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Preliminary Thesis Report

"A Study of the Macroeconomic Effect of an Oil Price Drop"

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1.0 – Introduction

The impact of oil changes on macroeconomic activity is well documented. Many papers have been written about the effects of an increase of oil prices and about the effects of adverse oil supply, demand and oil specific demand shocks (See Hamilton 1983, Kilian 2009 and Aastveit et.al 2012). However, not much has been written about the effects on the macroeconomic consequences of an oil price decrease.

Starting in June 2014, the real price of oil has seen a significant drop, not unlike previous oil price declines observed over the last 30 years. A significant drop in the oil price is usually accompanied by an increase in global economic activity and macroeconomists have viewed changes in the price of oil as an important source of economic fluctuations (Blanchard and Gali 2007).

Hamilton (1983) discovered a negative relationship between oil price shocks and macroeconomic activity. This suggests that oil price increases and decreases should have opposite, but equal effects. Therefore, when considering the current sharp decline in oil prices, one would expect aggregate economic activity to pick up. However, the recent oil price decline differs in one significant aspect; global economic activity has not seen the expected benefit of lower oil prices.

Baumeister and Kilian (2016) report that the overall growth in the U.S. economy has been marginal at best. Following the 2014 oil price decline, the U.S. economy experienced only a slight increase in economic growth during the 2014Q2 from 1.8% to 2.2%. Theoretically, lower oil prices should increase demand for other goods and services proportionally as the amount of disposable income used on energy decreases. This increase in demand should increase overall economic activity and shift U.S. domestic aggregate supply curves.

The generally accepted view that lower oil prices are good for the world economy is being challenged. Bernanke (2016) suggests that the positive correlation between the stock market and the price of oil indicates a softening of global aggregate demand

that hurts corporate profit and the demand for oil. This implies that the falling price of oil is not necessarily good news for global economic activity.

Our objective with this paper is to investigate the relationship between lower oil prices and macroeconomic activity. The literature strongly suggests that the aggregate effects of an oil price change differs greatly across different regions. Net exporters and importers of oil react differently, with most importers being affected positively by an oil price decline due to the increased terms of trade and most exporters experiencing a loss due to the price drop (Mohaddes and Pesaran 2016).
In a 2012 study, Aastveit et.al found that *"Demand shocks in emerging countries, particularly in Asia, are twice as important as demand shocks in developed countries in explaining the fluctuations in the real price of oil and global oil production."*
Therefore, we believe there is a need to differentiate not only between net oil importers and exporters, but also between the developed- and emerging world. With this in mind we have constructed the following research questions:

1. *What happens to the world economy when the oil price drops?*
    - *Do the specifics of the shock matter?*

2. *Why hasn't world economic activity increased more following the oil price drop in 2014?*
    - *Are there regional differences that can account for this outcome?*

One hypothesis is that the aggregate effects on real activity are lower following an oil supply-based shock than a shock related to a decrease in demand. Another is that the massive burden of sovereign and private debt that has accumulated in most of the developed and emerging world in recent years is stagnating growth.

To answer these questions, we will use quantitative analyses, constructing several vector autoregressive models (VAR) and finally a factor augmented vector autoregressive model (FAVAR). We will look at data from different regions across economically advanced and economically developing countries.

When constructing the FAVAR model, we intend to extend the research of Aastveit et.al (2012) by supplementing their data set to include the oil price decline starting in 2014. Furthermore, we want to analyze the results of their model with the new data before adjusting for the relevant changes with regards to our research topic.

2.0 – Oil Price and Macroeconomic Fluctuations

Because oil is a prime source of energy, fluctuations in its price are believed to have significant macroeconomic consequences. Early studies on the relationship between oil and the macro economy were primarily based on oil importers. In these studies, Real Business Cycle (RBC) models were used to study the macroeconomic outcome of shocks to the price of oil. Hamilton (1983) investigated the role of Sims' macro model (1980) and found that oil price increases during the period 1948 to 1972 were usually followed by reductions in real GNP growth. This growth was not anticipated by previous behavior in output, prices or the money supply. In other words, most U.S. recessions prior to 1973 were directly preceded by a hike in oil prices and Hamilton found little evidence to support that *"some third set of influences was responsible for both oil price increases and the subsequent recessions"*. He does not include any discussion of oil shocks after 1973 because of non-stationarity in the data. But he did conclude that oil shocks were a contributing factor in some of the pre-1973 recessions.

