UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

The oil price-macroeconomy relationship revisited.

A comparative analysis between the Mundell- Fleming theoretical framework and VAR analysis of oil-macroeconomy variables.

Henrik Forsberg
Julius Hellström
Advisor: Heather Congdon Fors
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Abstract

Our study aims to evaluate the Mundell-Fleming model ability to predict the effects from a oil price shock to output and interest rates by analyzing data, from the last thirty years, by using a VAR-model. Our results show an asymmetric effect between oil price and GDP growth while the oil price-interest rate relationship partly holds. The conclusion is thus that the Mundell-Fleming theoretical framework performs badly in its predictions on oil price changes effect on output. We also test if financial stress (FSI) is relevant when analyzing the oil-macroeconomy relationship. Our conclusion is that the FSI is relevant when studying the oil price-macroeconomy relationship and needs to be studied further and on a larger sample.

1. Introduction

In the second part of 2014 the oil price began on a downward trend that eventually would make it to fall 70 $ (approximately 65%) and it has since then stayed low. This made international organizations like the IMF and important researchers (Arezki, Blanchard, 2015) to predict tha6t the oil price fall would boost the world economy. When this failed to happen the question was raised to how the oil-macroeconomy relationship works. This is what this thesis will try to answer.

We will do this by evaluating the Mundell-Fleming model with regard to how an exogenous oil shocks affect interest rates and output. We will do this by emulating the paper *Oil Price Shocks and Real GDP Growth: Empirical Evidence for Some OECD Countries.* Rebeca Jiménez-Rodríguez, and Marcelo Sánchez (2005) and then compare the result to the prediction from the Mundell-Fleming framework.. First, our analysis includes a later time period than Jiménez-Rodríguez and Marcelo Sánchez. Second, we will also add a financial stress variable, recommended by Nazlioglu, Soytas and Gupta (2015) to a subsample of the study to see if this variable changes the result. Our selection will be of the G7 countries. In the G7, we get developed economies with both oil producers and oil importers.

Our results can be summarized as follows. We find an asymmetric relationship between oil price increases and GDP growth while the interest-oil symmetric macroeconomic relationship holds except for the short term rates to an increasing oil price. We can thereby conclude that the Mundell-Fleming predictions of what will happen in the short run after an oil shocks fits badly to our sample. There is reason to question the stability of the oil price parameters after 2008 when the financial crisis turned macroeconomic data on it's head. The effect of the post 2008 data on the result could be a factor to explain our result. When adding the financial stress variable to the restricted sample we experienced different results with some granger causality relationship disappearing and some appearing. Our conclusion is, as suggested by Nazlioglu, Soytas and Gupta (2015), the FSI variable contributes to the analysis and further research from more economies should be conducted.

1.1. Previous research

Jiménez-Rodríguez and Sánchez (2005) use a vector autoregressive model with both linear and asymmetric oil variables to evaluate oil price changes and its effect on economic activity.

Their results points to that the context in which the oil shock takes place is vital to the effect it will have on GDP growth. In a context of high price stability, the effect on GDP growth is stronger than in a context of high volatility. Nazlioglu, Soytas and Gupta (2015) show how there are volatility spillover effects between financial stress and oil prices that run both ways before a crisis, a causal link between oil prices and to financial stress after the crisis and a causal link between financial stress and oil prices during a crisis. This suggests that besides direct effect of oil and/or financial crisis on the economy there can be secondary indirect effects when the two markets continue to affect each other after the crisis. This relationship between the energy market and the financial market could make the effect prolonged on the economy. They recommend for future research that you take both these variables into account when analyzing how financial/oil shocks affects the economy.

An oil shock is defined as the gap between the expected price, by consumers, governments and corporations, and the eventual outcome of the price. What constitutes a shock is that it is unexpected. Causes of oil shocks have historically been seen as an exogenous supply shock, often caused by political events in big oil-producing countries. This understanding has been challenged by recent research which gives the alternative explanation that most major oil shocks are caused by changes in demand.

The oil shock of 1973/1974 was a result of a withdrawal of the Tehran/Tripoli agreement by the Gulf states. The agreement stipulated a fixed price over a five-year period and that foreign oil companies were allowed to extract as much oil as possible for that price. The price might have seemed reasonable when the agreement was but had been eroded by dollar inflation and higher demand for crude oil and in 1973, the Arab countries decided to cut production and raise the price.

The sharp oil price fluctuations in the 1980s which earlier has been attributed to the Iranian revolution and the Iran-Iraq conflict can also partly be explained by an increase in demand. The price hikes were probably caused by an increased inventory demand in anticipation that the Iranian revolution would cause an oil shortage.

The sharp price decline prices in 1986 were caused by members of OPEC cheating the agreed price which in turn caused a revenue fall for the Saudi Arabian state. This in forced them to increase production in 1986.

When the US attacked Iraq in the early 1990s the price rose due to both a decrease in supply but also because of anticipated attacks on Saudi oil fields by Iraqi military forces. This caused governments and industries to stockpile oil which hiked the price. The lowering of the price in the late 1990s was caused by lowering of demand due to the Asian financial crisis in 1997. (Baumeister and Kilian, 2016)

The earlier research concludes that the effect of a changing oil price on output is asymmetric. An asymmetric effect means that economic activity is more harmed by an increasing oil price than it is helped by a decreasing price aka a negative oil price shock. (Balke, Brown and Yucel, 2002) (Lardic & Mignon, 2006). Balke, Brown and Yucel, (2002) also researches different channels by which oil price changes affects the American economy. They do this by using a vector autoregressive model to try to establish through which channels the oil price effect moves through. Among others, they are researching the relationship between bond yields, oil price, and output. They present two main explanations to the nature of the relationship between bond yields and the price of oil. High volatility in the price of oil causes financial distress which in turn affects yields. The other explanation is that the market responds to changes in the real economy which will change the changing oil price. They also take monetary policy into consideration for the asymmetric effect but are unable to find conclusive evidence for this, although not ruling it out. Cologni and Manera (2008) in their paper presents how the relationship between positive changes in oil prices affects the economies of the G7 and through which channels the oil price effects these economies. They in turn also presents two explanations similar to the ones Balke, Brown and Yucel, (2002) suggested.

Hooker (1996) is of the opinion that the role of the oil price in effecting economies has changed and that it's hard to find a simple relationship between oil price and macroeconomic variables. His research is centered on the relationship between oil prices and recessions. He claims that the relationship between recessions and changes in oil price is weak in the 1980s but stronger before that period and he doesn't find Granger causality between output and oil price and unemployment and oil price after 1973.

Several papers point out that there is a negative relationship between economic activity and a higher oil price as well as between output and a decreasing oil price and output. The

explanation presented is that a prices chock whether negative or positive on a major input causes reallocation of capital and labor from the sectors affected negatively and into the sector affected positively. This means that the effect of a higher oil price on productive capacity in the sector with a high usage of oil will be amplified by the inability for the freed resources to be picked up somewhere else. On the other hand, when the oil price is decreasing and an economy is experiencing a negative oil shock the positive increase in ability in sectors where oil is an important commodity will be mitigated by the inability for these industries to find the right kind of labor. It will, therefore, be hard to take advantage of the lower price to expand output in these sectors. (Lilien, 1982). This theory is supported by Loungani (1986) that finds support for this to be a major reason for the increasing unemployment in the late 1960s early 1970s.

2. Theory

2.1 Mundell-Fleming framework

Mundell-Fleming is a model describing how interest rate and GDP growth is determined in an open economy. It can be applied during both a fixed and a flexible exchange rate regime, and for different levels of capital mobility. It originates from the IS/LM model.

The IS-curve (investment-saving) is showing all combinations of interest rate and GDP growth where the goods market is in equilibrium, aggregate supply equals aggregate demand. The LM-curve (liquidity preference-money supply) is showing all combinations of interest rate and GDP growth where the money market is in equilibrium, money supply equals aggregate money demand. Thus, the Mundell-Fleming equilibrium shows the interest-GDP growth combination where both markets are in equilibrium.

Since we are dealing with an open economy we need to take foreign trade and capital flows into account. We therefore add a third curve to the model, the BP-curve (balance of payments). This curve is showing combinations of interest rate and GDP growth where the balance of payments is in equilibrium (current account and capital account balance sums to zero) at the current exchange rate.(Daniels & VanHoose, 2014. s302ff.)

The model is based on some fundamental assumptions: First of all we hold all other factors fixed when testing the effect of a change in one variable. A fall in interest rate increases investment and thereby total GDP growth, since everything else is held constant.

A rise in interest rate attracts capital from abroad, since investors are assumed to be rational and seek the highest possible return on their capital.(Daniels & VanHoose, 2014. s302ff.)

A rise in GDP growth will increase demand for money since more transactions will occur, the increase in demand for money will drive up the interest rate, if money supply is held constant. An important factor in the model is the degree of capital mobility, which is how easily capital can flow across the borders of a nation, mainly determined by tariffs and regulations. The lower level of capital mobility the steeper the slope of the BP curve, because a rise in interest rate won't attract as much new capital when capital mobility is low. This means that the economy has more influence on the domestic interest rate than in the theoretical case of perfect capital mobility where the interest rate cannot differ from abroad, because all capital would flow to the country where rate of return is highest (interest parity condition). The BP-curve shifts upward because if the exchange rate is unchanged, an increase in GDP growth will decrease net exports (increase in imports and unaffected exports (which depends on exchange rate and foreign demand) and to compensate for a deficit in current account we need a surplus in the capital (financial) account, the interest rate has to rise to attract more foreign capital keeping balance of payments in equilibrium.

