Department of Economics and Finance – Chair of Money and Banking

ORIGINS AND CONSEQUENCES OF OIL PRICE SHOCKS

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Index

Introduction

The oil price is considered to be one of the most important variables in the global economy. The attentions economists pay on forecasting and interpreting the changes in the price of this commodity triggered my interest to further investigate on this topic. In this paper, and mainly in chapter one, are discussed the macroeconomic and financial effects of shocks to oil prices over time and the different transmission channels through which oil price shocks propagate. Indeed, while the first episodes of sharply rise in the price of oil, occurred in 1973 and in 1979, have been followed by dramatic economic performances with high level of inflation and negative output growth rate, more recent oil price shocks, occurred in 1999 and 2002, have led to effects so small to be considered negligible. Two different hypotheses are reported to explain this difference. The first one is linked to structural changes in the economy that have helped the economy to better respond to unexpected rise in the price of oil. The structural changes refer to the increase in central banks' credibility, the fall in oil consumption as a share of GDP and the high reduction in the level of nominal wage indexation. The second hypothesis of the different impacts each shock has brought over time, is rooted in the nature from whom it stems. While the first two shocks, the ones occurred in 1973 and 1979, are driven by oil supply disruption, the latest ones, happened in 1999 and 2002, are mainly driven by an increase in global demand. Therefore, whether oil price shocks are the cause or simply the mirror of global economic conditions mainly depends on the nature of the shock. In chapter two the relationship between oil price changes and U.S stock return is analysed. When the price of oil rises, the price of many inputs go up together with the cost of energy and this leads to a decline in the corporates' profits. Consequently, the shares price of corporation should fall. Nevertheless, the expected negative correlation between the two variables seems to have vanished in the last five years and, in order to find an explanation for this phenomenon, I have applied a decomposition of oil proposed by Hamilton (2014) to test whether the reason that explain why stock returns and oil price move in the same direction can be attributed to a softening in the global demand. The results obtained confirms the hypothesis that the two variable taken into consideration moves together not because one affects the other, but because they both respond to the same external factor, a decrease in the global demand. Furthermore, the equation proposed by Hamilton has been augmented by the introduction of an additional variable, the volatility index, namely the VIX index. The introduction of the volatility further explains the positive correlation between the stock market returns and the oil price change. Nevertheless, the decomposition described above only partially explains the trend of oil and stocks to move together, since subtracting the demand and the volatility component of the oil price, the correlation approaches zero, but is still not negative as it should be expected.

Chapter 1

The Macroeconomic Reactions to Oil Price Shocks

1. Oil prices over time

From the late 1940's to the 1970's the oil price was very stable and exceptionally low compared to modern price. The stability of oil price, during this period, was granted in the U.S. by the Texas Railroad Commission (TRC). Along with some other state regulatory agencies, TRC made previsions and predictions about the quantity of oil demanded for the upcoming month, and set production quotas in order to satisfy the forecasted demand. As a result, the quantity produced was enough to meet the quantity demanded, and consequently, the price of oil remained essentially stable. The calm experienced by oil price was interrupted on October 1973, when the Yom Kippur War started. In this occasion, the Organization of Petroleum Exporting Countries (OPEC[1]) experienced for the first time the great power it had over the level of oil price. Due to the support the U.S. and many European countries offered to Israel in the conflict, OPEC imposed an oil embargo on western countries. The result was dramatic, and the first oil shock occurred. Oil production felt by 5 million barrels a day and the price of oil rose by more than 200 percent, reaching 11,16 USD per barrel[2] in 1974 . Afterwards, the price of oil remained stable for a period of two years, until the second oil price shock occurred. Two events triggered the second shock: The Iranian Revolution (1979) and the following Iran-Iraq war (1980). The oil production decreased by around 10 percent, due to the fact that Iran nearly stopped supplying oil, and Iraq production had been really harmed by the war. Consequently, oil price experienced an upward change from 14,85 USD to 39,5 USD by April 1980. During the following years, in the first half of the 80's, OPEC tried to stabilize the oil price by setting production quotas for its members. This attempt, due the internal conflict in the organization, and to OPEC members cheating on production quotas, finished up to be a failure, and new producers entered in the

