTRIAL_INDEX_D_3	3.49
BRENT_D_11	1.67	INDUSTRIAL_INDEX_D_4	3.31
CHINA_IMPORTS_D	1.38	INDUSTRIAL_INDEX_D_5	2.73
CHINA_IMPORTS_D_2	2.44	INDUSTRIAL_INDEX_D_6	1.70
CHINA_IMPORTS_D_3	3.92	URBAN_INVESTMENTS	9.49
CHINA_IMPORTS_D_4	2.63	URBAN_INVEST_1	19.34
US_IMPORTS_D	1.48	URBAN_INVEST_2	17.74
US_IMPORTS_D_3	1.37	URBAN_INVEST_3	16.96
VI_CHINA_1	1.54	URBAN_INVEST_4	15.31
VI_CHINA_4	1.83	URBAN_INVEST_5	15.29
VI_US_1	1.94	URBAN_INVEST_6	8.24
VI_US_2	2.57	TOE_CAPITA_DD	1.37
VI_US_3	2.61	TOE_CAPITA_DD_1	1.32
VI_US_4	2.16	TOE_CAPITA_DD_2	1.24
VI_US_6	1.49	TOE_CAPITA_DD_3	1.37
CNYUSD_D	2.18	TOE_CAPITA_DD_4	1.25
CNYUSD_D_2	2.23	TOE_CAPITA_DD_5	1.14
CNYUSD_D_3	2.50	TOE_CAPITA_DD_6	1.12
CNYUSD_D_4	2.52		
CNYUSD_D_6	2.19		

Data obtained using Eviews Package
Source: Author´s Table

6. References

Anandan. M. and S. Ramaswamy (2015), “Global Oil Market: Macro Economic Scenario”, *Global Journal of Research Analysi,s* Vol. 4, N°9, pp. 53 – 57.

Askari, Hossein and Noureddine Krichene (2010), “An oil demand and supply model incorporating monetary policy”, *Energy* Vol. 35, pp. 2013-2021.

Alejandro Badel and Joseph McGillicuddy (2015), "Oil Prices: Is Supply or Demand Behind the Slump?”, Federal Reserve Bank of St. Louis. Economic Synopses, Vol. 8.

Balding, Christopher (2015), “Fed Leaves China Only Tough Choices”, *Bloomberg View,* Accessed on 15 Dec 2015, http://www.bloomberg.com/view/articles/2015-12-16/fed-rate-hike-leaves-china-only-tough-choices, 4 April 2016.

Baumeister, Christiane and Lutz Kilian (2015), “Understanding the Decline in the Price of Oil Since June”, *CEPR Discussion Paper,* N° 10404.

Baumeister, Christiane and Lutz Kilian (2016), “Forty Years of Oil Price Fluctuations: Why the price of oil might still surprise us*”, Journal of Economic Perspectives,* Vol. 30, N°1, pp. 139 – 160.

Behmiri, Niaz and José Manso (2013), “Crude Oil Price Forecasting Techniques: a Comprehensive Review of Literature”, *Alternative Investment Analyst Review,* Vol. 2 N°3 pp. 30-48.

Beirne, John et al. (2013), ”Global oil prices and the impact of China”, *China Economic Review,* Vol. 27, pp. 37-511.

Bern, Gianna (2011), *Investing in Energy*. Hoboken: John Wiles & Sons Inc..

Cooper, John C.B. (2003), “Price elasticity of demand for crude oil: estimates for 23 countries”, *OPEC Review,* Vol. 27, N°1 pp. 1 - 8.

Cong, Rong-Gang and Yi-Ming Wei (2008), “Relationships between oil price shocks and stock market: An empirical analysis from China.” *Energy Policy,* Vol. 36, N° 9, pp. 3544 – 3553.

Crooks. Ed (2015) “The US shale revolution”, *Financial Times* 24 April 2015, https://next.ft.com/content/2ded7416-e930-11e4-a71a-00144feab7de, Accessed on 2 May 2016.

Curra, Enda (2016), “China´s Debt Bomb: Danger or Dud?”, *Bloomberg Quick Take*, 24 May 2016, http://www.bloomberg.com/quicktake/chinas-debt-bomb, Accessed on 26 May 2016.