In the model we distinguish between perfect and imperfect capital mobility, and between fixed and flexible exchange rates. The G7 countries all have high capital mobility and flexible exchange rate which means a flatter BP-curve.(Daniels & VanHoose, 2014. s302ff.)

We will focus on the short run effect of an oil price change. The reason for this is that the long run effects are dependent on the reactions of policy makers and the financial markets and harder to predict through the model. In the short run the model would predict a decreasing interest rate and increasing GDP growth if the oil price declined and the opposite if the oil price rose. An oil price shock affects the economy through the price level channel, the reason for this is a change in autonomous money demand When oil price goes up/down the Md curve will shift upwards/downwards . If nominal money supply is unchanged this means real money supply has decreased/increased. This in turn will shift the LM-curve leftwards/rightwards. (Daniels & VanHoose, 2014. s302ff.)

You could argue that the IS/LM/BP-model is normally used to describe a *small* open economy (SOE), small meaning that its actions doesn't affect the rest of the world. However we do know that USA is considered a *large* open economy, meaning that its actions in fact

will affect the rest of the world. Despite this fact we will apply the model also when analyzing the USA. (Daniels & VanHoose, 2014. s302ff.)

3. Methodology

We will perform this study in essentially the same manner as Jiménez-Rodríguez & Sánchez (2005). We will test how the model performs with data gathered from quarter one 1980 to quarter four 2015. This means we will use 137 observations.

We apply a VAR model (vector autoregression), where all variables are treated symmetrically. This is advantageous since we are dealing with multiple time series which all could affect each other.

$$Y = c + \sum_{i+1}^{p} \Phi_i y_{t-n} + \varepsilon_t$$

Where y_t is a (n×1) vector of endogenous variables, $c = (c_1, ..., c_n)$ is the (7×1) intercept vector of the VAR, Φ_i is the (7×7) matrix of autoregressive coefficients for i = 1, 2, …, p, and $\varepsilon_t = (\varepsilon_t, ..., \varepsilon_{nt})$ is the (7×1) generalization of a white noise process. A VAR model is, to explain it in simpler terms, a model where each variable (in this case) performs once as a dependent variable and six as an independent variable. The dependent variable is in every case also present as an independent variable. Each variable is also expressed with n lags.

We use quarterly data and the variables included in the model are: real GDP, real effective exchange rate (REER), real oil price, real wage, inflation and short and long-term interest rates. (see Appendix for data references).

As the main purpose is to analyze the effect of real oil price on real GDP growth and interest rate, these three variables are obviously added to the model. The remaining variables are included to capture some of the most important transmission channels through which oil prices may affect economic activity. These channels are the oil price change affecting inflation which in turn affects exchange rates. Monetary policy will in turn affect short rates which then affects long rates. We also incorporate the labour market by adding real wages which affects aggregate demand. Some variables (real GDP, REER, real oil price and real wage) are expressed in logs.

We perform a augmented Dickey–Fuller to test if the variables is stationary. To be conservative, we include four lagged differences to eliminate serial correlation in the error term. We have to take the first difference of all the variables included.

As a second step we added a financial stress index (FSI), developed by the St Louis Federal Reserve Bank, to the model. This is one way in where we differ from Jiménez-Rodríguez and Sánchez (2005). FSI is, as the name implies, a measure of the general level of stress in the US financial market, it is calculated using several interest rates, yield spreads and other indicators such as volatility indexes. The interpretation for the FSI is that when the normal stress level is zero. When it is below zero the financial stress is lower than usual and when it is over zero the financial stress is higher than usual.(Federal Reserve Bank of St. Louis, 2014). We will place FSI after the oil variable. The reason behind this is that we are interested in the oil variables affect on the other variables, including FSI and therefore we place it after the oil variable. As specified by the way the model is constructed the variables can only affect the variables it is placed before directly. Since it is a measure of financial stress the US, we use FSI only for USA and Canada, as they are the most compatible to the data, and we believed it was too unclear whether it could be applied on european countries. We did search for a similar measure of financial stress for Europe but we only found data from 1999.

To analyze oil price fluctuations we will, besides the real oil price variable (which henceforth will be referred to as the symmetric variable) use four different oil price variables. The reason to use them is to test/capture the asymmetric relationship between the oil price and macroeconomic variables.. The real oil price impact on the economy is said to be non-linear, several studies from the past find that a rise in oil price retards the economy more than a price fall stimulates it (Balke, Brown and Yucel, 2002)(Lardic & Mignon 2006). In order to test for asymmetry we add one variable for oil price increase (O+) and another variable that only measures oil price decreases (O-). They are calculated in the following way:

$$O^+ = max\ (0, ln(Oil_t)$$
$$O^- = min\ (0, ln(Oil_t)$$

This means that if there is an increase in oil price from the previous period it will equal that increase. If there is no increase or a decrease it will take the value of zero, it cannot have a negative number.

In the case of a price decrease, the variable will have a negative number corresponding to that decrease, if there is no decrease or an increase will have a value of zero. Therefore it never has a positive number.

To capture more long term changes in oil price, we add another two variables. These variables are based on the same principles but instead of focusing only on the previous period they compare current oil price to the four preceding periods. They are called NOPI (net oil price increase) and NOPD (net oil price decrease). (Jiménez-Rodríguez & Sánchez, 2005)

$$NOPI = max\,(0, ln(Oil_t) - ln(max(Oil_{t-1}, ..., Oil_{t-4})))$$
$$NOPD = min\,(0, ln(Oil_t) - ln(min(Oil_{t-1}, ..., Oil_{t-4})))$$

NOPI tells us by how much the oil price has increased from the maximum price of the previous 4 periods. If the price is not higher than all 4 previous periods NOPI has a value of zero. It cannot have a negative value. This way of measuring an oil price shock was introduced by econometrician James D. Hamilton (1996).

NOPD is the difference between current price and the minimum price of the previous 4 periods. A decrease will therefore yield a negative number. However, it cannot have a positive number, if the price is not lower than all four previous periods the NOPD will have a value of zero. We will conduct the regressions with each oil variable individually.

With all variables onboard, we first look for *Granger causality* between variables, which means the ability of one time series to predict another, with a certain time lag. After performing a Granger causality-test we will be able to see whether the interaction between oil price and the macroeconomic variables are significant.

To choose the appropriate number of lags in the model we take help from Akaike Information Criterion and Schwartz-Bayesian Information Criterion and then use Lagrange multiplier test to check for autocorrelation and calculate the eigenvalues for the companion matrix to the model to check the stability of the model. For most of the vector autoregressive model we performed it with six lags except for when the post estimation commands showed that additional lags were needed. We never exceeded 8 lags.[1]

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[1] [1] For the U.S we use 8 lags on NOPD and the asymmetric oil price decrease variable as well as 7 lags on the asymmetric price increase variable. For the U.K we used 7 lags on the symmetric oil variable and on the asymmetric price increase variable. For Canada we used 7 lags on the NOPD variable.

In the next step we want to see what the effect of oil price on GDP growth and interest rates actually looks like. We do this with the so-called orthogonalised impulse response function (OIRF), which measures the reaction of one variable (response variable) to a change in another variable (impulse variable) over a time line. We run this test on all significant causations we got in the Granger test, and we then receive a table and a graph of each impulse-response pair, we set them to show the response from the time of the shock and 8 years forward (Period 0-32). Because of this it is important in the way we place the variables because of a shock to the first variable affecting all the other variables contemporaneously while the second variable only affect the variable placed after it contemporaneously and so on. The ordering we choose is accordance to Jiménez-Rodríguez & Sánchez (2005).

and "assumes, as in much of the related literature, that real output does not react contemporaneously on impact to the rest of the variables."

In conclusion what we will first test if:

- h0: The oil price coefficients equal to zero in the GDP equations of the VAR model without FSI.

- h0: The oil price coefficients equal to zero in the LTIR|STIR equations of the VAR model without FSI.

And then we will test if:

- h0: The oil price coefficients equal to zero in the GDP equations of the VAR model with FSI.

- h0: The oil price coefficients equal to zero in the LTIR|STIR equations of the VAR model with FSI.

We will the take the significant results and look in which way the oil shock affects the dependent variables.

Under *Empirical findings* we will present the results from the Granger causality analysis both for the VAR:s with and without FSI. We will then under *Impulse response functions analysis* describe the findings from the IRF graphs. Under *Discussion* we will discuss the results and finally conclude them under *Conclusion*.

4. Empirical findings

In the upcoming section, we will analyze the empirical results for the symmetric oil price variable as well as the four asymmetric variables. Our sample consists of two oil-exporting countries U.K and Canada and five oil importing countries, the U.S, Italy, Japan, Germany, and France. The first part of the analysis will present the granger causality test performed after the VAR:s for the different countries and oil price variables. The variables highlighted in this, and the upcoming sections will be the different oil variable's effect on GDP growth followed by their effect on long-term interest rates as well as short-term interest rates. The reason for our focus on these variables is that they are the variables highlighted in the Mundell-Fleming framework. We will first present the Granger causality and present which variables that are significant at the 5% (medium), and 1% (high) levels. In the next part of the analysis, we will add a new variable, Financial stress index, and look at how it changes the results of the regressions. In the last part, we will present in which way the oil price affects the interest and output variables that are significant by looking at the response impulse functions. Thus, the analysis will be presented in three parts.