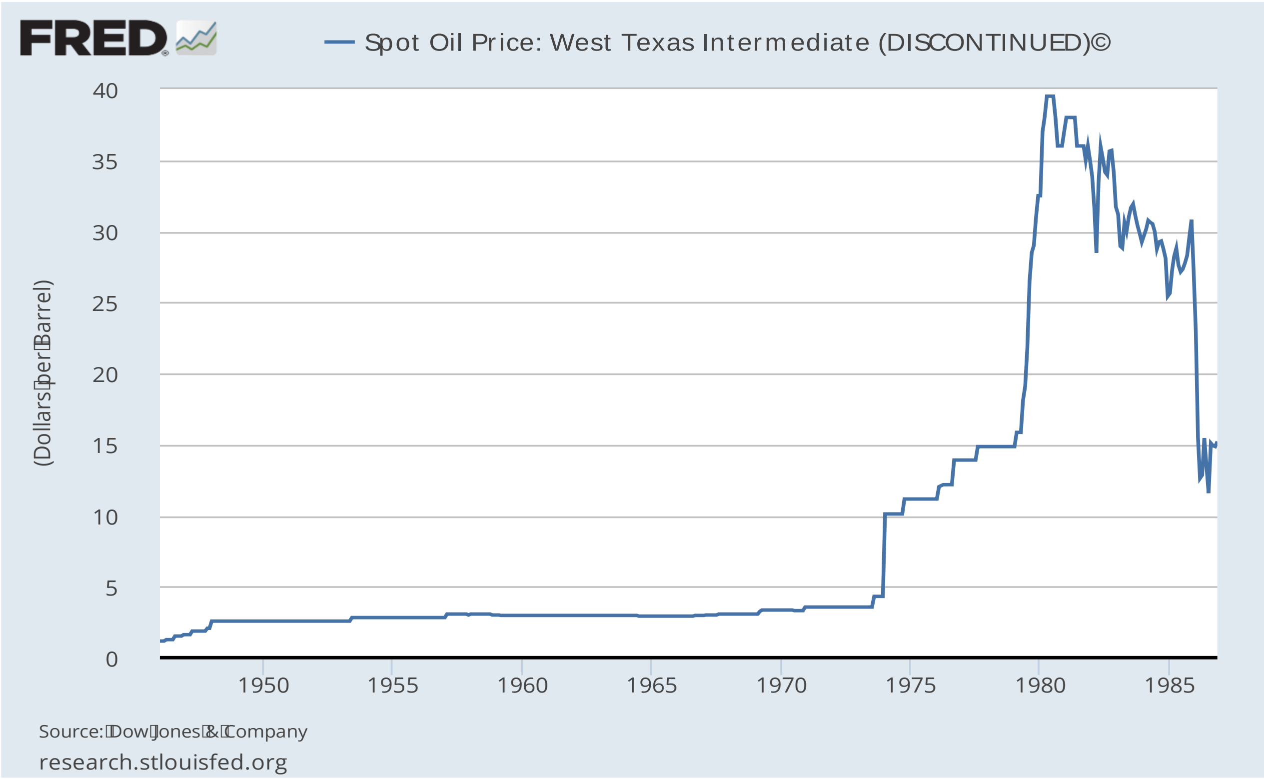
[1] : OPEC was formed in 1960 by 5 founding members: Iraq, Iran, Kuwait, Saudi Arabia, and Venezuela. Now it counts 13 country members. Qatar, Indonesia, Libya, the United Arab Emirates, Algeria and Nigeria joined the organization by the end of 1971 and, more recently, in 2007, Angola and Ecuador decided to be part of it

[2] Crude Oil Prices: West Texas Intermediate (WTI) - Cushing, Oklahoma. Prices are reported, on quarterly base, according to U.S. Energy Information Administration data.

market. Consequently, given the increase in the supply of oil brought by new entrants, on July 1986, oil price fell sharply reaching 13,81 USD.