Several others have also found a clear negative relationship between energy prices and aggregate measures of output (Rasche and Tatom 1977, 1981). Studies by Burbidge and Harrison (1984) and Gisser and Goodwin (1986) support the findings of Hamilton. Both show similar results for the 1973-74 shock in the U.S., when looking at data from 1962-1982 respectively. Findings by Mork (1989) suggest asymmetry in the relationship between oil and the macro economy. Based on Hamilton's work, Mork's study showed that when increases and decreases of the price of oil are entered separately in a VAR framework, the coefficients are significantly different. His results showed that price increases Granger-Cause output, while price decreases did not.

Hooker (1996) analyzed the aspect of asymmetry and tried to re-establish a robust link in the relationship between the macro economy and oil prices by re-specifying the oil price. He found that when post-1980 data are included, the *"original specifications of oil price in log levels or differences break down."* Moreover, he found that since 1972, the significance of oil shocks has decreased and that oil prices fail to Granger-Cause the most important macroeconomic indicators such as real GDP, the unemployment rate and aggregate employment. Hooker examined three possible explanations. The first being that there were significant breaks in most U.S. macro series around 1973. Second, that the oil price was no longer exogenous and last, that there was asymmetry between oil price increases and decreases. He concluded that while there appears to be a structural break in the GDP growth rate around 1973, it was not due to oil price interactions. He went on to say that the price of oil did not appear to be any more endogenous post-1973 than in the period immediately prior and finally that *"transformations of oil prices consistent with asymmetric responses also fail to Granger cause macro indicators after 1973 and in the full sample."*

Hamilton (1996) rejected Hooker's conclusion and argued that since 1986, the majority of oil price increases occurred after even larger price decreases. Hence, to measure the real effect of an oil price increase on consumer and corporate spending, one should compare current oil prices with previous years, not with the previous quarter. He proposed a new measure that he called "net oil price increase" (NOPI). NOPI is defined as the difference between the current price of oil and the maximum observed value from the last four quarters. This new measurement removes any increases in the price of oil that act solely as a direct correction of a previous price decline. Contrary to Hooker's findings, Hamilton's results showed that the relationship between NOPI and GDP growth was still statistically significant.

Lee, Ni & Ratti (1995) argued that innovations to the price of oil is more likely to have a greater impact on real activity in an environment where oil prices have been stable, than an environment where the oil price has been more volatile.

Another explanation of impact of oil prices on economic activity is the *uncertainty hypothesis,* which suggests that increased volatility in the price of oil can have a negative effect on output. This explanation suggests that both positive and negative oil price shocks can have a negative effect. The reasoning behind this hypothesis is that uncertainty makes investors wary. Hence, activity will be lower when volatility increases.

Ferderer (1996) lent further support to the uncertainty hypothesis when he used daily observations to construct a VAR with monthly standard deviations (volatility) in the oil price. He concluded that the standard deviation in the price of oil could be used to forecast GDP growth in the U.S. and get better results than with oil price changes. He went on to discuss three factors that have the potential to explain what he calls "the Asymmetry Puzzle." First, whether oil price shocks adversely affect the economy through sectoral shocks and investor uncertainty. Second, whether a monetary policy reaction can explain the real effects of oil price shocks and finally, how these factors can explain the asymmetric relationship between oil prices and output growth. His findings indicate that monetary policy responses do not explain why output does not pick up after an oil price decline. On the other hand, oil market disruptions affected the U.S. economy through sectoral shocks and uncertainty channels.

However, Hamilton (2000) states that: *"the suggestion that oil price shocks contribute directly to economic downturns remains controversial."* He attributes this to the fact that the correlation between the price of oil and economic activity becomes much weaker in data post-1985, as reported by Hooker (1996). Later, Kilian (2009) would emphasize the importance of the specifics of the shock supported and critiqued by Hamilton (2012) among others.

