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Oil Price Effects on Economic Growth

A Comparison between the BRIC countries and the Western World (G7)

Bachelor Thesis in: Economics

Authors: Andreas Nilsson
Adam Sundqvist

Tutors: Andreas Stephan, Professor
Jan Weiss, Ph. D.

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Titel: Oljeprisets effekt på ekonomisk tillväxt – BRIC mot västvärlden

Författare: Andreas Nilsson
Adam Sundqvist

Handledare: Andreas Stephan, Proffesor
Jan Weiss, Doktorand

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Sammanfattning

Syftet med denna uppsats är att undersöka om ekonomisk tillväxt i BRIC länderna (Brasilien, Ryssland, Indien och Kina) kan förklaras av förändringar i oljepris med fokusering på utvalda makroekonomiska variabler. Vi kommer också analysera om det finns några skillnader i ekonomisk tillväxt mellan BRIC länderna och västvärlden (G7) när förändringar i oljepris existerar. Modellen som appliceras är en Koyck omvandling, som utvecklades av Leendert Marinus Koyck år 1954, vilken omvandlar en distriburerad lagg modell till en autoregressiv modell. Den statistiska datan täcker 11 länder och deras kvartals data för variablerna: real ränta, oljepris, US dollar växelkurs och bytesbalans, vilka är ekonomiskt och teoretiskt kopplade till den undersökta variabeln, real BNP. Den distrubuerade lagg modellen inkluderar föregågna värden av real BNP samt oljepris. De förklarande variablerna är laggade upp till 4 perioder, där en period är ett kvartal.

Det framkom att det finns ett klart förhållande mellan oljepris och ekonomisk tillväxt, samt att det inte finns något konsekvent resultat för hur oljepriset påverkar BNP. Varken för BRIC länderna eller G7 klustret. BRIC länderna genererade ett delat resultat, vilket förklaras av olje-export/import. För västvärlden erhålls en positiv korrelation mellan ekonomisk tillväxt och förändringar i oljepriset som kan förklaras av ett befintligt oljeberonende.

I vår model förekommer det både negativa och positiva resultat, samt en okänd variabel som påverkar några av länderna. Denna variabel bör undersökas ytterligare huruvida resultatet är konsekvent i varje enskilt fall. Från resultaten samt tidigare studier kan man konstatera att det inte finns ett säkert resultat av hur oljepriset påverkar ekonomisk tillväxt.

Bachelor Thesis in Economics

Title: Oil Price Effects on Economic Growth – BRIC versus the Western World

Authors: Andreas Nilsson
Adam Sundqvist

Supervisors: Andreas Stephan, Professor
Jan Weiss, Ph.D.

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Abstract

The purpose of this thesis is to investigate whether economic growth in the BRIC countries (Brazil, Russia, India and China) can be explained by changes in the oil price, with a focus on selected macroeconomic variables. We will also investigate if there are any differences in oil price effects on economic growth between the BRIC countries and the western world (G7). The model used is a Koyck transformation model developed by Leendert Marinus Koyck in 1954, which converts a distributed lag model into an autoregressive model. The data used in this thesis covers 11 countries and their quarterly data for the variables: real interest rate, oil price, US dollar exchange rates and current account (exports-imports), which are all economically and theoretical linked to the dependent variable, real GDP. Our distributed lag model will include past values of real GDP as well as oil price. These explanatory variables will be lagged up to 4 periods, where one period is equal to one quarter of a year.

The findings showed a relationship between oil price changes and economic growth. However there are no consistent results for how the oil price affects GDP, neither for the BRIC countries nor the western countries. Furthermore, in the case of the BRIC countries, the cluster generated divided results: A possible reason for these differences were oil exports/imports. For the western world, oil price changes and economic growth is positively correlated and the reason is probably the already existing oil-dependency.

In our model both positive and negative results were found, but also an unknown variable affecting some of the countries. Whether it is consistent in each case needs to be analyzed further. From the findings and previous research one can conclude that there are no certain results of how oil price changes affect economic growth.

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Andreas Nilsson & Adam Sundqvist

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"The most important thing for a young man is to establish credit - a reputation and character."

John D. Rockefeller

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1 Introduction

In the last decade, average economic growth for the BRIC countries (Brazil, Russia, India and China), have outpaced the western economies as well as the rest of the world; and today the BRICs lead the global recovery by its strong resilient domestic demand (Claymore Securities. Inc, 2009; Ahmed, S., et al. 2009). In a 50 year time period the ten largest economies in the world today (by GDP), will not be the richest nor the most powerful economies. If the BRIC countries maintain their proactive economic policies and develop institutions supporting growth, the dream of converging growth between developing and developed economies can become true (Wilson & Purushothaman, 2003).

Natural resources have always been of great importance of countries wealth and economic development, especially the countries' oil reserves. Changes in oil price should have an impact on one country's; energy intensive industries, transportation sector and personal consumption of oil. Throughout the world the countries dependency of oil products are diverse and fluctuations in oil prices can have different effects. In the upcoming BRIC countries the energy demand has increased significantly simultaneously with their economic activity and what effects of oil price changes in these countries are of importance for their future economic growth.

To see the emerging markets make their way through the already established westernized global economy is fascinating and has lured us in to an analysis of their economic growth path. Being dominated by existing technologies and development of such, has been keeping developing countries one-step behind. But the world has become theoretically smaller through more effective trade, easier communications, integrated financial markets etc, which dramatically has increased the possibilities of emerging markets, especially for the BRIC countries (Goldman Sachs, 2004).

Therefore the purpose of this thesis is to investigate if economic growth in the BRIC countries (Brazil, Russia, India and China) can be explained by changes in the oil price, with a focus on the selected macroeconomic variables; oil price, real interest rate (short-term) USD exchange rate, GDP and the Current account (export-import). We will also investigate if there are any differences in oil price effects on economic growth between the BRIC countries and the western world (G7).

We hope to find a relationship that proves that economic growth is affected by changes in oil price. The expected result is not that there is a consistent effect within the BRIC countries but whether there is a difference between the clusters and the individual countries. The clusters will consist of BRIC, North America, Japan and Europe, where the major countries in these regions will be analyzed (Group of Seven, G7).

1.1 Outline and Limitations

The thesis will begin with basic information about the variables and countries involved. Followed by an explanation of the chosen model and available data. Finally an analysis of the result will be presented and concluded.

Some limitiations involved in our thesis are missing values of some countries and wheter the collected data is completely reliable. Another limitation is the Koyck model fit, since it might not be as effective and correct for all sample countries.

2 Background

In this section a brief introduction of oil and the BRIC countries will be presented with focus on previous growth, which is the foundation of these emerging markets tremendous growth today. A short history of each countries relationship to oil will also be presented to clarify the status of the today's oil dependency in these countries.

2.1 Oil History and its Impact in the World

Oil has always been an indicator for economic stability in modern times, much due to the World's high dependence on oil products. If acquainted with the stock market, it can be seen that it is affected by speculations and quantities of oil reserves in economically important countries, such as the United States. This data does not only affect the world economies, it has a great impact on the world oil price, especially if the true report is far from the speculated values. But whether the oil price can be seen as an economic indicator on GDP growth is however not as clear (Adelman, 2004).

"According to conventional wisdom, humanity's need for oil cannot be met and a gap will soon emerge between demand and supply. That gap will broaden as the economies of Europe, Japan and several emerging nations grow and increase their energy needs" (Adelman, 2004, p16).