Figure 1

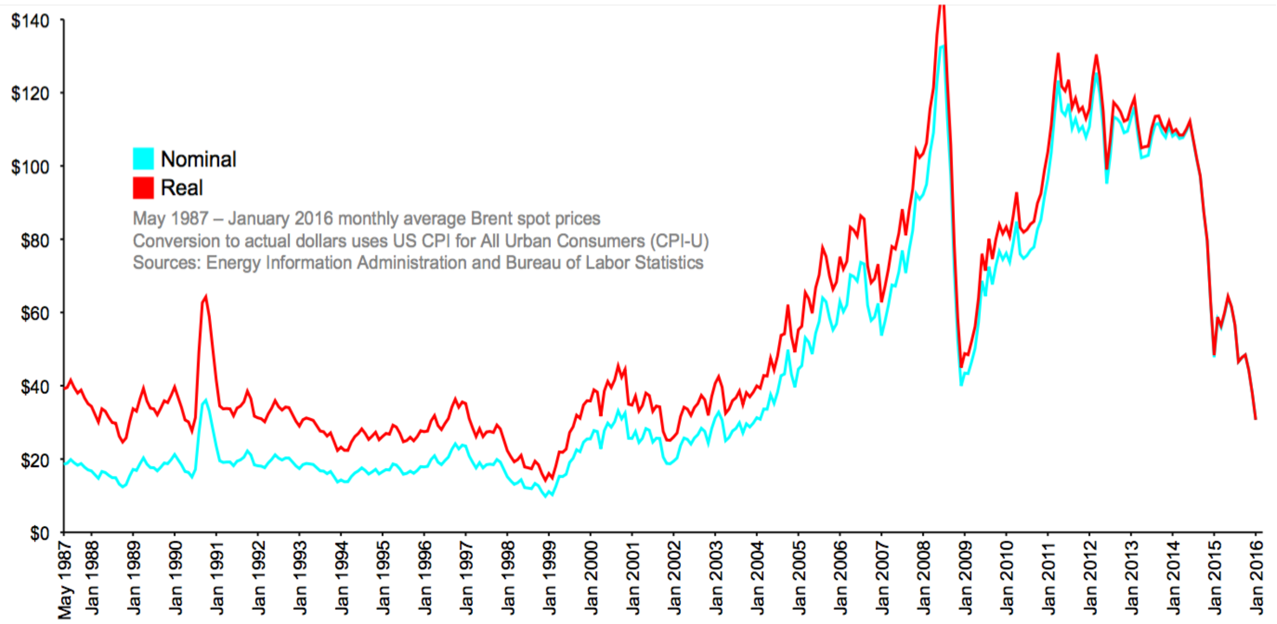
Oil Price ($ per Barrel)



Thenceforth, oil price appeared to be very volatile with some increase in 1990, due to the Kuwait war, and some downturn caused by changes in emerging countries' demand. From 1999 oil price started to increase for several years until it came to its peak in April 2008, reaching 123,78 USD. This enduring rise in oil price stems from the enormous increase in the oil demand from emerging East countries, especially China and India, and also for the beginning of the US invasion in Iraq. As the financial crisis of 2007-2008 started, oil price experienced a new and drastic downturn. Oil price rapidly fell to 43,14 USD, reflecting also the expectations about a prolonged recession. Although this rapid decrease, oil price soon came back up, starting to rise from 2009 and reaching Brent price of 100 USD by January 2011.The recovery was driven both by revisions on expectations about recession and to a recovery of the global state of the economy. Afterwards, oil price trend has been reasonably stable, with some small deviation of around 10 USD. The stability lasted until 2014, when oil prices dramatically started to fell. The downturn, was triggered by an increase of oil production in the United States and a simultaneous decrease in the oil demand from East emerging countries. In addition, oil cartel OPEC, differently from the preceding oil price downturn, did not decrease the production. Instead, OPEC increased its oil production, especially due to Iran. The decline was so persistent that on February 2016 oil price was below 30 USD, a drop of “almost 75 percent since mid-2014 as competing producers pumped 1-2 million barrels of crude daily exceeding demand, just as China's economy hit lowest growth in a generation."[3]

Figure 2

Nominal and Real Oil Price ($ per barrel)



Oil price shocks often anticipate economic downturn, and data, even if with some exceptions, confirm this trend. An increase in oil price is often followed by recession and by an increase in inflation. During the first two shocks, the OECD countries faced an inflation rate that reached its maximum of about 15 per cent in 1974 and 13 per cent in 1980. GDP growth rate was hit as well, and in 1975 and 1982 it was close to zero, meaning a 4-5 per cent decrease from the moment of oil shocks. Oil-price spikes do not always lead to economic downturn, but as Keith Sill suggested in 2007 “In the post-war U.S. data, the correlation between oil-price spikes and economic downturns is not perfect — some oil-price increases are not followed by recessions. But five of the last seven U.S. recessions were preceded by significant increases in the price of oil. The most recent rise in the price of oil has not led (at least not yet) to an economic recession, but history nonetheless suggests that oil prices are an important element in assessing the economy’s near-term prospects”. Indeed, the 2007 oil spike was followed by what is known as the Great Recession that leads the U.S to GDP decline of 4,3%