2.1 – The Importance of Demand vs. Supply

Variations in the price of oil have an effect on real activity. The literature defines three kinds of shocks that are important when describing fluctuations in oil price: oil

supply shocks, global demand shocks and oil market-specific demand shocks. Supply shocks are defined as shocks caused by disruptions in supply proliferated by geo-political events and developments. Global demand shocks are identified as shocks caused by fluctuations in demand that cannot be explained by changes in oil supply. Furthermore, changes to the oil price that occur when controlling for demand and supply shocks is defined as oil market-specific demand shocks. The latter is a shock to prices that is caused by the market's expectations of future oil disruptions (Kilian 2009). Previous assumptions about disruptions in the oil supply due to political unrest or conflict in oil-producing nations could actually be explained as a demand shock initiated by expectations about supplies running low in the near future.

Kilian (2009) further argues that fluctuations in the price of oil have different effects on real activity depending on the specific underlying reasons for the shock. An adverse supply shock causes minimal increase in prices because other suppliers are quick to adjust their productions to fill the gap in the market. Hence, disruptions to supply don't cause significant changes in real activity and fluctuations in oil prices are primarily driven by "precautionary demand shocks".

Hamilton agrees that the underlying cause of the shock is important but criticizes Kilian's approach to the problem. He argues that Kilian is attaching too little importance to the effect of supply disruptions and claims that if one were to measure precautionary demand as changes in inventories, then the outcome would change. He put forth the notion that at the time of the sharpest price movements, inventories tend to decrease and suggested that, *"inventory changes were serving to mitigate rather than aggravate the magnitude of the price shocks"* (Hamilton 2012). This argument suggests that oil supply has a significant effect on the price of oil and thus on global activity.

Another aspect of Kilian's argument, that demand plays a larger role than supply, is based on an example from the Iranian revolution. During that period, the surge in oil prices was mainly driven by increased precautionary demand and increased global activity. Kilian's claim is backed by an impulse response analysis that shows that shocks related to precautionary demand and global aggregate demand cause a

persistent increase in price. On the other hand, the impulse response function for an adverse supply shock causes an insignificant increase in price that dies out quickly.

Aastveit et.al (2012) argue that a model based on a single index for global activity will not show the full picture. They emphasize that any analysis of the effects of an oil price shock should include factors for both developed and emerging economies. Their justification for this statement is that different regions respond differently to changes in the global economy and that these differences must be accounted for.

2.2 – Regional Differences

In the large body of literature concerned with the effect of the price of oil on economic activity, the effect on emerging countries has been given surprisingly little attention. Rasmussen and Roitman (2011) stated that, on average, non-OECD countries are about twice as oil dependent as OECD countries. This is consistent with Aastveit et.al (2012) who found that when explaining fluctuations in the price of oil and global oil production, demand shocks in emerging countries are twice as important as demand shocks from developed countries. Sachs and Warner (2001) also contributed to the debate claiming that resource rich countries tend to have a lower growth rate than resource poor countries; the so-called "resource curse." Rasmussen and Roitman (2011) found that the impact of oil price shocks to oil-importers were smaller, suggesting that the cross-country differences depend mainly on the relative size of oil imports.

2.3 – Oil Price Drop of 2014 and Recent Developments in the Field

The oil price drop in the summer of 2014 saw the price for crude oil plunge from $110 to $30 per barrel. Theoretically, a decline in the price of oil is good news for the global economic activity. However, the economy has not picked up pace. In fact, IMF (2016) numbers point out that the global GDP growth has gone from 3.4 percent to 3.2 percent during the year 2014 to 2015. Their official forecasts for 2016 and 2017 are 3.1 percent and 3.4 percent, respectively, which arguably is in contrast with standard economic theory.

Baumeister & Kilian (2016) studied how the drop affected the US economy. Their results suggest that the U.S. has not had the expected activity increase after the oil price plunge. Their estimates are somewhat consistent with the IMF (2016) report. They found that private real consumption and non-oil related investments increase by about 0.9 percentage points of real GDP growth and that oil-related real investments fell dramatically. The U.S. oil industry has seen an impressive upturn and oil production has doubled, from 5-10 million barrels a day, in the last 5 years. The increased importance of the oil sector in the U.S. could explain why the "expected" upturn did not occur following the oil price drop.

Blanchard & Gali's 2010 study concluded that the effect of oil price shocks has changed over time, with noteworthy changes in prices, wages, production and output. These effects were significantly larger pre-1984 than after. They cited three plausible causes: the decrease in real wage rigidities, increased credibility of monetary policy and the decrease in the share of oil in consumption and production.