Energy Information Administration (2015), "Energy & Financial Markets: What Drives Crude Oil Prices?", http://www.eia.gov/finance/markets/, Accessed on 7 November 2015.

Fan, Ying and Jin-Hua Xu (2011), "What has driven oil prices since 2000? A structural change perspective", *Energy Economics* ,Vol. 33, pp. 1082 – 1094.

Fattouh, Bassam (2007), "The Drivers of Oil Prices: The Usefulness and Limitations of Non-Structural Model. the Demand–Supply Framework and Informal Approaches", *Oxford Institute for Energy Studies,* WPM 32.

Fattouh, Bassam, Lutz Kilian and Lavan Mahadeva (2012), "The Role of Speculation in Oil Markets: What Have We Learned So Far?", *The Energy Journal,* Vol.34, N°. 3.

Gallo, Andreas et al. (2010), "What is behind the increase in oil prices? Analyzing oil consumption and supply relationship with oil price", *Energy,* Vol. 35, pp. 4126 – 4141.

Ghalayini, Latifa (2011), "The Interaction between Oil Price and Economic Growth", *Middle Eastern Finance and Economics,* Vol. 13, pp. 127 – 141.

Gopinath, Swetha and Joshua Schneyer (2016), "As US shale drillers suffer. even the bankrupt keep pumping oil." *Reuters*, 1 April 2016, http://www.reuters.com/article/us-usa-energy-bankruptcies-idUSKCN0WY3JU, Access 2 April 2016.

Gracie, Carrie (2015), "China´s ´new normal´- a bit too much like the old normal", *BBC News,* 29 Dec 2015, http://www.bbc.com/news/world-asia-china-35149258, Accessed on 11 Jun 2016.

Halcoussis, Dennis (2005), *Understanding Econometrics*, Ohio: South-Western.

Hamilton, James (2008), "Understanding Crude Oil Prices", *National Bureau of Economic Research (NBER) Working Paper,* N°. 14492.

Hamilton, James (2010), "Nonlinearities and the Macroeconomic Effects of Oil prices", *National Bureau of Economic Research (NBER) Working Paper* N°. 16186.

Jones, Donald, Paul Leiby and Inja Paik (2004), "Oil Price Shocks and the Macroeconomy: What Has Been Learned Sicne 1996", *The Energy Journal,* Vol. 25, N°2, pp. 1 -32.

International Energy Agency (2015), "Medium-Term Oil Market Report 2015", http://www.iea.org/publications/medium-termreports/, Accessed on 12 April 2016.

Kawa, Luke (2016a), “Deutsche Bank: China's Oil Demand Growth Could Be Cut in Half by the End of the Decade”, 9 March 2016, *Bloomberg,* http://www.bloomberg.com/news/articles/2016-03-09/deutsche-bank-china-s-oil-demand-growth-could-be-cut-in-half-by-the-end-of-the-decade, Accessed on 3 May 2016.

Kawa, Luke (2016b), “Credit Suisse: The Death of Oil Demand has been Greatly Exaggerated”, 28 Mach 2016, *Bloomberg,* http://www.bloomberg.com/news/articles/2016-03-28/credit-suisse-the-death-of-oil-demand-has-been-greatly-exaggerated, Accessed on 2 April 2016.

Kawa, Luke (2015), “Jefferies: China´s Demand for Oil Is Totally Misunderstood by the Market”, 29 September 2015, *Bloomberg,* http://www.bloomberg.com/news/articles/2015-09-29/jefferies-china-s-demand-for-oil-is-totally-misunderstood-by-the-market, Accessed on 3 April 2016.

Kilian, Lutz (2009), “Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market” *American Economic Review,* Vol. 99, N°3, pp. 1053 - 1069.

Kilian, Lutz and Bruce Hicks (2013), “Did Unexpectedly Strong Economic Growth Cause the Oil Price Shock of 2003 – 2008?”, *Journal of Forecasting,* Vol. 32, N° 5, pp. 385 - 394.

Kilian, Lutz und Thomas Lee (2014), “Quantifying the Speculative Component in the Real Price of Oil: The Role of Global Oil Inventories”, *Journal of International Money and Finance,* Vol. 42, pp. 1053-69.