[3] “Oil futures bounce on OPEC deal speculation". CNCB via Reuters. 16 February 2016. Retrieved 17 February 2016

and to an unemployment rate of 10%[4]. The economic downturn, subsequent to oil price shocks, are due to the fact that oil is an essential input in industrialized economies. Changes in the price of oil strongly influence the price of goods made of petroleum, fuel, transportation vehicles, and heating bills. Furthermore, an increase in oil price can have a psychological effect. Indeed, oil shocks can lead to uncertainty about the future, which in turns can make consumers more reluctant to invest and consume. In addition to those effects, oil changes can lead also to structural changes in the economy. Reallocation of labour and capital between energy-intensive sectors and those that are not energy intensive, can be very expensive and dangerous for countries. Many economists, supported by a great multitude of data, suggest that oil price shocks are able to hurt many areas of the economy. In 1993, Bresnahan and Ramey, in their work, found out that the oil rise in correspondence of the first two shock occurred in 1974 and 1980 led to a drastic shift in the size classes of automobiles, that consequently reduced, in the U.S., the capacity utilization at automobile plants. Furthermore, in 1997, Davis and Haltiwanger documented the striking effect on the rate of job loss in determined sectors of the economy. Their analysis found out that oil shocks can be responsible for 20-25 per cent of the variability in the employment growth rate, with an effectiveness that is proportional to the capital intensity, energy intensity, product durability and plant and age size. Nevertheless, the fact that oil price shocks are directly related to economic downturn remains controversial. The relation between oil price and the economic activity performance appears, according to data, to be much weaker in modern times than what it has been before 1986. In order to understand the reasons and the conjectures behind the difference of oil shock's impacts on economy in different time periods, the different channels of oil shock propagation in the economy must be analysed. This analysis is then reported in the following section.

2. Oil Shocks Propagation Channels

The sharp oil price increases registered in the 1970s were associated with dramatic downturn in the economy. Oil is considered as a macroeconomic variable, whose changes are able to lead to recession or high inflation and sometimes both, causing an economic disaster, known as stagflation. As mentioned before, oil price shocks have historically preceded many of the economic crisis occurred in the past. Nevertheless, the share of oil consumption in GDP is relatively small. In the U.S, the highest percentage of GDP of oil consumption has been around 4% during the beginning of the 80's[5],

[4] According to Civilian Unemployment Rate

[5] According to the U.S Energy Information Administration and Haver analytics

and have been declining since then. Therefore, how can the change in the price of a so small variable lead to dramatic effects in the economy?
Oil price shocks affect the economy of countries through various and connected channels that lead to small single effects, but summed up, have a much larger impact than what it could be thought. In the following subsections the impact of oil price shocks on two different aspect of the economy, namely GDP and inflation, will be analysed.

2.1 Oil Price Shocks and Recession

The importance of oil price shocks is directly proportional to the amount of imported and consumed oil in a given country. The output growth will be hurt much more in economies in which oil is the main energy element. According to Table 1, in 2015, USA has the highest amount of crude oil and petroleum products imported per day (8744), followed by China (7143) and India (4313). In most of the main oil importers countries, oil price shocks have an impact on both supply and demand. Supply is affected as production is more expensive for firms. All the various sectors of industries and firms are hurt; from the production, performed by fuel machines, to the delivery, carried out by fuel cars or other fuel vehicles. Furthermore, the costs of firms increase even more if goods produced are made by petroleum derivatives. On the other hand, demand is affected as well. Consumers' wealth is hurt, and this, in turn, can lead to a high level of uncertainty. Investments and purchases are delayed, and output growth slows down.