In their 2016 paper, Mohaddes and Pesaran analyzed the effects of oil price declines on the U.S. and world economies. They concluded that an oil price decline is good for the world economy. However, they failed to take into account the specifics of the shock.

2.4 – The Purpose of This Study

The purpose of this study is to analyze the effects of an oil price decline on the world economy. We intend to expand upon the literature in two main areas. First, we want to examine what happens to the world economy when the oil price drops. We will assess whether there are statistically significant outcomes between demand shocks and supply shocks. Second, we want to investigate why the world economy has not picked up pace following the recent oil price decline and find out why the decline has not brought about the expected increase in real activity. Could sectoral shocks and uncertainty channels provide an explanation for this? If so, have the recent oil price

decline and the oil price volatility that followed, increased uncertainty in particular emerging economies? Could this have the effect of increasing the value of waiting and thus explain why certain regions react differently to oil price shocks?

For the purpose of our investigation, we intend to construct a VAR for the U.S. economy, which will enable us to analyze the effect of a negative oil price shock. Afterwards, our plan is to do the same for China and compare the results. Furthermore, we want to look at the results in other countries, both developed and emerging. Lastly, our aim is to build a FAVAR model, based on the model used in Aastveit et.al (2012), to analyze the effects on multiple countries. After analyzing the oil price shocks, we want to investigate whether the specifics of the shocks matter. When comparing supply vs. demand shocks, are there any differences to the outcome if both are of the same magnitude? Looking at the GVAR model described by Mohaddes and Pesaran (2016), we wish to examine if their use of a proxy of the dividend yields of the S&P 500 is justified, and if not, look for alternative variables to measure real activity.

3.0 – Methodology

In our analysis we will use a VAR model. The high flexibility of the VAR to check the effects on different variables in a system makes the VAR approach an ideal choice for this type of analysis. All variables are treated symmetrically, meaning that they are treated as endogenous and there is no causality relationship between the variables. This means that we allow the different variables in the VAR to directly and indirectly affect each other.

We intend to use the following variables in our models: oil price, oil production, (oil specific) demand, real/nominal GDP (in different countries and regions) and the FED interest rate. First, our plan is to test the data sets for stationarity using a Dickey Fuller test. Then, if necessary, we will take the log changes of some of the data and add a linear trend as an exogenous variable to the VAR model, given that there is an observed trend in the data. Moreover, we must check if the models are stable.

Stability implies that the persistence of the shock will be finite. Thus, the shock will eventually die out, i.e. covariance-stationary.

When choosing lag length, we will may choose to use one of two well-known methods: The Bayes or Akaike information criterion (BIC and AIC) or follow the suggestions in "Applied Time Series for Macroeconomics" by Bjørnland & Thorsrud (2015). If we choose the later, we will start by choosing a relatively large lag length and then subsequently check the robustness of the results by re-estimating using a shorter lag length. We will perform a Cholesky decomposition to impose restrictions and prevent contemporaneous effects on the variables. Before deciding upon the ordering of the variables, we plan to experiment to ascertain if different ordering gives different results. Thus, we can get an indication whether some variables will have a greater affect than others.

After analyzing the impulse response functions of the SVAR models, we will extend the analysis further by following the approach done by Aastveit et.al (2012) and utilize a FAVAR model approach to model the world economy. While their analysis focused on how different regions (developed and emerging) affect the real price of oil, we will use the same methodology to study the two-way causation between the oil price and the macro economy. Our model will include separate factors for developed and emerging economies, oil production, the real price of oil, a factor to measure changes in aggregate GDP growth and possible industrial output.

4.0 – Road map

June 1st: Hand in thesis registration form
January 1st-16th: Work on preliminary thesis report
January 17th - February 16th: Collect data, improve report and prepare for presentation
February 17th: Thesis seminar, presentation of the report
February 17th - 20th: Reconsider thesis based on feedback from presentation
February 21st- Mars 15th: Continue collecting data and building FAVAR model
Mars - April: Analyzing results and get feedback from supervisor

April - May: Complete thesis draft

May - June: Revise thesis based on feedback

June - August: Finish thesis and deliver

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