4.1 Granger causality

4.1.1 Oil price changes effect on GDP growth

Table I

p-VALUE FROM Granger Causality Walds test.

h0: The oil price coefficients equal to zero in the GDP equations of the VAR model without FSI.

	Symmetric	Net oil price		Asymmetric	
	Ot	NOPI	NOPD	O -	O +
Country					
USA	0,296	0,139	0,058	0,000***	0,128
CAN	0,084	0,380	0,000***	0,064	0,163
FRA	0,105	0,693	0,115	0,045**	0,720
U.K	0,001***	0,319	0,001***	0,015**	0,094
ITA	0,304	0,493	0,680	0,764	0,009***
GER	0,001***	0,001***	0,967	0,530	0,000***
JPN	0,062	0,238	0,000***	0,028**	0,248

Analyzing the oil price column, one can notice that the symmetric oil price has a significant effect on real GDP growth in in the U.K and Germany. When looking at NOPD and its effect on real GDP growth we note a significance level for the oil exporting countries and Japan.

The German GDP growth is Granger caused by NOPI and the O+ variable. We also find a significant Granger causality between O+ and Italian GDP growth as well as between the O- variable and U.S GDP growth.

4.1.2 Oil price changes effect on Long- and short-term interest rates

Table II

p-VALUE FROM Granger Causality Wald test.

h0: The oil price coefficients equal to zero in the LTIR|STIR equations of the VAR model without FSI.

	Symmetric	Net oil price		Asymmetric	
	Ot	NOPI	NOPD	O -	O +
Country					
USA	0,014**/0,127	0,067/0,007**	0,126/0,015**	0,002***/0,077	0,234/0,018**
CAN	0,442/0,549	0,811/0,334	0,045**/0,001***	0,034***/0,241	0,553/0,804
FRA	0,005***/0,157	0,789/0,278	0,028**/0,105	0,010***/0,041**	0,201/0,096
U.K	0,266/0,255	0,801/0,661	0,012**/0,088	0,103/0,008***	0,0406**/0,753
ITA	0,066/0,011**	0,659/0,381	0,748/0,024**	0,570/0,026**	0,018**/0,181
GER	0,537/0,419	0,948/0,554	0,399/0,043**	0,091/0,176	0,896/0,719
JPN	0,087/0,102	0,610/0,700	0,049**/0,637	0,037**/0,447	0,382/0,146

When looking at the symmetric oil price variable we find three significant relationships. On a high significance level we find that the symmetric oil variable granger cause the long-term interest rates in France. If we look at medium level we find a relationship between the symmetric oil price variable and long rates for the U.S and between the symmetric oil price and short rates for Italy.

The price increase variables don't seem to have as much effect on long-term interest rates according to our results. The NOPI variable does not granger cause long-term rates to any country on a high or medium significance level. We do find a significant granger causality

between NOPI and U.S short rates. The O+ variable granger cause U.S Short rates as well as U.k long rates and Italian long rates.

The effect of NOPD on long-term rates is on a medium significance level for Canadian long rates. On a medium significant level we also find that NOPD granger cause U.K and Japanese long rates. Between NOPD and short rates we find granger causality between Canadian short rates on the highest significant level and to short rates on a medium level in the U.S, Germany, Italy and France. For O- there is a high significance between the oil price and long rates for USA and Canada and medium level for Japanese long rates. The O- also granger causes the short rates on a highly significant level in U.K and on a medium level in Italy and France.

4.1.3 Oil price effect on GDP growth with FSI

Table III

p-VALUE FROM Granger Causality Wald test.
h0: The oil price coefficients equal to zero in the GDP equations of the VAR model with FSI.

	Symmetric	Net oil price		Asymmetric	
	Ot	NOPI(7 lag USA)	NOPD	O -	O +
Country					
USA	0,515	0,699	0,964	0,290	0,548
CAN	0,001***	0,130	0,008***	0,007***	0,132

When adding the FSI the symmetric oil price variable goes from weakly significant to significant on a one percent level in it´s Granger causality on the Canadian GDP growth while the US GDP growth show no significant result on the symmetric variable as well as on either of the other oil price variables. This is a change from before when we could find a causality between O- and american GDP growth.

We find a significant Granger relationship on the O- variable and Canadian GDP growth. This is also a change from before where we found no relationship between these variables.

The NOPD variable granger cause Canadian GDP on a one percent level, but this is no different from the regression without the FSI variable. We also find a new granger causation from O- to Canadian GDP growth.

The result from adding the FSI variable to this limited size of the sample is that we found two new relationships and lost one.

The result when adding the FSI variable strengthens the results from before and makes new findings but it also removes certain findings.Since the Granger test is for determining a significant relationship it is in this part of the text hard to assess what this implies in regard to the Mundell-Fleming model, this will be more researched in the section focused on the impulse response functions.

4.1.4 Oil price effect on short and long-term interest rates with FSI

Table IV

p-VALUE FROM Granger Causality Wald test.

h0: The oil price coefficients equal to zero in the LTIR|STIR equations of the VAR model with FSI.

	Symmetric	Net oil price		Asymmetric	
	Ot	NOPI(7 lag USA)	NOPD	O -	O +
Country					
USA	0,012**/0,198	0,080/0,001***	0,012**/0,013**	0,003***/0,444	0,455/0,002***
CAN	0,747/0,000***	0,447/0,256	0,702/0,004***	0,913/0,000***	0,062/0,011**

When adding the FSI we get a few more significant relationships and a few less. The symmetric oil price still granger cause U.S long rates while we also find a new relationship between symmetric oil price and Canadian short rates. The relationship between O- and U.S long rates is still present while the relationship between O- and Canadian long rates disappear. A new relationship is this fund between O- and Canadian short rates. A new relationship is found between NOPD and U.S long rates. Two other new result is that both US short rates and Canadian short rates is granger caused by O+ variable. Adding the FSI variable to these models gained more significant results and made us lost a few.

4.2 Impulse response functions analysis

In this part, we will use impulse response functions (IRF) to analyze the previously found Granger relationships with medium or high significance.This will show us how GDP growth and interest rates respond to an oil price change . The oil price shocks will be negative for NOPD and O- and positive for the other oil price variables. We will start by analyzing the different oil variables without FSI and then go on to analyzing the oil variables effect when

the FSI variable has been added. We will compare the different oil price variables and compare their result to the predictions made in the Mundell-Fleming framework for oil price shocks. For graphs see appendix (8.2 IRF graphs)

4.2.1 Symmetric effect on GDP growth

The countries affected by a shock to real GDP growth on a high significant level is one oil importing country and one oil exporting country, Germany and the U.K. Their response to a positive shock path is quite similar with both experiencing a decrease in GDP growth, even though Germany first experiencing a sudden increase which later sharply falls.

With FSI included, the only significant granger causality on real GDP growth is Canada. Here the effect is ambiguous and it isn't of the same magnitude as with the two significant other countries without FSI included. The deviations from the equilibrium are smaller. The response starts with a rise in GDP growth, with its peak after the first period. Then it dives and reaching the bottom after 6 periods. The recovery starts and it then exceeds zero again after 10 quarters. It then sinks below zero and after 23-24 quarters the effect has died out. The effect could be described as volatile rather than negative or positive.

4.2.2 Symmetric effect on long term interest rate/short term interest rate

The only country where the relationship between the real oil price and interest rates are significant on a one percent level is between symmetric oil price and French long-term interest rates. A shock to the symmetric oil price causes France long term rate to an immediate increase followed by a prolonged dive and then stabilizing in the 15 to 20th quarter after the shock. Mostly negative effect.

One a five percent level we find a significant relationship between the symmetric oil price and United States long term rates. A shock to the symmetric oil price starts a volatile reaction to long rates which moves up and down along the equilibrium line with the effect clearing out after about fifteen quarters.

On the five percent level we find a relationship between the Italian short rates and a shock to the symmetric oil price. This causes the Italian short interest rates to take a hike in the first 2-3 quarters followed by a prolonged negative trend which hits the floor under equilibrium and then stabilizing in the fifteenth quarter. Mostly negative effect.

With FSI added to the model, the effect on Canadian short term interest rate is ambiguous. The effect comes after 3-4 periods, and first there is a rise in interest rate, then it falls until it reaches the bottom after 7-8 quarters, after 10 quarters it starts climbing to and then comes back to zero around quarter 16, it finally levels out after 20 quarters. The reaction to U.S long rates when adding the FSI looks similar to the reaction without FSI, both in magnitude and reaction. Both can be described as volatile reactions.

4.2.3 Symmetric oil price increase in relation to the Mundell-Fleming network

A oil price increase, according to the model, should result in a decreasing GDP growth and increasing interest rate.