TABLE 1

Word Imports of Crude Oil and Petroleum Products

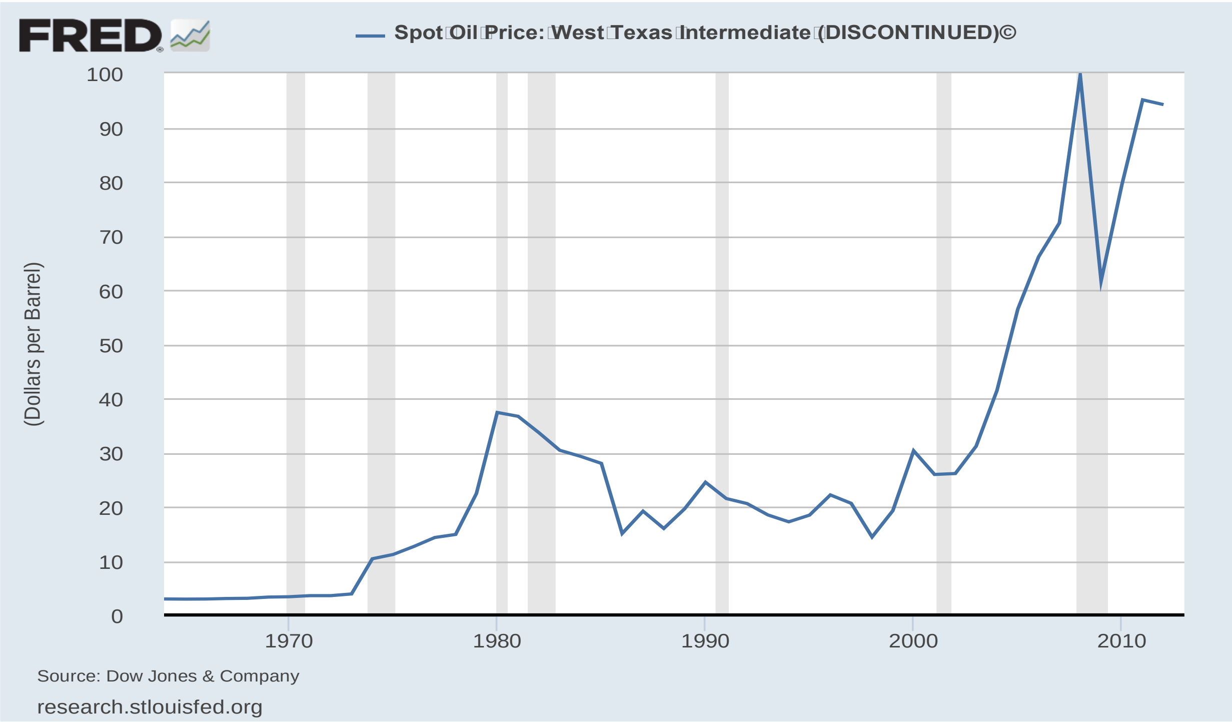
Country	Oil Imports (1000 b/d)
USA	8744
China	7143
India	4313
Japan	4258
Germany	2588
Italy	1342
France	1328
U.K	1149

Source: Annual Statistical Bulletin OEPC (2015)

In some sense, an oil price increase acts as a tax both on firms and households. Indeed, an oil price is similar to a tax imposed on imports, and, as oil is not easy to substitute, the impact on the economy strongly depends the elasticity of the demand for energy. The less elastic the demand for energy, the greater the effect of an oil price shock. This leads to an outflow of funds from the importer country that implies a reduction in the available funds for spending in consumption and investments. Although some indirectly, mainly all areas of the economy are influenced by the oil shock, and that is why economists highly focus on oil price fluctuations. Moreover, the impact oil price shocks to the GDP growth rate is not only influenced by the amount of oil imported, but also by how energy and capital are implemented in the production process. When fuel is the main source of energy, an oil shock can cause a huge loss for firms. In order to make positive profits again, firms must invest in more efficient machines thus changing the investments' plans. Reallocation of capital may change the structure of the firm, and labour force may be the first actor to pay for this change. Indeed, as mentioned earlier, according to a research conducted by Steven Davis and John Haltiwanger (1999), oil price shocks are the determinants of about 20 to 25 percent of the change in the employment rate in the manufacturing sector. The latter effect, directly depends on the frictions in the market. The stronger are wage rigidities, the higher will be the effect of an oil price shock in unemployment. Moreover, as production costs increase, goods' prices rise as well. Consequently, consumer may delay their purchase or reallocate their spending on different sectors.

Figure 3

Oil price ($ per barrel)



Usually, economists expect energy-using durables consumption to decrease because consumers tend to wait for a new less energy-consuming technology to be brought into the market. The demand side effect increases with respect to the level of uncertainty. Indeed, whether consumers perceive the oil-price hike as temporary or persistent is crucial. Spending decisions, by consumers, completely change according to how long-lasting the shock will be. As a result, many of the last price shocks have been followed by a recession. As can be seen from Figure 3, the period of recession (indicated by the grey shaded vertical lines), in the US, are always preceded by an oil price shock, with the only exception in the 1969-1970's recession.