Although it is hard to find arguments that support this statement. According to theory the probability for the world to run out of oil is practically zero. Although, the costs of extracting and refining oil will only increase as the world supply decreases since new technologies and oil sites are costly to develop. Finally the prices will be so high that there will be no demand, thus the oil price will get a larger effect as long as the extraction becomes more expensive and no effective alternative fuels are existing. The biggest historical economic effects from changes in oil price come from the Organization of the Petroleum Exporting Countries (OPEC). By their acts in predefining oil supplies, they have been able to more or less control the oil price. With a higher price they have increased their revenues of petroleum exports. But as oil is traded as a commodity on the New York Mercantile Exchange (NYMEX), the oil price is heavily fluctuating since traders include calculations on supply, demand, current economic situation, OPEC quotas etc. Thus it is harder for any cartel or individual country to steer the economy in a certain direction (Adelman, 2004).

The current predictions implying that non-OPEC oil reserves are running out and that this oil is of a lower quality are not true, rather a psychological game in order to keep the oil price at profitable levels. As this is becoming more known in developing countries, such as BRIC, and as long as non-OPEC oil is profitable, there is no need for these countries to fear that oil might be used as an economic weapon to hinder further economic growth (Adelman, 2004).

It is theoretically known that due to price changes in oil, consumption of petroleum related goods and services in western countries move in the opposite direction. What is still to examine is whether such patterns will be present within BRIC.

If considering cars, which are mainly driven by fuels generated from oil, they are seen as normal goods in western countries but not in developing countries, where cars are

considered luxury goods. There is a major difference between increasing an already existing market compared to a start-up. In the latter, one might oversee large initial costs due to a great benefit of a new car over time. The calculations and expected returns on investments might not be equal between industrialized and developing countries. Thus a high oil price might influence a western consumer to buy a car with lower fuel consumption, whereas a consumer in a developing country might buy a car without even comparing fuel consumption.

With the potential currency appreciation of BRIC mentioned in the 2005 Goldman Sachs article becomes reality, a price change in oil will not affect consumers to the same extent. It also holds for the costs involved with reallocation of capital and labor between areas and industries (1988, Hamilton).

2.2 Previous Research on Oil

In the paper Oil and the Macroeconomy, by Hamilton in 2005 he discusses the effects of oil price changes on economic growth in the US economy. He clearly states that there are several research studies carried out on this subject with results arguing that the relationship between oil price changes and economic growth is hard to determine, at least through statistical analyses. There might be another force affecting both economic growth and oil price that currently is undetectable. The effects of heavy oil price changes have a great influence on unemployment in capital and energy intensive industries (2001, Davis-Haltiwanger).

What was found in the working paper by Jimenez-Rodriguez in 2004 was that there is a significant relationship between oil prices and macroeconomic variables in some of the OECD countries, with regard to oil importing countries, except Japan. These results were obtained through a Granger causality test, followed by a multivariate VAR analysis. However the effects of decreases and increases in oil price, has different effects in different countries.

The studies mentioned above leaves no clear solution whether oil price affects economic growth, vice versa or whether there is an unknown variable steering them in certain directions. A possible reason why there are so many different results regarding the subject is the usage of several different models. By using one model a certain solution is found and in another one might find the opposite results. At the time this thesis is being written, we are not aware of any research covering a comparison of BRIC GDP and the oil price.

2.3 Economic Background of Brazil

Since the beginning of the 20th-century until the 1980s the economic development of Brazil has been exceptionally good (Werner Baer, 2001). In the 1980s, poor economic conditions escalated and serious negative consequences decreased the economic progress and Brazil was falling behind Latin America and the rest of the world. The following 13 years, growth of the annual income per capita declined by 0,2 percent and the inflation rate increased to historical 2947.733 percent in 1990 (IMF database, 2008).

The hyperinflation took years to dampen and in 1996 consumer prices were back at lower figures at approximately 16 percent. In the 1990s, policy makers structurally changed the economic platform towards an open market economy, focusing on private enterprises and price stability, which has improved the economic system and generated economic growth (The CIA World Fact Book, 2009).

Today Brazil is ranked as the 10th largest economy in the world and number one in Latin America. The Brazilian economy is characterized by their well developed agricultural, mining, service and manufacturing sectors, as well as the rapid expanding export sector which is significantly important for the country and is a major source to the last decades increased economic growth (Zagha, 2005). The trade surplus in 2003 was US $24.4 Billion (Brazilian Government). Within the area of infrastructure, a partnership worth US $300 billion between private and public actors has emerged to modernize the country's railroads, ports, airports, and waterways. The fast pace of the Brazilian economic growth and the development of the country's infrastructure increases the capacity for generating long-term sustainable economic growth and wealth improvement that could converge with the G7 countries.

The energy sector constitutes mainly of the ethanol, oil and hydroelectric power industries, which is the largest energy source in Brazil. The rapid increase in demand for energy has increased the incentives for supplying more energy and Brazil have recently discovered new oil deposits which have made the country less dependent on imported oil, which could transform the country in to one of the largest oil producers in the world (U.S. Energy Information Administration, 2009).

2.4 Economic Background of Russia

After the fall of the Soviet Union the Russian Federation has struggled to establish a democratic political system and a market economy. Although the transition to a democratic market economy is moving slow, the economic development has gained momentum with an average annual growth of 6.5 percent since 1998, fueled by high oil prices and a cheap Russian ruble in. The oil and gas production in Russia is one of the highest in the world and constitute 80 percent of the country's export (The CIA World Fact Book, 2009. The Russian reserves of oil and gas are the driving force of the economy, which indirectly makes the country vulnerably to fluctuations in world energy and fuel prices. The case of a fall in the price of oil can be reduced by usage of a foreign exchange reserve, which can cover the losses (The CIA World Fact Book, 2009).

Throughout the last nine years the Russian economy has been formed by an increasing investment and consumer-driven demand. In 2008 economic growth was driven by non-tradable services and domestic manufacturing instead of the export sector of oil and gas (The CIA World Fact Book, 2009). During the last decade the economic development in Russia has improved the Russian wealth, the real personal income have increased by 12% to $10,700 in terms of PPP and the poverty is continuously declining **(**Cheng et al, 2007**).** Furthermore Russia's foreign debt has significantly been reduced and the current account balance measures up to $89.31 billion (2008) even though governmental control and restricted economic freedom are still present. The current financial crisis has affected the Russian banking system and the liquidity problems were immediately responded by a governmental aid initiating over $200 billion into the system and creation

of a stimulus plan to dampen the crisis. Russia does still have problems concerning: overvalued currency, lack of rule of law, private enterprises highly affected by authorities, lack of trust of government institutions, non-tariff barriers and the addressing of fundamental weaknesses in the banking system.

2.5 Economic Background of India

India with its 1 billion inhabitants has during the last 25 years sustained an averaged economic growth of more than 6 percent per annum and if this growth continues throughout the next 45 years the Indian economy will approximately equal the size of the U.S. economy (in PPP terms) by 2050 (Cheng et al, 2007). The main sectors of the Indian economy are village farming, modern agriculture, handicrafts, diversified manufacturing industries and the service sector that amount to 53,4 percent of GDP (Desilva, 2006). 60 percent of the population is working in the agricultural sector, which is controlled by laws and regulations negatively affecting the poor people. During the 1980s and 1990s the government decentralized business and markets reforms that ignited the people's optimism and increased the income levels, which accelerated consumption. The Indian industry is continuing to industrialize by the help of increasing foreign direct investments where U.S constitutes of approximately 10% (Desilva, 2006).

The increasing percentage of youth enrolling in education carries an important role for future development and the most important issue to be addressed is the lack infrastructure investment (The CIA World Fact Book, 2009). The government needs to improve the general infrastructure, especially in the rural areas where millions of poor people lives. However large cities also need to be addressed. New Delhi and Bombay are continuously in need of better infrastructure management to provide clean water, electricity, transportation, airports and highways. The economic development of India has during the last 25 years reduced poverty by more than 10% and this trend will continue (The CIA World Fact Book, 2009). Furthermore the government needs to decrease spending on social programs and price subsidies, especially for oil and gas, to deal with the federal budget deficit. The government also needs to solve the issue of the huge and growing population, which constitutes a social, economic, and environmental problem.