The relationship between a shock to symmetric oil price and GDP growth is weak and we only find three significant relationships, two between oil exporters and GDP growth and one between a oil importing country and GDP growth. The relationships look pretty similar regardless of importing or exporting countries even if the magnitude is greater in the oil importing country. A shock to the symmetric oil price causes a small increase followed by a decrease in GDP growth. In short we find a relationship between a increasing symmetric oil price and decreasing GDP growth even though it is limited to three countries.

Regarding the interest rates the significant result are few. Before adding the FSI variable we have three relationships between interest rates for oil importing countries and none for a oil exporting country. When we add the FSI variable we get a significant result for a oil price shock on Canadian short rates. Of the relationships we find two is for short rates and two for long rates. One is an exporter three are importers.

For the oil exporting country a shock to the oil price causes volatility to interest rates but it is hard/meaningless to describe it in way of a distinct increase/decrease. Regarding the importing countries the shock to the symmetric oil price causes a downward slump in the interest rates, except for the U.S where a shock to oil price causes volatility with no clear trend.

In conclusion the interest rates for the oil importers with significant result works the opposite of the predictions made by the model while for the exporter we see no clear negative or positive trend but it causes volatility.

4.2.4 NOPD and O- effect on GDP growth

The highly significant relationships between the NOPD variable and GDP growth exist for Canada, U.K and Japan and the O- granger cause GDP growth for The U.S. The response in the movement for GDP growth to a one standard deviation shock in NOPD is different between Canada and Japan and the U.K. For Canada a shock to NOPD causes GDP growth to rise and then to fall back to equilibrium and stabilizing after about ten quarters. For Japan and the U.K the shock causes a negative effect to GDP growth which make a sudden increase just after the shock which then turns downwards and hits the floor under equilibrium and then level out after roughly ten quarters. The difference is in the magnitudes. In Japan, a one standard deviation shock has twice ass big effect on GDP growth than in the U.K.

The effect of a shock to the O- variable on the U.S GDP growth is a small decrease followed by an equally big increase followed by a decrease and then the effect levels out when we reach the tenth quarter.

On the five percent level a shock to the O- variable causes French GDP growth to fall to the tenth quarter and then stabilizing after about ten quarters. Japanese GDP growth show a similar, negative, response. U.K GDP show a clear negative effect.

When we add the FSI variable we still have a significant result for Canada on the NOPD variable but we also get a new significant result for the O- variable. A shock to the NOPD variable with FSI looks similar to the effect without FSI. A shock to the O- variable causes a volatile response with a direct increasing effect on GDP growth followed by a decreasing effect and then leveling out. The magnitude is very small.

4.2.5 NOPD and O- effect on long term interest rate/short term interest rate

The shock of the O- have a significant effect on the Canadian long-term rate and on the U.S long-term rate where the magnitude and path is quite similar. The shock causes a volatile reaction with no clear trend. The O- variable have a negative effect on French rates where a

shock causes an immediate increase in French long rates which then turns down and turning under equilibrium and then stabilizing after ten quarters. A shock to O- causes Japanese long rate to an immediate increase followed by a sharp decrease and then stabilizing in the tenth quarter.

On the five percent level we find a significant result between NOPD and the long rates for Japan. The effect to one a negative shock to the oil price is a negative effect to the Japanese long rates in the first quarters and then increasing and stabilizing in the fifteenth quarter. NOPD causes U.K long rates to a sharp increase which then stabilizes. NOPD causes a Canadian short decrease followed by a movement back to equilibrium followed by another deep decrease and then stabilizing in the tenth quarter. A shock to NOPD causes French long rates to an immediate sharp increase followed by a prolonged decrease which hits the floor below equilibrium and then stabilizes before the tenth quarter. The effect is mostly negative.

For the U.K, a shock to the O- variable causes a sharp increase in the short rates followed by a decrease and it stabilizes in the tenth quarter. A shock to O- causes Italian short rates to an immediate increase and then a fall under equilibrium and then stabilizing in the tenth quarter. For the French short rate a shock to O- causes a small increase followed by a decrease and the a volatile recovery to equilibrium. All have prolonged negative effects and immediate increases.

A shock to NOPD causes volatility in the short interest rate for Canada and it stabilizes after 15 quarters. The response to U.S long rates are quite similar with a volatile response. Italian and German short rates responses to a shock to NOPD are quite similar with an immediate increase followed by a prolonged decrease under equilibrium which holds on until the tenth quarter for Italy and continuing a bit longer for Germany. The effect is similar that of the O-variable.

When we add the FSI variable the relationship on the one percent level between the O-variable and U.S long term rates is still there while the Canadian relationship disappears. The volatile effect is still present.

On the five percent level when adding the FSI variable we find a relationship between NOPD and U.S long rates while the relationship to Canadian long rates disappears. A shock to the oil price variable causes the U.S long rates to go down in the first quarter and then stabilizing during the following quarters. The long rates have a more volatile response with both

increases and decreases. The effect also have a longer effect slowly stabilizing in the twentieth quarter.

On the one percent level for the FSI we find a relationships both between NOPD and O- and the Canadian short interest rates. The relationship between O- and Canadian short rates are new. A negative shock to the O- causes an increase in the short rates about five quarters in while the the NOPD effects is smaller in magnitude and no sharp changes.

On the five percent level when adding the FSI variable the relationship between NOPD and U.S short rates are still present and looks the similar with the volatile effect holding on a little longer.

4.2.6 NOPD and O- in relation to the Mundell-Fleming network

According to the Mundell Fleming model a decrease in the oil-price would lead to a decreasing interest rate and an increasing GDP growth. Both for the NOPD and O- minus variable the effect to GDP growth looks similar across countries on the one percent level as well as on the five percent level, even though the magnitudes are little different. The effect of a decreasing oil price is negative on GDP growth for Japan, France and the U.K while the effect for U.S and Canada are more volatile. For the NOPD variable the slope of the curve are steeper, which is expected, while the O- variable causes more volatility.

When we add the FSI variable to the Canadian and American sample we get a significant negative effect for the Canadian GDP growth on the O- variable while the NOPD stays significant. The effect on GDP growth is still volatile.

Concerning the decreasing oil price effect on interest rates the effect is harder to generalize. For Canada and the U.S the effect, both on long and short rates and for both variables, is that a shock to the oil variables cause volatility in the interest rates. For the other economies the short rates, on both variables, moves first up during a brief time and then decreasing under equilibrium and then stabilizes. For France and Japan this is also the case for the long rates to a shock to O-. The effects is mostly negative. For NOPD almost every economy reacts differently where U.K:s interest rates increases while French Japanese and Canadian decrease although with different magnítudes and the French long rates first increasing. Two main

patterns materialize, one where a decrease causes volatility and one where a fall in oil price causes short rates to increase immediately and then falling below equilibrium before stabilizing. It is therefore hard to make any clear cut generalizations. You could say that the prediction of the model is semi correct regarding a decreasing price effect on interest rates, except in the case of U.K long rates for the NOPD variable where it acts the opposite of the theory and in the cases when it shows a volatile effect.

When adding the FSI variable we get one new significant relationship, between Canadian short rates and the O- variable while losing the relationship to Canadian long rates. The reaction to a shock to O- looks similar to how other countries interest rates react without FSI. We also get a new relationship between NOPD and U.S long rates while losing the relationship between NOPD and Canadian long rates. The effect to the U.S long rates is volatile.

To summarize GDP growth acts the opposite of the model. For the interest rates we can find two main patterns. One where the interest rates act volatile (USA and Canada) and thus partly opposite of the model and one where the effect is negative and the interest rates act according to the model.

4.2.7 NOPI and O+ on GDP growth

For the asymmetric and net increase variables, we have highly significant causations on GDP growth for Germany (NOPI and O+) and Italy (O+). Comparing O+ and NOPI graphs for Germany we notice that they are very similar. Initially a sharp rise followed by a similar fall after 2-3 quarters. Then the recovery towards the initial level starts almost immediately. The effect is over within ten quarters. The effect mostly negative.

For Italy, the effect is a little different from Germany. The fluctuations of GDP growth is of a much smaller magnitude. First a dive and after one period it starts rising, it then fluctuates around zero, these fluctuations ceases and the line stays slightly above the initial level. There is no sharp trend but rather a volatile effect.

Both effects could be described as volatile with larger up and downs for Germany.

4.2.8 NOPI and O+ on long term interest rate/short term interest rate

There is no relationship between increasing oil price and interest rates on the one percent level. On the five percent level we find a significant relationship between U.S short rates and

NOPI as well as between O+ and U.S short rates as wella s between O+ and U.K short rates and O+ and Italian short rates.. A increase in NOPI causes volatility in the U.S long rates followed by a fall five quarters in. It then turns upward and stabilizes fifteen quarters in. A shock to O+ causes a similar pattern where the U.S short rates goes down to the tenth quarter and then begins to stabilize.

A shock to O+ causes U.K short rates to increase a little and the a prolonged downturn and stabilization to equilibrium in the fifteenth quarter. The Italian short rates show a similar pattern when experiencing a shock to the O- variable but the magnitudes of the increase is larger and the following path is less volatile than the british.

On the five percent level when adding the FSI variable we find a new relationship between the O+ variable and the Canadian short rates. The effect is however small and a shock to the oil price cause a small volatile effect. The relationship between NOPI and O- to U.S short rates are still there.