Kilian, Lutz. and Robert J. Vigfusson (2009), “Are the Responses of the U.S. Economy Asymmetric in Energy Price Increases and Decreases?”, *University of Michigan Working Paper.*

King, Kathleeen, Ai Deng and David Metz (2011), “An Econometric Analysis of Oil Price Movements: The role of Political Events and Economic News. Financial Trading. and Market Fundamentals”, *Bates and White Economic Consulting.*

Krugman, Paul (2016), “Oil goes non-linear” *The New York Times* – The opinion pages, 16 January 2016, http://krugman.blogs.nytimes.com/2016/01/16/oil-goes-nonlinear/, Accessed on 4 February 2016.

Lechthaler, Filippo and Lisa Leinert (2012), “Moody Oil - What is Driving the Crude Oil Price?” *Center of Economic Research at ETH Zurich (CERETH)* Economic Working Paper N°. 12/168.

Li, Minqi (2007), “Peak Oil. the Rise of China and the Global Energy Crisis.” *Journal of Contemporary Asia* Vol. 37 (4) pp. 449 – 471.

Lilien, D. (1982) "Sectoral shifts and cyclical unemployment*", Journal of Political Economy,* Vol. 90, pp. 777 – 793.

Mănescu, Christiana Belu and Galo Nuño (2015), “Quantitative effects of the shale oil revolution”, European Central Bank Working Paper Series, N° 1855.

Meidan, Michal, Amrita Sen and Robert Campbell (2015), “China: the `new normal´.” Oxford Institute for Energy Studies.

McCracken, Ross. “Stockpiling or Consuming: China’s Current Oil Demand”, IAEE First Quarter 2010.

Morck, Knut Anton (1989), “Oil and Macroeconomy - When Prices Go Up and Down: An Extension of Hamilton´s Results.” *Journal of Political Economy,* Vol. 97, N° 3 pp. 740 – 744.

Morrison. Wayne M. (2009), “China´s Economic Conditions.” *Congressional Research Service 7-5700.*

Mu, Xiaoyi and Haichun Ye (2011), “Understanding the Crude Oil Price: How important is the China Factor?” *The Energy Journal* Vol. 32 (4) pp. 69 – 92.

Preston, Felix et al. (2016), “Navigating the New Normal: China and Global Resource Governance”, *A joint DRC and Chatham House Report.*

Rapier, Robert (2016), “The Break Even Costs for Shale Oil.” 29 February 2016, Forbes http://www.forbes.com/sites/rrapier/2016/02/29/the-break-even-cost-for-shale-oil/#32c8e3b5e792, Accessed on 1 April 2016.

Roncaglia, Alessandro (2003), “Energy and Market Power: An Alternative Approach to the Economics of Oil”, *Journal of Post Keynesian Economics* Vol. 25. N°. 4 pp. 641-659.

Smith, James L. (2009), ”World Oil: Market or Mayhem?” *Journal of Economic Perspectives* Vol. 23, N°. 3, pp.145-164.

Shinn, David (2010), “Africa. China the United States and Oil.” *Centre for Strategic and International Studies (CSIS)* http://csis.org/print/13848 Accessed on 03 April 2016.

Stevens, Paul (1995), “The determination of oil prices 1945 – 95: A diagrammatic interpretation.” *Energy Policy* ,Vol. 23, N° 10, pp. 861 -870.

The Economist (2014a), “Saudi America”, 15 February 2014, http://www.economist.com/news/united-states/21596553-benefits-shale-oil-are-bigger-many-americans-realise-policy-has-yet-catch , Accessed on 24 March 2016.

The Economist (2014b), “In a bind”, 6 December 2014, http://www.economist.com/news/finance-and-economics/21635505-will-falling-oil-prices-curb-americas-shale-boom-bind ,Accessed on 4 June 2015.

Yuan, Jia-Hai et al. (2008), “Energy consumption and economic growth: Evidence from China at both aggregated and disaggregated levels”, *Energy Economics,* Vol. 30, pp. 3077-3094.

Zou, Gaolu and K.W. Chau (2006), “Short- and long run effects between oil consumption and economic growth in China”, *Energy Policy,* Vol. 34, pp. 3644 – 3655.

Zweig, David (2005), “China´s Global Hunt for Energy”, *Foreign Affairs* Vol. 84 N°5, pp. 25-38.