The Indian oil sector is dominated by state-owned enterprises, although recent years the government has deregulated the market to encourage more foreign direct investment. The Indian oil consumption has substantially increased throughout the years and today it is the 5th largest oil consuming country in the world and if the consumption will increase with the same pace as today it will be the largest consumer in the world by 2025 (The CIA World Fact Book, 2009).

2.6 Economic Background of China

Throughout the last 30 years the economic system in China has been gradually transformed from a centrally planned economy to a market oriented economy were rapid expansion of private enterprises and increased inflow of foreign trade and investments have generated substantial economic growth and today the export sector measures up to $1.435 trillion (The CIA World Fact Book, 2009). The implementation of new structural reforms in the 1970s, liberalized markets where increased autonomy for state enterprises and creation of diversified banking system, as well as development of stock markets, increased the momentum of the ongoing industrialization. In the last 25 years the average annual GDP growth rate has been approximately 9.4% and today China is the second largest economy in the world after the U.S by PPP **(**Cheng et al, 2007**)**. Although the fast economic growth, the income level per capita is still lower middle-income (The CIA World Fact Book, 2009).

In July 2005 the Chinese government revalued its currency towards to the U.S dollar by 2.1% and moved to an exchange rate system that is dependent of a basket of currencies after having it fixed to the U.S dollar. The current economic transition in China also has some serious issues to address. The Chinese government need to: improve the social safety net, maintain the massive job growth for millions of migrants, keep fighting economic crimes and corruptions and diminish the environmental damage linked to the rapid economic development (The CIA World Fact Book, 2009).

The energy demand in China has surged to fuel the fast expansion of the industrial and commercial sector as the economy is growing. China is the second largest consumer of energy products in the world behind United States (Crompton & Wu, 2004). The majority of the energy consumption in China originates from coal, which China is the largest producer and consumer in the world of. The oil consumption is the second largest energy source and China has emerged from being a net oil exporter to becoming the world's third-largest net importer of oil (U.S energy information administration, 2009). The high-energy demand in China is expected to increase in the future and the government has declared interests in oil exploration and production abroad, as well as strengthening their current agreements with oil production countries and regions such as Russia, Central Asia, Iran, Venezuela and Myanmar (Bhar & Nikolova, 2009).

2.7 Previous research of the BRIC Cluster

Wilson and Purushothaman (2003) have performed a study, suggesting that the economic growth generated by the BRIC countries in the future will have a greater economic impact on the world economy than it has today.

The study uses a long-term economic Cobb-Douglas growth model including the variables; labour, capital stock and total factor productivity. The study also includes a real exchange rate model that is calculated from the prediction of labour productivity growth. Wilson and Purushothaman (2003) strongly address the importance of the conditions for economic growth within the BRIC's for generating a new world economy in the future. If the BRIC countries could maintain the sound economic policies and institutions as well as sustaining development, the BRIC countries aggregate economies could in less than 40 years become bigger than the G7 in US dollar terms. Furthermore the study relies on clear assumptions and a formal framework for long-term economic

growth, although the projections in the study are optimistic and economically sensitive. The projections in the study are supported by contemporary studies made by Heytens and Zebregs, (2004) regarding the potential economic growth in China and by Rodrik and Subramanian, (2004) concerning the growth in India.

In the financial journal by Cheng, Gutierrez, Mahajan, Shachmurove and Shahrokhi(2007) the authors address the future global economy to be built by the BRICs by looking at economic indicators. These five indicators are essential characteristics that play a significant role in making foreign investments. These markets indicators are; starting a business, hiring and firing workers, enforcing contracts, getting credit and closing a business (Zagha, 2005). These indicators are some of many variables that constitute the domestic private sector and therefore, by analyzing them the degree of doing business in that country can be measured.

Cheng et al (2007) presents the various variables for the BRIC countries and compare the figures with the OECD countries and concludes that the BRIC countries have many hurdles to pass and to achieve sustainable economic growth. It will be necessary for each country to expand participations of the most deprived segments of their work force. Furthermore the business conditions of the four markets are far from good, many obstacles preventing the development of the private sector and the entrepreneurial ability to open, develop and sustain successful growing businesses exists.

Haugaard Jensen and Kjærgaard Larsen, (2004) says that the BRIC's future prospects of the convergence in economic development (GDP per Capita adjusted for PPP) with the developed world (G7) requires a sustained high economic growth. They use an output Cobb-Douglas function with three assumptions: first the catching-up as absolute convergence in total factor productivity between the BRIC countries and the US; secondly the BRIC countries will first experience a strong increase in total factor productivity and lastly their future increased economic growth will substantially appreciate the local currencies.

2.8 Western Countries General Information

The western countries included in the regression-analysis consist of the Group of Seven, also known as the G7 countries. G7 was founded in 1975 by 7 major industrialized economies; United States of America, Canada, Japan, Germany, France, Italy and the United Kingdom. Their work together has had a great influence on international economic policies and global economic governance. (Fratzscher 2009**).** With a main goal to control the current exchange rates between the US dollar, Yen and Euro, the question of how G7 will manage to control the exchange rates even in the future arises, especially when considering upcoming countries such as BRIC that are on a fast track economic growth. With the BRIC countries expected growth the position of G7 might not be as powerful as it currently is. G7 accounts for roughly 40% of the world's total oil consumption, which implies that the G7 countries are very dependent on oil (U.S. Energy Information Administration, 2006).

3 Methodology

In this chapter the different variables, mathematical formulas and econometric models will be presented.

3.1 The Explanatory Variables

In a regression model there is a set of explanatory variables that each has a relationship with the dependent variable. In our models (linear and distributed lag) we use five different explanatory variables that are economically and theoretical linked to the dependent variable, which is real GDP.

The explanatory variables used in our regression consist of: real interest rate, oil price, exchange rate and current account (exports-imports). Our distributed lag model will include past values of real GDP as well as oil price. These explanatory variables will be lagged up to 4 periods, where one period is one quarter of a year. The reason that we chose these variables is because of their theoretical economic influence on economic growth (measured in the national currency of each country). Looking at the general formula for economic output:

$$Y = C + I + G + EX - IM$$

The exchange rate is closely linked to economic growth through international trade and as domestic currency appreciates against all other currencies, holding all other variables constant, trade will decrease due to cheaper imports and followed by decreased production and output, thus causing GDP to decline. The exchange rate is also affecting oil imports/exports, since the price is benchmarked in US dollars (Frank & Bernanke, 2008).

The direct effect of inflation is the loss of purchasing power that dampens the consumption spending (C) and consequently decreases economic growth (Y). The escalation of the inflation rate is significantly important for the effect of domestic spending and economic growth. The inflation rate decreases the level of investment and the efficiency of the used productive factors. However, in our case we will be using the real interest rate which is the current interest rate with respect to the rate of inflation (Andrés and Hernando 1997). International trade is a very important element in a nation's output; hence changes within the current account, affects GDP. International trade play a considerably important role for the process of industrialization and development.

3.2 Modelling

The most commonly used model for forecasting and analyzing the relationship between many countries and some explanatory variables is Vector Autoregression (VAR), since it will examine the relationship between each variable in a matrix. A general VAR model is formulated:

$$\gamma^t = \alpha + \beta_1 \gamma_{t-1} + \cdots + \beta_2 \gamma_{t-p} + u_t$$

"Where γ at time t depends on past values of γ up to a lag length of p , α is a constant and β is a regression coefficient that symbolizes the contribution of the independent variable to predict the dependent variable γ and u_t is the error term." (Pilström & Pohl, 2009, p3).