4.2.9 NOPI and O+ in relation to Mundell-Fleming framework

According to Mundell-Fleming a increase in the the oil price would have a negative impact on output and raise interest rates.

The significant relationships found are few for the increasing oil price variables. For Germany and Italy the effect from NOPI and O+ where a more volatile effect on GDP growth than a decreasing effect, with a sharp immediate increase followed by a similar negative effect and then leveling out.

The relationship between the interest rates and a increasing oil price is different for long rates and short rates. For the long rates the effect is a sharp immediate effect stabilizing back to equilibrium for Italian rates and for the U.K the effect is volatile. The significant relationships between the increasing oil price variables can be described a mostly negative or volatile.

To summarize the effect to GDP is in contrast to the model with no clear negative or positive responses. The short rates correspond opposite to the model while the long rates move in accordance to the model.

Since there are few significant result it is hard to generalize the result. We only have eight significant relationship on both price increase variables. The few significant results is a sign

of the weak economic relationship between oil price increases and movement in interest rates and output.

5. Discussion

So how does the oil price-macroeconomy relationship work and how does a economy react to changes in oil price? Does the Mundell-Fleming theoretical framework predictions about a higher/lower price resulting in a Higher/lower interest rate and lower/higher output?

We find twelve significant results for the NOPD variable and ten for O-. In comparison the we only found two and six significant granger causations for the NOPI and O+ variables.

For NOPD we have three(Canada, Japan och U.K) significant granger causations to GDP growth. Out of these one response is positive(Canada) and two are negative(Japan and U.K). For O- we also find three (USA, Canada and France) granger causations to GDP growth. Of these one response (France) is negative and two (USA and Canada) is volatile. For the NOPI variable we find one(Germany) Granger causation to GDP growth and the response is volatile. The O+ variable have two(Italy and Germany) granger causations to GDP growth. Both responses are volatile. The symmetric variable have three(Canada, Germany and U.K) granger causations to GDP growth. One response (Canada(when FSI is added)) is volatile and two(Germany and U.K) are negative.

When it comes to effect on interest rates, there are more significant relationships with the price decreasing variables than price increasing. For NOPD we got five significant relationships on long rates (USA, Canada, Japan, France and the U.K) and four on short rates (USA, Canada, Italy and Germany). Of these, two responses are negative (France and Japan), one is positive (U.K) and two are volatile (USA and Canada) on the long rates. On the short rate the response is negative for two (Italy and Germany) and volatile for two (USA and Canada).

For O- we got four significant granger relationships on the long rates (USA, Canada, Japan and France) and three on short rates(Italy, France and U.K). Of these two are negative(France and Japan) and two are volatile (USA and Canada) on the long rates. On the short rates all responses are negative.

For NOPI we have a granger causation on short rates when we add FSI (USA). This effect is negative. For the O+ variable we have two significant result on the long rates (U.K and Italy) and two for the short rates (USA and Canada(when FSI is added)). Of these the response on the long rate is positive. On the short rate one response (USA) is mostly negative and one (Canada) is volatile.

On the symmetric variable we have two (USA and France) granger causations on the long rates (The relationship between oil price and long rates appears for the U.S when we add the FSI variable) . Of these one response (France) is a sharp increase followed by a prolonged decrease and one (USA) is volatile. We also have two (Canada and Italy) granger causations on short rates. Of these one response (Italy) negative and one response (Canada) is volatile.

According to the Mundell-Fleming framework the relationship between exogenous oil price change and GDP growth is negative and the relationship between exogenous oil price and interest rates are positive in the short term (Daniels & VanHoose, 2014. s.302ff). The only increase in GDP growth we experience is for Canada on the NOPD variable. Our main result points to a fall in GDP growth whether there is a decrease or increase in the oil price. This is a clear break with the predictions of the model. The interest rates for the decreasing oil price moves in accordance to the model, except for the French long rates which in both the O- and NOPD first experience an immediate increase in followed by a decrease under equilibrium before stabilizing.

For the interest rates for the increasing oil price variables the long rate moves in accordance to the models and the short interest rates move in the opposite direction.

We can therefore conclude that the Mundell-Fleming modells prediction fits badly to our sample when it comes to GDP but better for interest rates except for short interest rates for increasing oil price. But since the Mundell-Fleming theoretical framework is a combination of interest rate level and GDP the model as a whole also fits badly to our tested sample. The overall conclusion is that its predictions fits badly to the empirical data. What does these findings finding mean for the IS/LM framework in general? The interest channel generally worked in the way the model predicted but since the oil-output relationship broke down it´s hard to say what that means for the model. It could imply that the LM-curve should be completely horizontal but then it won't have an effect on output. The IS/LM framework, its validity post 2008 and how it should, and could, be changed to better grasp economic reality

is currently being debated by, among others, Scott Sumner and Olivier Blanchard (Blanchard, 2016) (Sumner, 2016). Blanchard (2016) wants to revive the model by getting rid of the LM curve and change it to a curve corresponding to changes in the policy rates by the central banks. He also suggests to stop teaching the AS/AD framework altogether. This might be in line with our findings where the relationship between changes in exogenous factors and responses by a central bank seems to fit our result better. Sumner (2016) criticise this standpoint on the account that the monetary authority's problem with the zero lower bound traps the model. He also argues that this would mean that a leftward move in the IS-curve won't result in a declining interest rate and thus interest rate changes will always look like a result from a easy money policy. This is a good point. It is hard to make a recommendation on changes in macro models only when accounting for one type of cause and effect, in our case an oil price change, but it also highlights one of the greatest problems of macro models, the ability to handle complex multiplicity.

You could describe what we have found as a asymmetric effect in GDP growth to an oil price change. The effect on interest rate is partly asymmetric with account to the short rates for the increasing oil price variables. There are earlier research that support these findings.
Lilien (1982. s.780ff.) explain that a decreasing oil price has a contractionary effect on GDP growth by the fact that decreases, as well as increases, leads to reallocation of labour from industries where oil is an important input to industries that don´t uses oil in the same capacity in an increase and in the opposite way in a decrease. Since this process takes time i´t becomes hard to take advantage of a oil price decrease/increase and therefore both increasing and decreasing oil prices can cause contractions in GDP growth. The contractionary effect is caused hy reallocation. It should be noted that since this theory stems from the 1980:s and the validity of it might be questioned because of structural changes in the G7 industrial construction.

Balke, Brown and Yucel, (2002), Cologni and Manera (2008) and Lardic & Mignon 2006), among others, also finds support for an asymmetric relationship. It is surprising that international organizations like the IMF expected the falling price to cause a boom to output when there are empirical work conducted that points to the fact that the oil price have a clear

asymmetric effect on GDP growth. The question that arises are what explanations could be found to this phenomenon.

Balke, Brown and Yucel, (2002. s.50.) attribute the asymmetric effect of oil price changes on interest and GDP growth to two explanations. The first explanation relates to interest rates. Interest rates change to market anticipation of an asymmetric effect to the real economy to be realized later. Translated you could claim that an increase in long rates in an oil price increase could be a indication that´the price is suspected to last while a decreasing long rate in a oil price decrease is a indication that the effect will be prolonged. We had a symmetric effect on interest rates for both decreasing and increasing variables except for short rates in the increasing variables which went opposite of the Mundell-Fleming framework. Our asymmetric originated in the short rates rather than in the long, Short rates are controlled by policy makers and not by expectations of the market. What is interesting here is that the long rates and short rates goes in different directions to the shock in the increasing oil price variables, this could be an indication that the markets believes the higher oil price to either fuel real interest or inflation more than the policy makers. Unfortunately the significant effects are so few that you it´s hard to say anything conclusive,

The other explanation presented is that the asymmetric effect originates in financial stress brought on by the oil price change. The financial stress affects the real economy and interest rates in a negative way.

To check this we follow Nazlioglu, Soytas and Gupta (2015) recommendation to add the FSI variable when analyzing oil price changes to capture this effect and single it out from other changes. When we add the FSI variable the significance of the oil price variable changes in nine cases, three for GDP growth and six for the interest rates. Of these changes three are lost significant relationships and six are gained significant relationship between the oil variables and the response variables under study. This could point to the theory highlighted by Balke et al (2002. 50f) and Nazlioglu, Soytas and Gupta (2015), that the effect of financial stress is a big contributor to oil prices effect on interest rate.

When adding the FSI variable we get a new significant result between the O- variable and Canadian GDP growth where the variable causes volatility in GDP growth. For the US the relationship is the opposite where the relationship between O- and GDP disappears. A new

granger causation is also found between the symmetric oil variable and Canadian GDP growth. Also here the effect is volatile.

Concerning the interest rates relationship with FSI included, we get some more significant results on especially short rates. For the symmetric variable we gain a significant granger causality to Canadian short rates where the relationship is volatile. On the NOPD variable we lose the significant relationship to Canadian long rates while we gain a significant relationship to U.S long rates where we find a volatile reaction. For the O- variable we lose a significant relationship to Canadian long rates and gain one to Canadian short rates. Both of these new relationship is volatile. We also gain a new significance between the O+ and Canadian short rates . The sample we test the financial stress variable on is limited and it is thus hard to draw any general conclusion about the effect of financial stress. But for these two economies there were definitely a difference in results. Most new and lost results came from the relationship between the oil price variables and interest rates. This could be an indication that the theory lifted by Balke, Brown and Yucel, (2002) that the asymmetric relationship between interest rates and oil price changes could be attributed to financial stress. The lost relationships between the interest rate and oil price changes could be caused by the variation previously attributed to interest rates where in fact variation coming from some sort of financial stress and when the FSI variable was added the relationship between changes in oil price and interest rates became insignificant.