However, with our research consisting of 11 countries and several explanatory variables, such a model would be very complex. Another issue is the scarce availability of quarterly data of BRIC countries since in order to get a reliable and accurate regression one would need a very large sample. Thus the VAR model was excluded. Another model was developed by Leendert Marinus Koyck in 1954 and is called Koyck transformation[1], which converts a distributed lag model into an autoregressive model. This model will be explained in section 4.2. We will be using PASW Statistics 17 (SPSS) in our analysis.
As our data consist of time series the analysis will start with a Granger causality to see if there is any direct influence of the explanatory variable on economic growth or vice versa. Such a test will not only test the relationship between two variables but which of the variables that affect each other. For example, changes in the oil price might affect GDP, but changes in GDP might not affect the oil price (Gujarati, 2005).

The formula for Granger Causality is as follows:

$$(1)\ \ \mathrm{GDP_t} = \sum_{i=1}^{n} \alpha_i \mathrm{Oil\ Price_{t-i}} + \sum_{j=1}^{n} \beta_j \mathrm{GDP_{t-j}} + u_{1t}$$

$$(2)\ \ Oil\ Price_t = \sum_{i=1}^{n} \lambda_i \mathrm{Oil\ Price_{t-i}} + \sum_{j=1}^{n} \delta_j \mathrm{GDP_{t-j}} + \mathrm{u_{2t}}$$

Where the unidirectional causality from oil price to GDP is specified if, the sum of the estimated coefficients on lagged oil price are statistically different from zero and the sum of coefficients on lagged GDP is not statistically different from zero, equation 1. The counterpart that GDP is affecting the oil price is specified if the opposite results are obtained, equation 2. If both coefficients are statistically different from zero we will have bilateral causality where both variables are affecting each other (Gujarati, 2005).

Through time series analysis with multiple variables we will create a new variable (1) without some of the exogenous variables. Thus we will remove the impact of real exchange rate, real interest rate and the current account from GDP data. This variable will then be examined together with the West Texas Intermediate (WTI) oil price (2) making it possible to see more clearly how the oil price affects GDP. In order to examine and

[1] With help from Professor Thomas Holgersson this old but still appropriate model was chosen.

compare the results we had to log the GDP data, since the data was in national currencies. Otherwise the analysis results would be hard to compare due to economic size and currency differences. The data became biased when a certain exchange rate was used, which resulted in non-comparable results.

$$(1)\ Economic\ growth_{Old} - \beta_i Real\ interest\ rate - \beta_j Current\ account\beta_i - \beta_k Real\ exchange\ rate = Economic\ growth_{new}$$

$$(2)\ Economic\ growth_{new} = \alpha + \beta_1 Oil\ price + \epsilon_t$$

A problem with Koyck models is the existence of serial correlation. Normally a Durbin Watson test would be applied, but is not applicable since our dependent variable is also a lagged explanatory; hence we will use the existing autocorrelation test in SPSS, which measures how much of the information that is correlated between the different lags, presented as a chart.

3.3 Time Series Analysis

When it comes to economic forecasting and analysis, time-series models are widely used. This method can be divided into two approaches; statistical and structural economics. Economic theory is used as a guideline for selecting appropriate variables for the time-series models, where past patterns in the data are used to predict future outcomes. On the other hand structural methods are far more complex and can contain several hundred different variables. This method is based on economic theory converted into empirical relations. Even though the time-series models have fever variables and simpler equations than structural models, time-series often outperform structural models. One of the reasons is because it takes past policies and changes into account where as the structural model often evaluates hypothetical policy changes (Stock, 2001).

That is why we have chosen a time-series model to evaluate and forecast the effects of oil price changes on economic growth in the BRIC countries.

The usage of lags in a regression model within economics plays an important role. Mainly because people will not change their habits immediately after a change has been made. One major influence is whether the change is temporary or permanent; for example a sudden increase in income. If this income is not known to be permanent, one might not increase their personal expenditures directly. However, if this increase in income is proven to be permanent, one might increase the expenditures in succeeding periods. Thus there is a time-lag between the actual income change and actions taken by the affected individual. But also institutional effects, such as contractual obligations may prevent a direct change of actions (Gujarati, 2005).

Since the explanatory variables effects on economic growth might be lagged due to different political reasons or preferred events, there is a need to lag the values in the model (Gujarati, 2005). This lag is implemented in the Koyck transformation, which has a general formulation as follows:

$$Y = \alpha(1-\lambda) + \beta_0 + \lambda Y_{t-1} + (u_t - \lambda u_{t-1})$$

3.4 Koyck Transformation

For estimating a Koyck model it assumes that all β's are of the same sign and geometrically decline, $\beta_k = \beta_0\lambda^k$. However since our model only carries one exogenous variable we do not have issues with different β values. In this model the λ value describes the rate of decline, which is a measure of the effects of a certain lag over periods of time. The λ value is greater than zero but less than 1 giving the 1- λ equation known as the speed of adjustment. The closer λ gets to one the slower the rate of decline in β_k and vice versa. Since λ is smaller than one the Koyck model gives less importance on the distant β's.

$$Economic\ growth_{new} = \alpha(1-\lambda) + \beta_0 Oil\ price + \lambda Economic\ growth_{t-1} + v_t$$

By including the Y_{t-1} ($Economic\ growth_{t-1}$) as an explanatory variable the originally distributed lag model is turned into an autoregressive model with only almost no reasons to expect multicollinearity. In this transformed model the error term $v_t = (\varepsilon_t - \lambda\ \varepsilon_{t-1})$ is a moving average of ε_t and ε_{t-1}. What is left to estimate after this Koyck transformation, are the estimated values of the coefficients β, λ, and α (Gujarati 2005).

In order to implement this in a model, there is a need to find the appropriate length of the lags. Since the trading of oil futures contracts and complications in long run forecasts, the effects on public consumption are in the short run. Thus, in our model we will consider a lag length of 4 quarter, except in the cases of France, Italy and Canada were 3 is the optimal lag. This length is obtained by the Akaike Information Criterion (Gujarati 2005).

3.4.1 Data Mining

In order to fill out the missing values in Chinas current account balance, which only were available semi-annually, we used linear interpolation. This is a commonly used method to find unknown variable estimates through the use of a straight line between two known values. The value that lies in between is the estimated value.

The formula for linear interpolation reads:

$$\text{Unknown value} = V_1 + \frac{V_2 - V_1}{t_2 - t_1} * (t_n - t_1)$$

Were V_1 is value 1, V_2 is value 2, t_2 time at 2, t_1 at time 1 and t_n is the time value at the unknown point (International Swaps and Derivatives Association, 2010).

4 Data and Descriptive Analysis

The obtained data information and descriptive analysis will be presented in this section.

4.1 Data

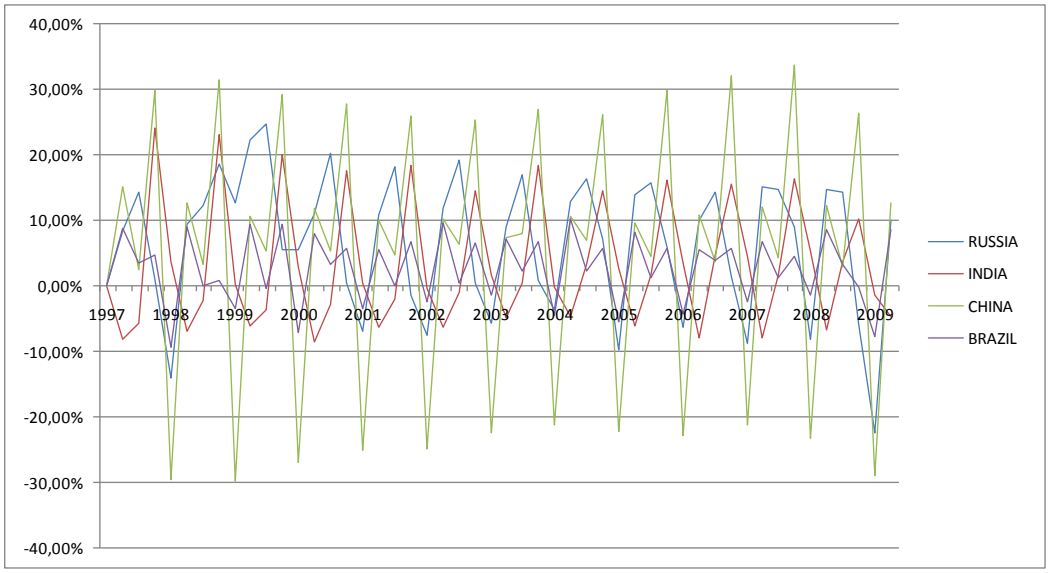
When looking for data in order to perform our regression analysis we found that the data availability in some of the BRIC countries was very low. Thus for our data analysis we have chosen to evaluate quarterly data from Q1 1997 to Q2 2009, since it was these quarters were most of the countries had available and reliable data. Since the oil price can fluctuate quite heavily over short periods of time quarterly data was the maximum time period we found suitable for our analysis, together with the fact that data in shorter intervals were missing in many cases. Due to differences in policies and technology in the different countries data was retrieved from:

4.2 Descriptive Statistics

In this part we describe quarterly data of GDP growth and world oil price changes in the BRIC countries as well as in the western countries. The spotlight will be on Brazil, Russia, India and China since this is the main area being investigated in this thesis. In order to compare the different countries, GDP data has to be converted into percentage changes due to the large differences in size between the examined countries. These figures will show how the clusters have changed over time since Q1 1997, with data gathered from Eurostat's and OECD's statistical databases.

By looking at the BRIC countries GDP growth in graph 4.1, it is easy to note that there are heavy fluctuations over the years which might be due to seasonal effects. This phenomenon is present globally but the changes over seasons are much higher within the BRICs compared to the western world. In this cluster GDP growth has differences of as much as 60% between quarters. China has more or less continuous seasonal changes, where as Brazil, Russia and India have the same patterns, excluding the time period before the millennium. In this period both Russia and Brazil experienced large negative GDP figures. In Brazil it was due to the monetary policies of elevated interest rates and a highly appreciated currency which collapsed, leading to a large fraction of foreign investors to cash out. In the same period Russia experienced a major financial crisis, which probably affected Brazil negatively, due to large Russian investments in Brazil (Averbug, 2002).
Another coherent peak can be seen in 2008 due to the current recession and financial crisis, which affected the entire world economy. The only country within the BRIC cluster that seem to have managed better during this crisis is India, much likely due to a lower share of country reserves invested abroad compared to other countries, but also its relatively stable agriculture and manufacturing industry which has seen an increase in exports over the past year due to a depreciating rupee against the US dollar (Department of Commerce).

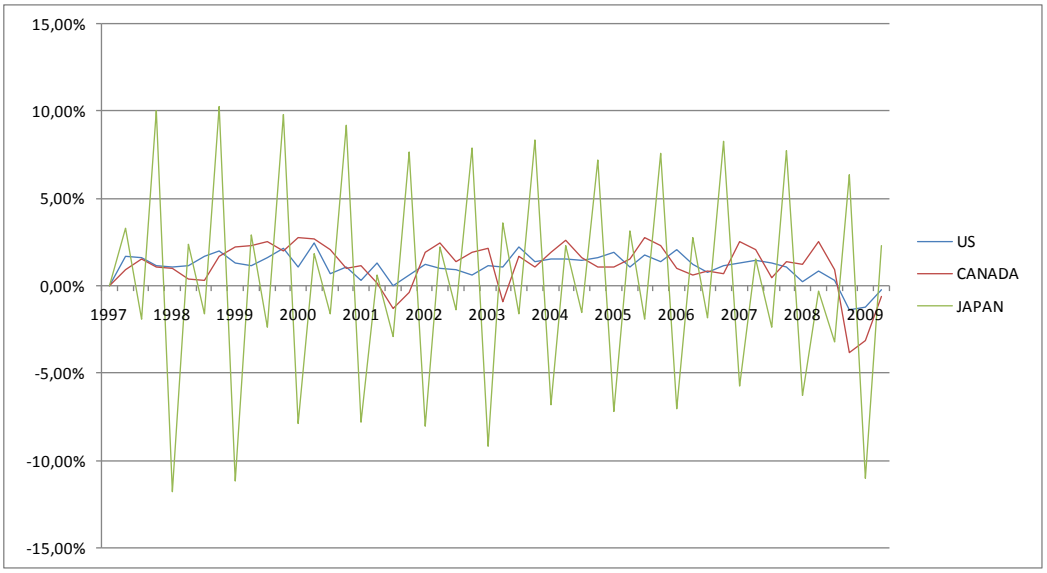
Graph 4.1



BRIC Quarterly GDP Growth

When observing graph 4.2, there are major differences in GDP growth over the examined time period. The United States almost have a constant growth rate between one and two percent per quarter and almost no seasonal effects. The most seasonally affected country in this cluster is obviously Japan, which also has had the highest growth rate. Japan's quarterly GDP growth volatility is similar to the BRIC countries. Although, while the United States and Canada, as well as some of the BRICs and EU countries showed a negative GDP growth in quarter 4 2008, Japan, France, India, the UK and China were the only countries in our sample that reported positive growth.

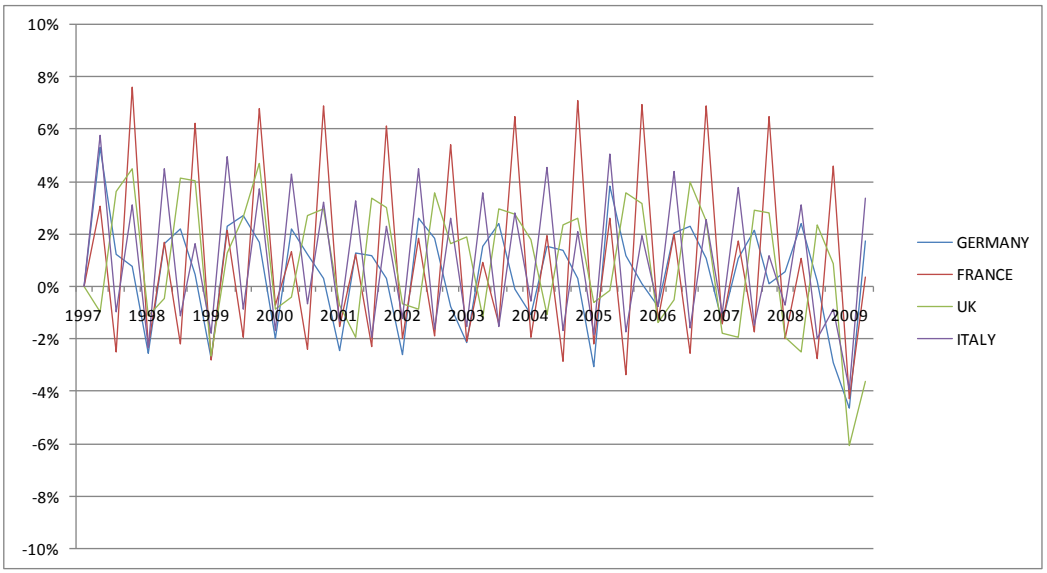
Graph 4.2



US, CANADA, JAPAN Quarterly GDP Growth

In the case of GDP quarterly growth in the European countries in our sample, graph 4.3, there is no clear consistency, although there are only small fluctuations between the different countries, except France. However, there are large seasonal changes, which can be compared to some of the BRIC countries and Japan. A notation is that the Euro countries have had larger positive growth rates than negative during the investigated time period.