The new relationships emerging when adding the FSI could be caused by the new variable capturing the noise interfering with the interpretation of the oil price /GDP growth/interest rate relationship. When that noise got cleaned out we could capture the significant relationship between oil price and GDP growth/interest rates. Overall the variable added new results to our study because of the added significant results. These new significant result confirmed the volatile reactions to both the U.S economy and Canadian on account to changes in oil price. Nazlioglu, Soytas and Gupta (2015) result is thus strengthens by our findings. We can also conclude that the results that become insignificant when adding the FSI are the ones attributed to oil price changes causing financial stress described by Balke, Brown and Yucel, (2002. s.50.). The ones remaining and becoming significant are probably not caused by financial stress.

Our few significant Granger causality relationship found is well established in the literature. (Hooker, 1996 s.196) Jiménez-Rodríguez and Sánchez (2005. s.215ff) found few significant result for the decreasing oil price variables but more for the increasing oil price variables. This is the opposite of our study where we found more significant relationships on the decreasing oil price variables on both GDP growth and interest rates few on the increasing oil price variables. It should be highlighted that we don't use the exact same variables on the decreasing price. They for example use a scaled price variable we don´t use. But they use the same variables for the increase (O+ and NOPI) and here we get different result as reported above.

One could question the stability of the oil parameter and also the effect of the financial crisis 2007-2008. The crash and the following strange behaviour of many macroeconomic variables could help explain the asymmetric relationship. One could also ask if oil has the same role in the G/ countries it had twenty, thirty or forty years ago.

A big drop in oil price was triggered by the financial crash of 2008 and the declining demand. In that sense it is the decreasing demand that causes the price to decrees and not the other way around. But as Nazlioglu, Soytas and Gupta (2015) points to financial stress and oil price trigger each other and thus the initial financial worry could trigger a response in oil price that in turn trigger the financial stress and output and it might seem as a decares in price cause a decrease in output even though the relationships is that they cause each other in waves.

This could also explain the asymmetric result for the short interest rates to an increase in oil price. Since the crash 2008 monetary policy has been focused on keeping interest rates down to initiate investment (Joyce et al, 2012). At the same time the oil price catched up from the decrease triggered from the crisis and went even higher compared to before the crash. The explanation to why it looks like the interest rate-increasing oil price relationship broke could be that unorthodox monetary policy conducted after the 2008 crash with rate hike after rate hike makes it look like there is a relationship between a increasing oil price and decreasing interest rates while this might not be the fact at all. We can have found a´nonsensical relationship. It is hard to say something definitive about this but it is clear that the one can question the stability of the parameters and the non normal situation after 2008 can play a role in our results.

6. Conclusion

Both policy makers and researchers predicted that the 2014 oil-price decrease would result in an output increase. Their hopes was put to shame when the predicted increase failed to emerge. Our results, which follows the results from previous research, is that a decrease in oil price as well as an increase in oil price causes GDP growth to decrease in the short term. For interest rates we find a symmetric relationship except for the short term rates to an increasing oil price. Our result for GDP growth is thus contradictory to the Mundell-Fleming framework where a oil price change should have a negative relationship to GDP growth. For interest rate our result is partly in line with the model.

This relationship between oil price and GDP growth and interest rates is referred to as a asymmetric effect in the literature and is explained partly as a result from market expectations, financial stress brought on by the oil change and the effect of reallocation of labour from oil intensive industries to less intensive industries and vice versa. Another possibility to the relationship between increasing oil price and decreasing interest rate could be a result from the unorthodox monetary policy conducted post - 2008. It is also possible that a instability of the oil price parameters are affecting the results. Economic data have behaved strange post 2008 and it is possible that this plays a part also here,even if our results are in line with previous research. This would be interesting to investigate further.

For the part of the sample where we add the financial stress variable (FSI) we get different result from the one where we don't use the variable. We get both new significant result and some significant results disappearing. The effect of the oil price looks similar both with FSI and without it, even if we capture some more volatility with the FSI variable. It would be interesting to use a similar variable for the rest of the sample. This is also something that should be further researched.

7. Literature

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8. Appendix

8.1 Data sources

The data used in this study are from 1980:I to 2015:IV. The corresponding sources are as follows:

Real GDP: IMF data (Real GDP (seasonally adjusted) Index from IFS database line 99bvr))
Nominal oil price: IMF (Primary commodity prices), UK Brent price (line 11276AAZZF).
US Producer price Index:IMF data (PPI from IFS line 63)
Real Oil price: Nominal oil price deflated by US Producer price Index.
Real effective exchange rate: OECD data, line CCRETT01.
Short term interest rate: IMF (IFS, line 60c, Treasury Bill Rate) for all except Japan which is from IFS line 60b (Money market) and Germany which is from OECD data line IR3TIB.

Long term interest rate: IMF (IFS, line 61, Government Bond Yield)
Nominal wage: OECD data, line LCEAMN01. These data are adjusted for seasonality.
Consumer price index: OECD data , line CPALTT01. These data are adjusted for seasonality.
Real wage: Nominal wage deflated by CPI.
FSI: Federal reserve bank of Kansas City Financial Stress Index, Index, Quarterly, Not
Seasonally Adjusted

8.2 IRF graphs

Impulse: Symmetric
Response:GDP

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Response: Long interest rates