Graph 4.3



EU Quarterly GDP Growth

As can be noted in the table 4.1 which focuses on the current financial recession, more or less all countries has experienced a substantial decrease in GDP growth in the last quarter of 2008 due to the global financial crisis.

Table 4.1

Period	Brazil	Russia	India	China	US	Canada	Japan	Germany	France	UK	Italy
Q1 2008	-1,31%	-8,27%	5,36%	-23,41%	0,25%	1,19%	-6,28%	0,59%	-1,97%	-1,91%	-0,74%
Q2 2008	8,60%	14,65%	-6,68%	12,25%	0,86%	2,52%	-0,30%	2,40%	1,10%	-2,50%	3,10%
Q3 2008	3,41%	14,19%	3,69%	2,87%	0,34%	0,88%	-3,17%	0,19%	-2,72%	2,32%	-2,01%
Q4 2008	-0,11%	-5,97%	10,24%	26,39%	-1,37%	-3,80%	6,36%	-2,90%	4,64%	0,88%	-0,87%
Q1 2009	-7,83%	-22,49%	-1,35%	-29,04%	-1,18%	-3,10%	-11,00%	-4,64%	-4,28%	-6,06%	-3,96%
Q2 2009	8,58%	9,94%	-4,75%	12,73%	-0,19%	-0,58%	2,26%	1,74%	0,38%	-3,61%	3,35%

As can be noted in table 4.2 and graph 4.4 GDP growth within the BRIC countries is substantially higher compared to the western world, which is due to the existing level of development which is almost incomparable in our sample.

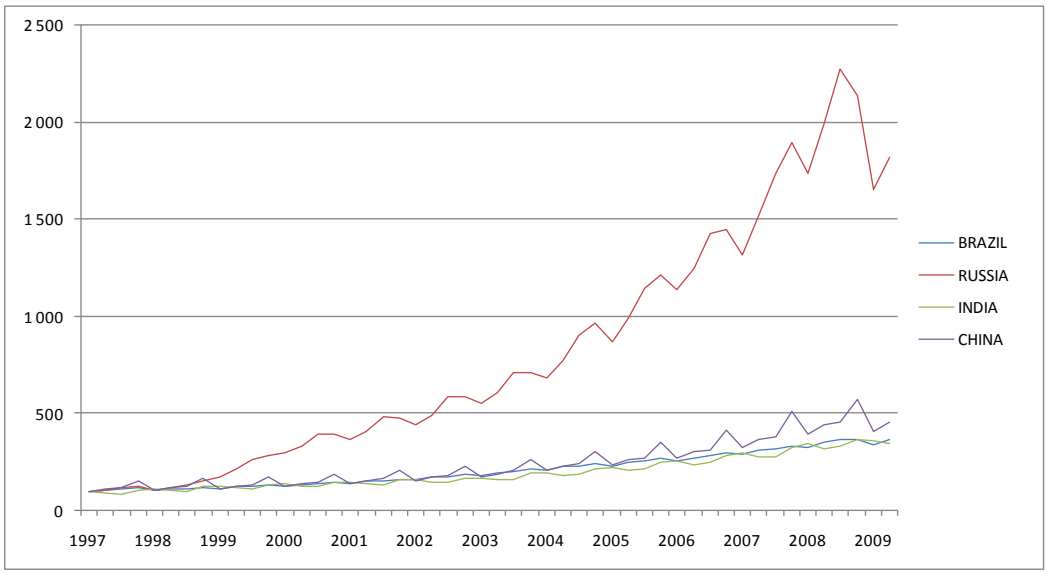
Table 4.2

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
GDP_BRAZIL	50	213,530	779,187	445,27927	177,647869	-1,086	,662
GDP_RUSSIA	50	512368,800	1,164E7	4,16568E6	3,197407E6	-,584	,662
GDP_INDIA	50	3326,563	14121,840	7488,44696	3132,077135	-,695	,662
GDP_CHINA	50	1,626E12	9,264E12	3,94187E12	1,937631E12	,001	,662
GDP_US	50	8,137E12	1,455E13	1,13606E13	2,033508E12	-1,297	,662
GDP_CANADA	50	216957,000	408167,000	3,06732E5	5,861014E4	-1,239	,662
GDP_GERMANY	50	455410,000	623440,000	5,40439E5	4,185984E4	-,734	,662
GDP_FRANCE	50	307875,000	498565,000	4,00680E5	5,614850E4	-1,161	,662
GDP_UK	50	195637,200	340796,000	2,73157E5	4,454312E4	-1,298	,662
GDP_JAPAN	50	1,157E8	1,382E8	1,25252E8	5,028263E6	-,064	,662
GDP_ITALY	50	244373,600	389892,300	3,22326E5	4,247872E4	-1,250	,662
Valid N (listwise)	50						

Descriptive Statistics

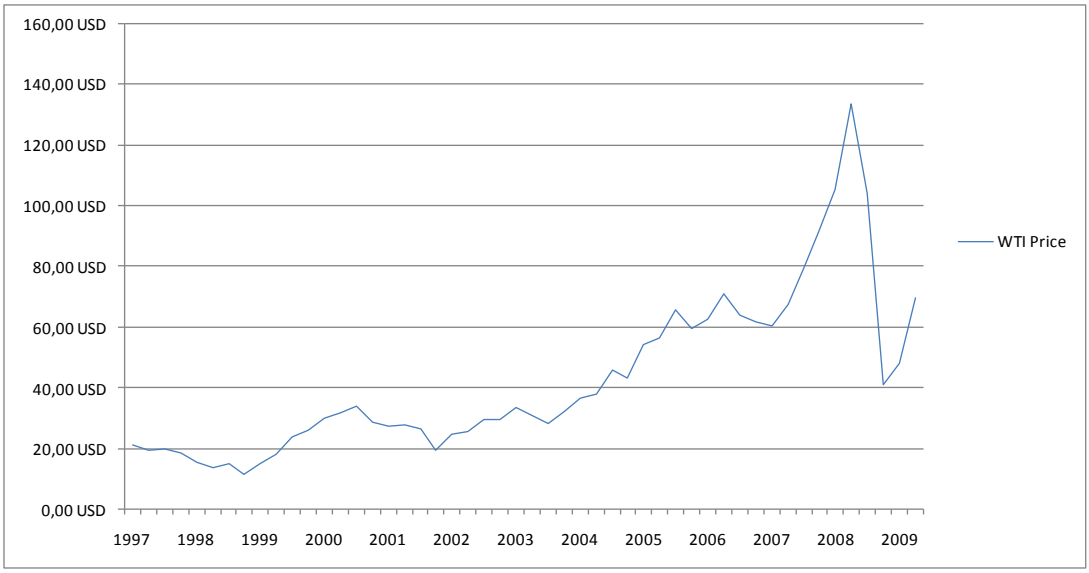
Graph 4.4



Percentage Change BRIC 1997-2009

Over the last period the oil price has been fluctuating tremendously, from far below 100 U.S. dollar per barrel, to all time high followed by a fast decrease below 100. By looking at graph 4.5 the previous statement is visualized.

Graph 4.5



WTI Oil Price Quarterly Change

A trend that can be seen is that the oil price has despite its peak and rapid decrease experienced an increase overall. This trend is likely to have followed the worlds growing dependency of oil. As the demand increases so does the price. But as the world entered a recession in 2008, countries decreased spending on oil, thus lowering the demand and price. It seems that we have experiences a "bull" market in oil terms, much like the IT bubble of 2000. The fluctuations might exist due to the globalized financial market, allowing anyone to trade with derivatives and raw materials including oil. As more actors enter the market the true value is biased due to uncertain speculation. The level of 100 + US dollars per barrel is not a stable equilibrium in today's economy, but this price level is not unlikely to be achieved in the future, as oil becomes more expensive to produce and distribute (Adelman, 2004).

5 Results

In this section the results from all stages of our method will be presented.

5.1 Granger Causality test

As the first step in our analysis is to perform a Granger causality test, we conducted this test at α= 5% level for each country in our sample. With an F critical value of 4.05, our null hypotheses of no bilateral causation, were rejected in most countries with only Japan and Canada experiencing a one way causation of oil price affecting GDP. Thus we found bilateral causality in the major part of our sample including BRIC, although with a lower probability of GDP causing the oil price to change. In Table 5.1 the result for Brazil is presented as an example of the obtained results.

Table 5.1

Pairwise Granger Causality Tests
Date: 01/12/10 Time: 12:11
Sample: 1 54
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
WTIPRICE does not Granger Cause GDP_BRAZ	46	11.6415	3.2E-06
GDP_BRAZ does not Granger Cause WTIPRICE		6.76083	0.00034

The table 5.1 shows the Granger Causality test for Brazil implying bilateral causality at the 5 % level.

The results above can be interpreted as a causation of the oil-price on GDP since the null hypothesis is rejected, but as mentioned it is a bilateral causality since the hypothesis is rejected in both cases.

5.2 Creation of a New Variable

In the first part regressions of the BRIC cluster (appendix 1), where we created a new variable by removing the effects on GDP by the current account, real interest rate and USD exchange rate. We found some differences between the western countries and BRIC. In the case of Brazil this linear regression generated an R-squared value of 0.280, implying that there are several other variables affecting changes in Brazilian GDP, thus leaving us with large residuals to be explained by changes in the oil price.

The Indian R-square measure was 0.341 (appendix 2), which is also fairly low, due to that GDP changes are much more complex than to be explained by our three variables.

In the cases of Russia and China, this regression generated higher R-squared values (0.856 and 0.766 respectively) (appendices 3-4). A brief reflection indicates that the effects on Chinese GDP growth will not be heavily affected by changes in the oil price since the linear regression provides us with less data to be explained by other variables. This could be a result from the linear interpolation calculations of the current account. However as we excluded these values we obtained a similar measure of R-square. This

is hardly a realistic scenario of the Chinese GDP growth, even though China is a very large economy with low dependencies on oil products, it might experience a higher influence from oil price changes than the residuals left to explain GDP growth.

A comparison with the western countries (appendices 5-11) showed that the regression R-squared results were around 0.7-0.8 in all cases except for Japan were we observed a very low value of 0.058. This probably due to their low interest rates which has not been fluctuating during the time period used in our sample.

The difference between our sample countries might be due to the highly developed and stable economies that exist in the western countries.

By the tests conducted in SPSS there were no signs of autocorrelation of the residuals in this first-stage regression, thus there are no difficulties in continuing with the next stage, as the residuals will be used as the dependent variable.

5.3 Koyck Transformation Results

With the created variable obtained in the previous section through the linear regression, the second step in the analysis was engaged. Applying the Koyck model to our data sample, gave the estimations of the unknown coefficients; α, λ and β, which explains changes in GDP due to oil prices and lagged effects of previous GDP data. In the tables α, λ and β, will be a, L and b0.

5.3.1 Brazil Results

The GDP growth in Brazil to be explained by the second stage of our analysis, were as follows in table 5.3.1.

Table 5.3.1

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	-,536	,124	-,786	-,287
L	,675	,083	,508	,841
b0	,006	,001	,004	,007

R squared = 0.857

By looking at this result one can draw a conclusion that in our Koyck model, changes in oil price and lagged growth explains 85,7 % of the forces affecting GDP growth with respect to our created variable. Thus, the effect is quite large according to our results. Although this might not be the real case since there are several other major variables affecting GDP. However what we can conclude is that the oil price changes has an effect on GDP in our model. The Oil price effects on economic growth in Brazil are positively

correlated, thus an increasing oil price will not affect the growth rate negatively. If there is a decrease in the oil price, Brazil might not be able to grow effectively. Probably due to the fact that Brazil is an oil exporting country. The beta value of 0.006 proves this positive relationship.

The speed of adjustment coefficient, (1-λ), has a rate of 0,325, which implies that the effects from one quarter to the next does not decrease substantially.

5.3.2 Russia Results

As can be noted in table 5.3.2 the R-square measure from the non-linear Koyck regression was fairly low, 0,344. One can conclude that changes in oil price explain 34.4% of the changes in GDP growth with respect to our created variable. However 34.4% seems quite low for Russia, which is one of the greatest oil net exporting countries in the world and the oil production in Russia, is the major force of the economy. The beta value is negative and indicates that there is a negative correlation between oil price changes and economic growth. When the oil price increases the economic growth will decrease. However this result is not probable. But as one can note by the low R-squared measure there are more variables influencing economic growth in Russia. For example that Russia is a major exporter of natural gas and has substantial taxes on oil exports (U.S. Energy Information Administration, 2010).

Table 5.3.2

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	,206	,142	-,080	,493
L	,601	,140	,318	,885
b0	-,001	,001	-,003	,000

R-squared = 0.344

The speed of adjustment coefficient for Russia is 0.399, which explains that the previous economic growth patterns will have a longer effect. Thus a deficit will have a greater impact in the upcoming periods.

5.3.3 India Results

With an R-squared at 0.678 presented in table 5.3.3 there is a major difference compared to Russia but the value is not far from what was obtained in Brazil. With 61.8 % explanation from Oil price changes on our created variable for GDP-growth, there is in the case of India effects in GDP due to changes in oil price. Thus, if the oil price is not at a price that is favorable to India, the growth rate will be affected. A possible theory is, as prices of oil increases, the western world spends more money on oil which will increase the demand for cheap imported goods. As the price level in India is far below the western standard this increase in demand for low-cost goods will have a positive effect on GDP-growth in India. Comparing the beta value, one can see that it is also in this case very similar to the results in Brazil. But again it is not possible to provide a certain figure of how much the oil price will affect economic growth, only that there is an effect.

Table 5.3.3

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	-,362	,161	-,688	-,037
L	,649	,114	,419	,880
b0	,004	,001	,001	,006

R-squared = 0.678

5.3.4 China Results

In the case of the last country of our BRIC cluster, China, we found some interesting results which are presented in table 5.3.4.

Table 5.3.4

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	-23,923	6,657	-37,357	-10,490
L	,458	,069	,319	,598
b0	-,006	,001	-,008	-,004

R-squared = 0.515

As we in the cases of Brazil and India found positive effects on economic growth, China proved to show the opposite. A beta value of – 0.006 shows that the effects of oil

price changes are negative. But as the R-squared is fairly low compared to Brazil and India, we have the same standpoint as in Russia. There are more variables that explain economic growth. In recent reports there has been proof of heavy increases in automobile sales in China (BBC News). This might not influence the economic growth at this point in time but as, more people will consume oil dependent goods the effects on the economic growth could become larger. The negative effects are most likely because China is an oil-importing country.

5.3.5 BRIC Result Comparison

The individual results presented in the previous sections are going in two separate directions within the BRIC cluster. As Brazil and India seems to follow the same path, Russia and China goes the other way. On the other hand the different coefficients and R-squared measures for the two pairs also seem to walk hand in hand. There might be an unknown effect, influencing both China and Russia. As will be presented in the next section of analysis of the western benchmark countries, it will be clear that it is China and Russia that deviate from the overall results in our sample. We did not expect that the results would be consistent throughout the BRICS since they cannot be treated as countries acting or being situated in the same region.