Graphs by irfname, impulse variable, and response variable

FRA_Realoil, Realoil_d, LTIR_d

Graphs by irfname, impulse variable, and response variable

Response: Short interest rates

IT_Realoil, Realoil_d, STIR_d

Graphs by irfname, impulse variable, and response variable
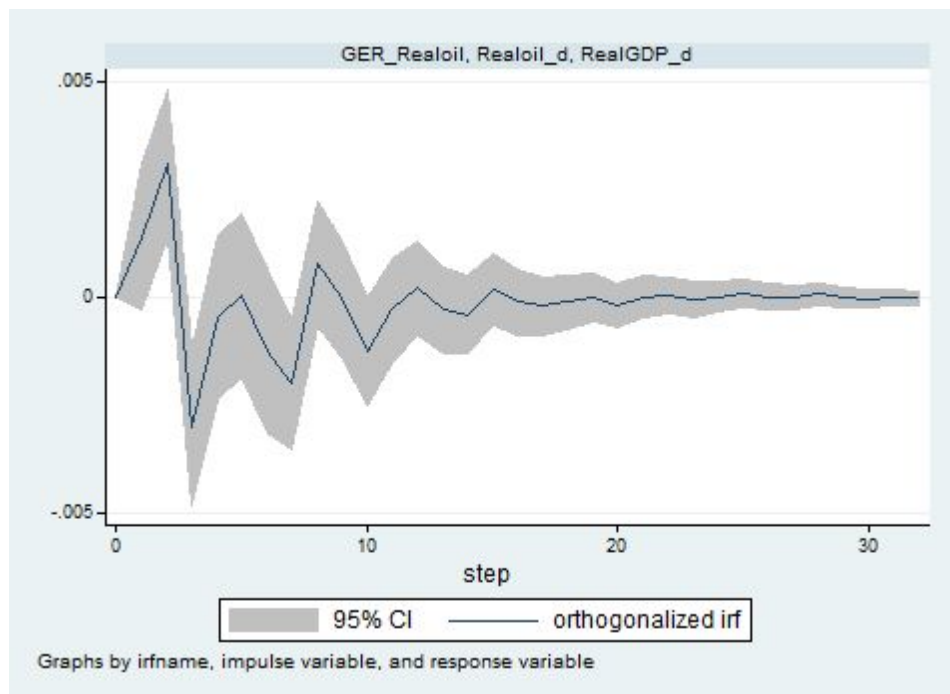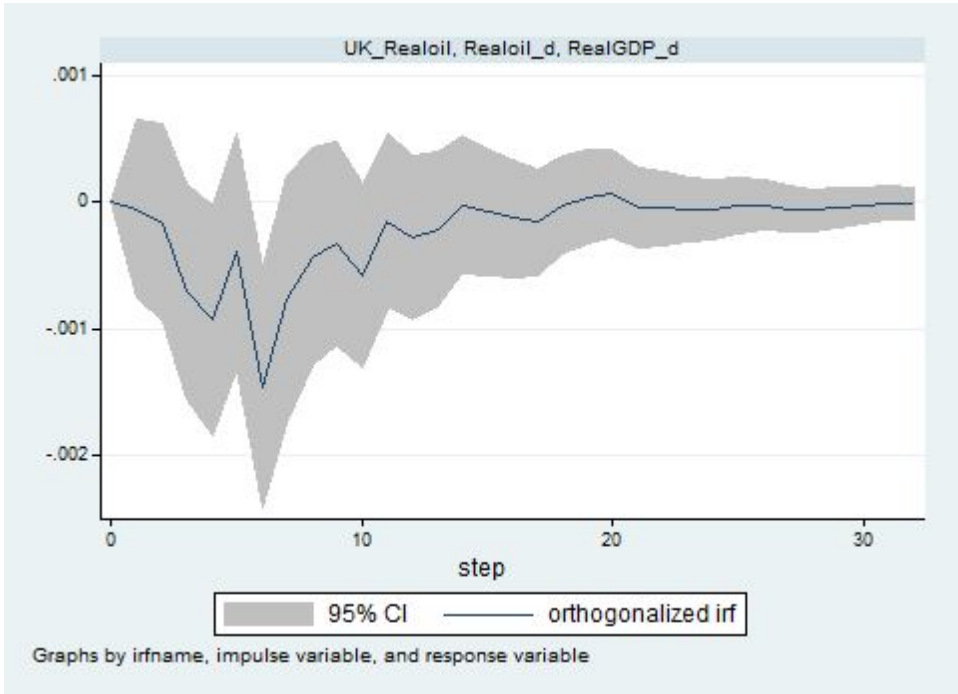
Impulse: NOPI
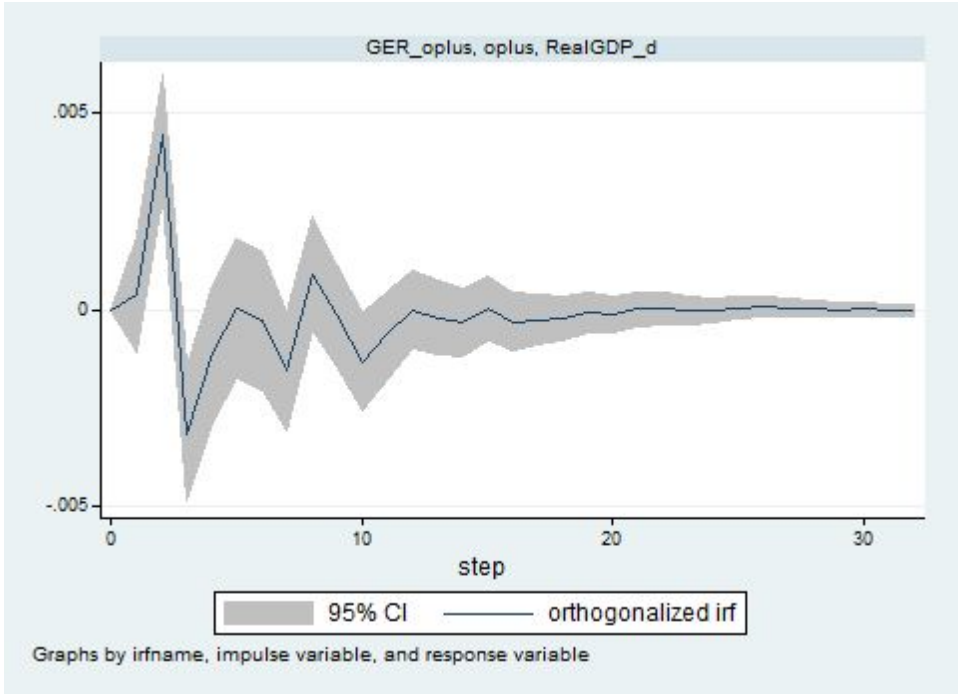Response:GDP
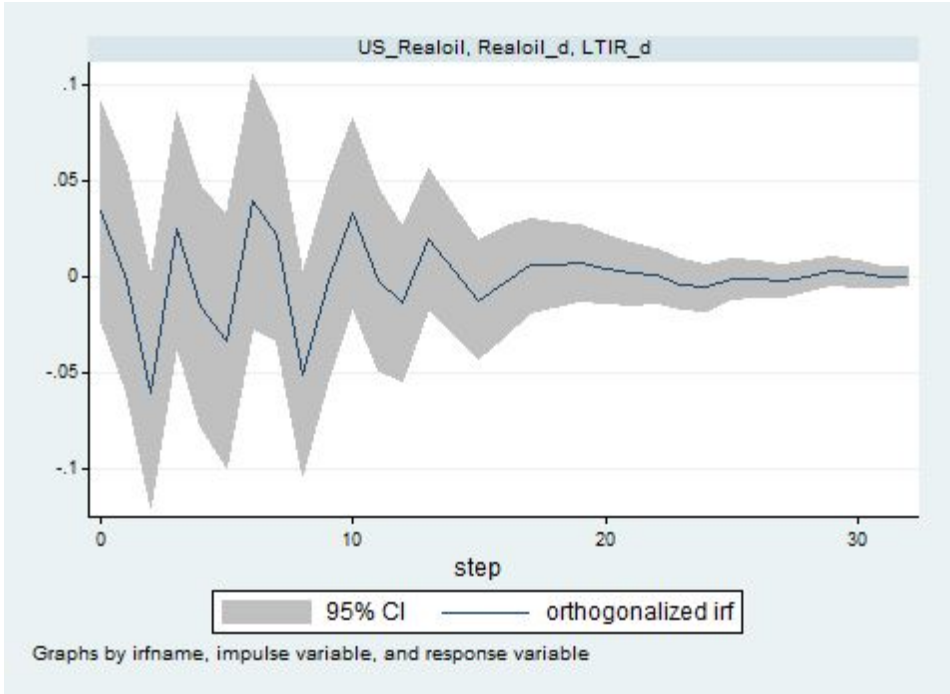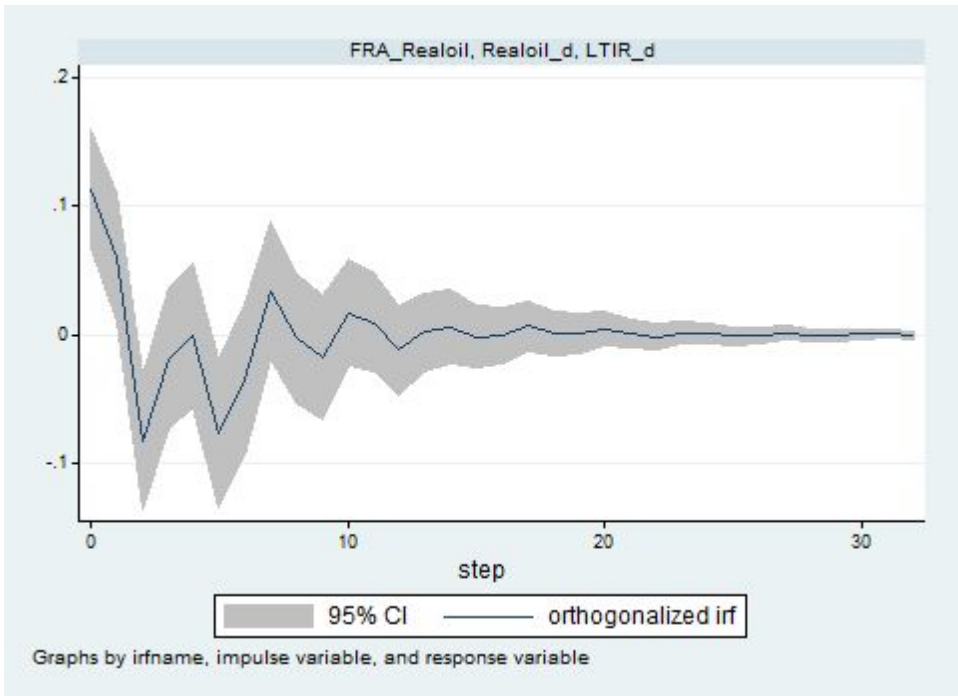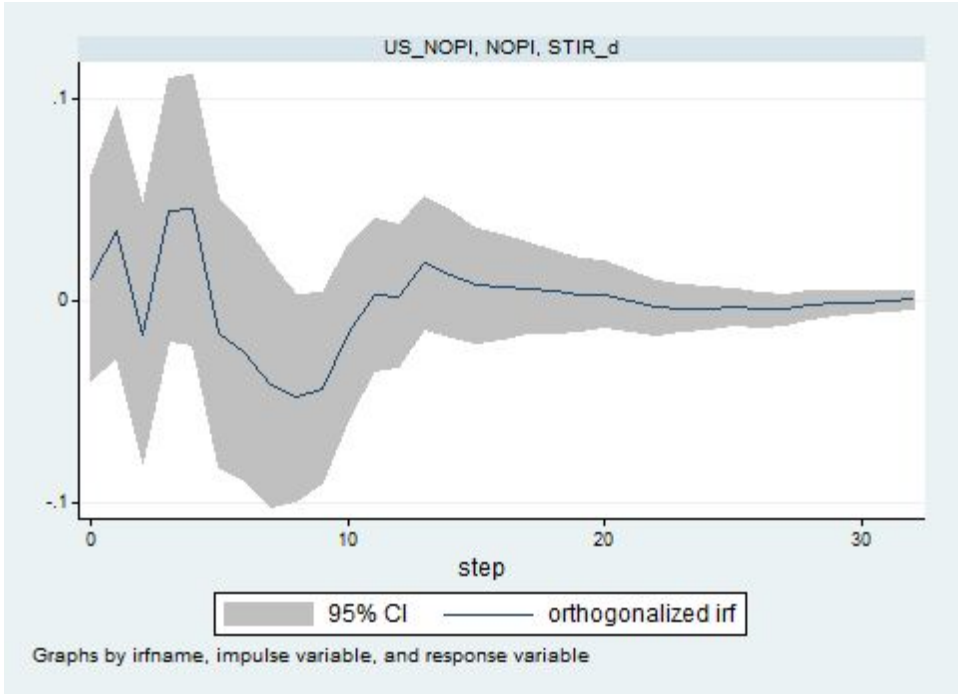
Response:Short interest rates