5.3.6 Western Countries Results

The overall result in the Koyck regression performed on the western countries were that the effects of oil price changes on economic growth are not at the same levels as in the less developed countries in the BRIC cluster (appendices 5-11). Also obtained in the western result was that the oil price has a positive effect in all cases, but the expected beta values are as mentioned above much lower. Maybe the effects have a lower influence in the already developed countries due to the already high dependency of oil products. The outlier in this cluster is Japan, which generated a zero effect, but as the results from the creation of the Japanese variable were not comparable to the rest of the countries, it is hard to analyze and draw conclusion for Japan. However, a major trend in the western analysis shows that the Koyck regression R-squared values are very low, except in the case of Japan. These low results explain that there are more complex variables affecting economic growth than the oil price. The UK showed a slightly different result, most likely since it is not connected to the Euro. Only the United States ended up with an R-square value close to the BRIC levels.

When comparing the results between the EU and North America the R-square measures are higher in the latter; much likely due to dependency of oil which is higher in North America than in Europe.

6 Conclusion

The purpose of this thesis was to investigate if economic growth in the BRIC countries (Brazil, Russia, India and China) can be explained by changes in the oil price, with a focus on the selected macroeconomic variables; oil price, real interest rate (short-term) USD exchange rate, GDP and the current account (export-import). We will also investigate if there are any differences in oil price effects on economic growth between the BRIC countries and the western world (G7). Thus the findings by Jimenez-Rodríguez & Sánchez state that there is a relationship between oil and economic growth was confirmed.

The overall results proved to show that there is a clear relationship between oil price and economic growth. In most cases there was a bilateral causation of oil and GDP, although in all countries there was a lower probability of GDP causing the oil price to change.

On the other hand, there are no consistent results for how the oil price affects GDP, neither for the BRIC cluster nor the western countries. What we did find was a pair-like relationship between Brazil and India as well as Russia and China. They seem to follow the same pattern with Brazil and India both generating a positive effect from increasing oil prices; this pair also generates similar measures of regression explanation.

As Brazil has increased its oil exports over time, a rising oil price will have a positive effect on GDP. In India with its main industry being agriculture together with low dependency on oil, India is also positively affected; much likely due to increasing exports to western economies, that arises when the consumers in the western world are forced to spend a higher share of their disposable income on oil products.

The results for Russia and China are the opposite, with a negative effect from increasing oil prices. In the case of Russia, high taxation on oil exports might be the influence or the fact that the main export is natural gas. The negative relationship in China is probably due to China being a large importer of oil.

The western benchmark countries were somewhat more consistent with similar figures within each region. The European cluster had more or less the same R-square values and estimations of oil price effects. Only the UK showed a slightly different result, most likely since it is not connected to the Euro. Canada and the United States also followed each other. Japan was as mentioned in the thesis an outlier in all parts of the analysis.

As has been analyzed and examined in several other studies concerning oil and the BRIC countries, our results both confirmed and rejected previous studies.

Wilson and Purushothaman claims in their paper that the BRICS will have a greater impact on the world economy than it has today, even outperforming the G7. In our analysis we have found that the effects from changes in the oil price will not affect the growth rates within BRIC substantially, thus it is very likely that the world economy influences in the future are coming from the BRIC cluster. The projected appreciation of the BRIC currencies will have a positive effect on oil consumption, thus increasing the positive effects in the case of Brazil and India, and a decrease in the negative effects in Russia and China.

Oil price changes are not to be seen as a hurdle to pass for BRIC countries, thus excluding one factor from the results presented by Cheng et al.

Another finding was that the fluctuations in economic growth was substantially higher within BRIC than in the western world, this since they are not yet well established economies, but as the oil price is proven not to be a threat to their economic growth, there are few limits of possible future development and world economic influence. With the BRICs not being as dependent on oil as the western countries they can, if investments and political decisions are made correctly, adapt their energy needs more efficiently. Even though car sales still are at very low levels compared to developed countries, there will be an increased demand for transportation and other energy dependent goods within the BRICs.

As Hamilton argued, that there are no certain results of how oil affects the economic growth, only different outcomes due to the different models; we can only conclude that this is the case. In our model both positive and negative results were found, but also an unknown variable affecting some of the countries, whether it is consistent in each case is still to be examined.

The comparison between BRIC and the western world is summed up by positively correlated effects from oil price changes on economic growth in the western world due to an already existing dependency on oil. In the case of Brazil, Russia, India and China the cluster generated a two way result. The reason for the differences was oil export/imports and what seems to be an unknown variable affecting economic growth.

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Japan Canada Russia India and Brazil: http://stats.oecd.org/

United States: Ecowin pro 6.0

Current Account: http://stats.oecd.org/

Inflation: Ecowin pro 6.0

Interest rates: http://stats.oecd.org/

8 Appendix 1 Brazil

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,529[a]	,280	,233	,35293	,247

a. Predictors: (Constant), EXC_BRAZIL, CA_BRAZIL, RI_BRAZIL

b. Dependent Variable: LOG_BRAZIL

9 Appendix 2 India

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,584[a]	,341	,298	,34359	,731

a. Predictors: (Constant), EXC_INDIA, CA_INDIA, RI_INDIA

b. Dependent Variable: LOG_INDIA

10 Appendix 3 Russia

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,925[a]	,856	,846	,16778	1,382

a. Predictors: (Constant), EXC_CHINA, RI_CHINA, CA_CHINA

b. Dependent Variable: LOG_CHINA

11 Appendix 4 China

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,925[a]	,856	,846	,16778	1,382

a. Predictors: (Constant), CA_CHINA, RI_CHINA, EXC_CHINA

b. Dependent Variable: LOG_CHINA

12 Appendix 5 United States

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,878[a]	,771	,761	,08826	,409

a. Predictors: (Constant), CA_US, RI_US

b. Dependent Variable: LOG_US

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	,060	,235	-,415	,535
L	1,106	,177	,750	1,463
b0	,001	,000	-7,185E-5	,001

R-squared = 0.542

13 Appendix 6 Canada

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,845[a]	,714	,695	,10700	,427

a. Predictors: (Constant), EXC_CANADA, CA_CANADA, RI_CANADA

b. Dependent Variable: LOG_CANADA

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	,076	,051	-,027	,179
L	,484	,125	,232	,736
b0	,000	,000	-,001	,000

R-squared = 0.255

14 Appendix 7 Japan

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,240[a]	,058	-,004	,04041	2,522

a. Predictors: (Constant), RI_JAPAN, CA_JAPAN, EXC_JAPAN

b. Dependent Variable: LOG_JAPAN

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	-,060	,046	-,152	,032
L	,815	,088	,638	,993
b0	,000	,000	,000	,000

R-squared = 0.671

15 Appendix 8 Germany

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,892[a]	,796	,783	,03587	,781

a. Predictors: (Constant), RI_GERMANY, CA_GERMANY, EXC_EURO

b. Dependent Variable: LOG_GERMANY

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	,007	,015	-,024	,038
L	,427	,144	,136	,717
b0	6,534E-5	,000	,000	,000

R-squared = 0.182

16 Appendix 9 United Kingdom

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,835[a]	,698	,678	,09442	1,097

a. Predictors: (Constant), EXC_UK, RI_UK, CA_UK

b. Dependent Variable: LOG_UK

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	-,030	,049	-,129	,069
L	,573	,141	,288	,858
b0	,001	,000	,000	,001

R-squared = 0.337

17 Appendix 10 France

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,874[a]	,763	,748	,07054	1,119

a. Predictors: (Constant), EXC_EURO, RI_FRANCE, CA_FRANCE

b. Dependent Variable: LOG_FRANCE

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	,023	,027	-,033	,078
L	,279	,147	-,017	,574
b0	,000	,000	,000	,001

R-squared = 0.082

18 Appendix 11 Italy

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,885[a]	,783	,769	,06449	1,173

a. Predictors: (Constant), CON_ITALY, RI_ITALY, CA_ITALY

b. Dependent Variable: LOG_ITALY

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
a	-,034	,017	-,068	,000
L	-,015	,180	-,377	,348
b0	,001	,000	4,203E-5	,002

R-squared = O.134