Impulse: NOPD
Response:GDP

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Response:Long interest rates

CA_NOPD, NOPD, LTIR_d

95% CI — orthogonalized irf

Graphs by irfname, impulse variable, and response variable

FRA_NOPD, NOPD, LTIR_d

95% CI — orthogonalized irf

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Response: Long interest rates

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

CA_NOPD, NOPD, STIR_d

Graphs by irfname, impulse variable, and response variable

US_NOPD, NOPD, STIR_d

Graphs by irfname, impulse variable, and response variable

Impulse: O-
Response:GDP

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Response: Long interest rates

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

CA_ominus, ominus, LTIR_d

95% CI — orthogonalized irf

Graphs by irfname, impulse variable, and response variable

FRA_ominus, ominus, LTIR_d

95% CI — orthogonalized irf

Graphs by irfname, impulse variable, and response variable

Response:Short interest rates

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Graphs by irfname, impulse variable, and response variable

Impulse: O+
Response:GDP

Graphs by irfname, impulse variable, and response variable

Response: Long interest rates

UK_oplus, oplus, LTIR_d

95% CI — orthogonalized irf

Graphs by irfname, impulse variable, and response variable

IT_oplus, oplus, LTIR_d

95% CI — orthogonalized irf

Graphs by irfname, impulse variable, and response variable

Response:Short interest rates

Graphs by irfname, impulse variable, and response variable

FSI

Impulse: Symmetric
Response:GDP

Graphs by irfname, impulse variable, and response variable

Response: Long interest rates

US_FSI_Realoil, Realoil_d, LTIR_d

Response: Short interest rates

CA_FSI_Realoil, Realoil_d, STIR_d

Impulse: NOPI
Response: Short interest rates

Graphs by irfname, impulse variable, and response variable

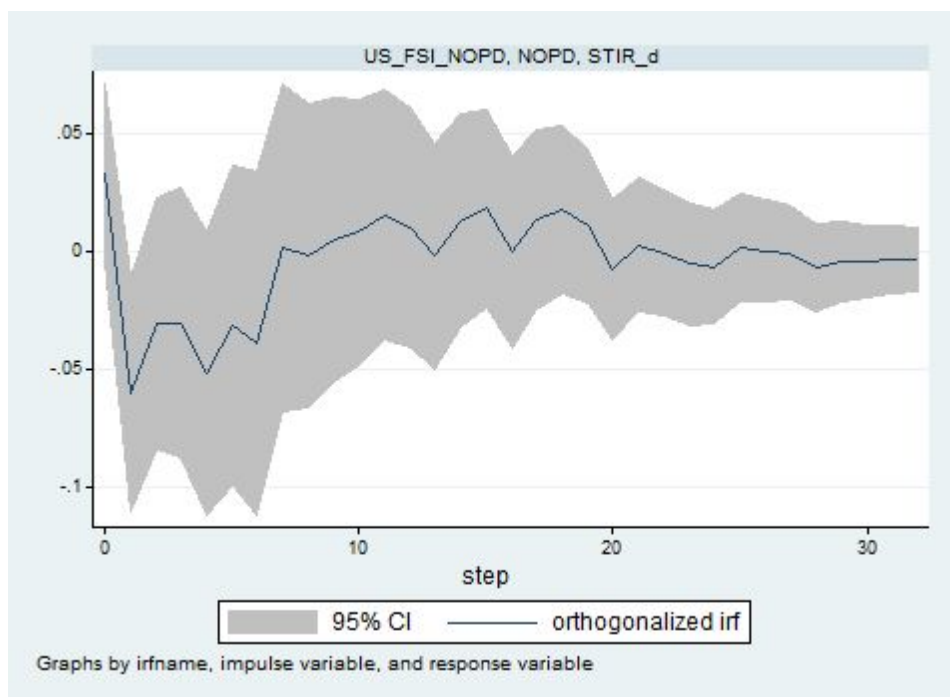Impulse: NOPD
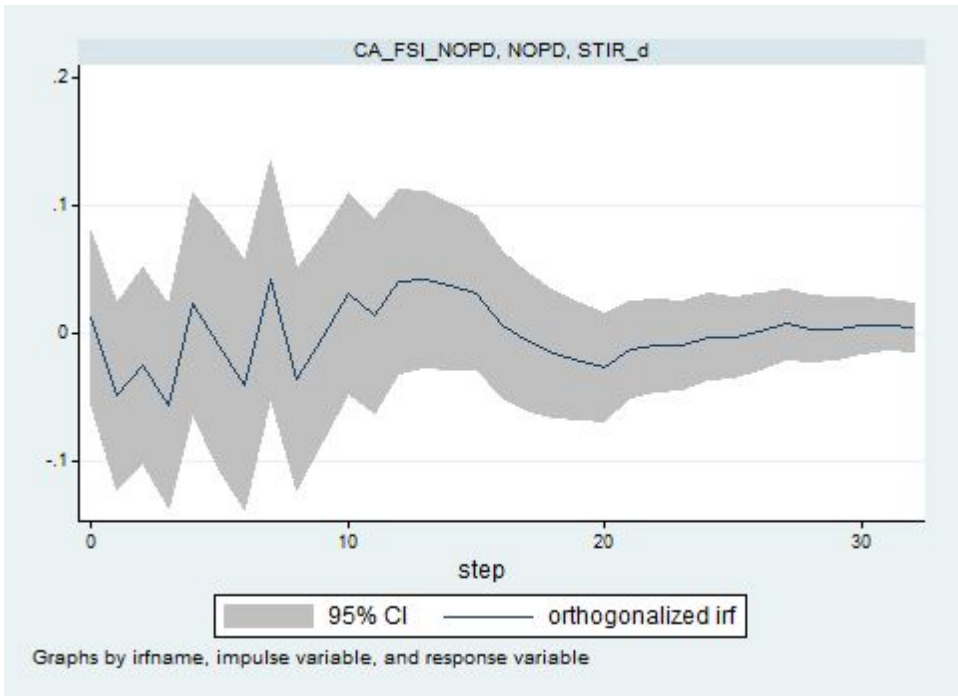Response: GDP

Graphs by irfname, impulse variable, and response variable
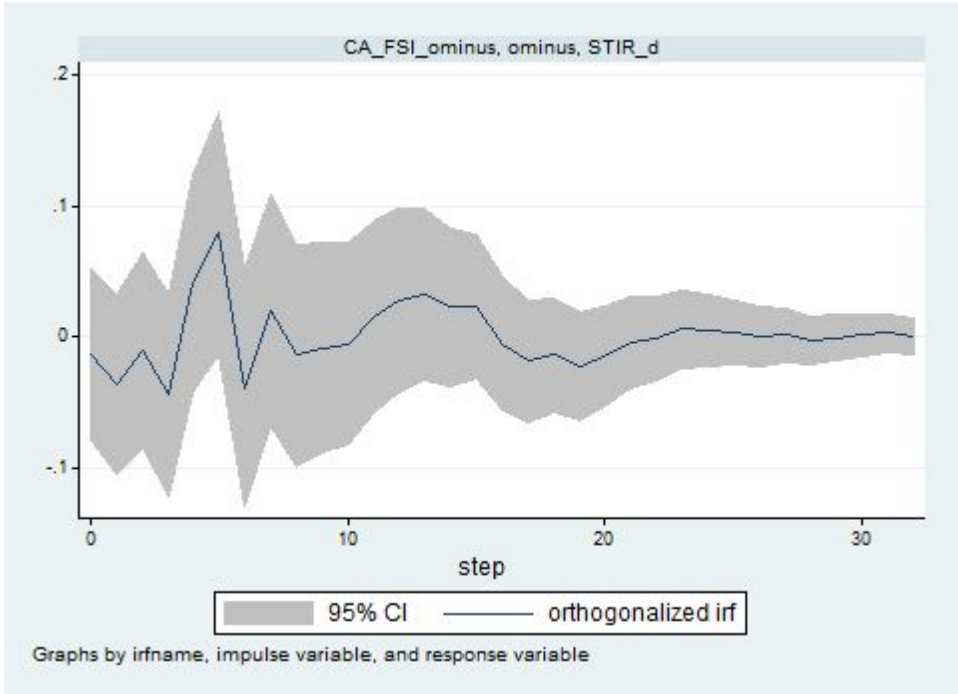
Response: Long interest rates

Response:Short interest rates

Graphs by irfname, impulse variable, and response variable

Impulse: O-
Response: GDP

Graphs by irfname, impulse variable, and response variable

Response: Long interest rates

Graphs by irfname, impulse variable, and response variable

Response:Short interest rates

Graphs by irfname, impulse variable, and response variable

Impulse: O+
Response: Short interest rates

US_FSI_oplus, oplus, STIR_d

95% CI   orthogonalized irf

Graphs by irfname, impulse variable, and response variable

CA_FSI_oplus, oplus, STIR_d

95% CI   orthogonalized irf

Graphs by irfname, impulse variable, and response variable