Although oil price shocks are usually followed by turndown in global economies, the effect of different oil spikes appears to change with respect to different periods. Following the research developed by Olivier J. Blanchard and Jordi Galì (2007), four time periods corresponding to different oil price shock are analysed. The episodes under analysis are those started in 1973, 1979, 1999 and 2002 that for convenience have been called from the two authors O1, O2, O3 and O4 respectively. Table 2[6] reports, for each oil price shock mentioned before, the length of the oil price rise and the percent change from trough to peak (measured by cumulative log change), both in nominal and real terms. As can be seen, the magnitude of the nominal price rise between different time periods is very similar and around 100 percent. The same can be said relative to the cumulative log change in real terms, they are similar with an average a bit smaller than the nominal one.

Table 2

Postwar Oil Shock Episodes

	Run-up Periods	**Max Log Change ($)**	**Max Log Change (Real)**
O1	1973:3-1974:1	104%	96%
O2	1979:1-1980:2	98%	85%
O3	1999:1-2000:4	91%	87%
O4	2002:1-2005:3	113%	104%

Source: Blanchard and Galì (2007)

[6] This table and the following (Table 3), and the relative data, are derived from the research of Banchard and Galì "The Macroeconomic Effects of Oil Price Shocks: Why are the 2000's so different from the 1970's?" (2007), with some modifications.

Although the different episodes share the same magnitude of oil price increase both in nominal and real terms, they are associated with very different global economic performances. Table 3 lists the different impact for each country and episode (or averages of two episodes in the case of the last two columns) the cumulative GDP gain or loss over the 8 quarters following each episode's benchmark date (at which 50% of threshold oil price is reached), relative to a trend given by the cumulative GDP growth rate over the 8 quarters preceding each episode. Table 3, highlights the commonly agreed fact that, even if oil shocks hurt the economy, the magnitude of their impact have been decreasing over time. Indeed, the first two shocks, namely O1 and O2, tend to have a stronger negative effect to the cumulative GDP change than what O3 and O4 have. The data in table 3, depicts how the change in oil prices can affect the economy and support the hypothesis that the impact of oil shocks in the global economies have become smaller over time, and it's now almost null. This hypothesis will be analysed later in this paper.

Table 3

Oil Shock Episodes: Cumulative GDP Change

	O1	O2	O3	O4	AVG (1,2)	AVG (3,4)
Germany	-9.6	-3.5	1.3	-2.5	-6.6	-0.6
U.K.	-16.4	-9.2	0.4	2.5	-12.8	1.4
Italy	-8.6	0.4	3.0	-2.0	-4.1	0.5
Japan	-16.1	-4.4	7.6	3.3	-10.3	5.4
U.S.	-13.3	-11.8	-3.7	7.1	-12.5	1.7
OECD	-11.2	-6.5	0.1	4.1	-8.9	2.1

Source: Data collected, on quarterly base, from OECD's Economic Outlook Database

2.1.1 Effects of an Oil Price Decrease on Output Growth

Until now, we have analysed oil price positive shocks and inferred that they often lead to economic downturn. Therefore, what happens when oil price goes down?

Since oil price shocks may lead to recession, one should expect oil price downturn to lead to economic growth. Instead, the facts show that this doesn't happen. This significant feature tells us that oil price shocks have an asymmetric effect on GDP and output growth. Albeit an oil price rise slows output growth, an oil price fall does not boost output growth. Clearly, a reduction in oil price should have an impact on both demand and supply. Indeed, as inputs are cheaper, production increases as well as output growth. On the other side, demand rises too. Consumers find it more convenient to buy, and, as uncertainty is low, people start to invest again. Both these supply and demand are positively affected by a fall in oil prices and together they increase the aggregate demand and in turn the output growth. Still, empirical results show that the supply and demand effects are offset by another effect, namely the reallocation effect. The latter, as in the case of an oil price increase, is harmful for the economy as resources and capital have to move across different sectors in the economy. The reallocation effect moves output growth in the opposite direction with respect to supply and demand effect, and on net, the impact of latters is washed out by the impact of the former. Moreover, many oil price decreases are only adjustment to previous oil spikes.

2.2 Oil Price Shock and Inflation

Oil shocks, as mentioned before, are historically associated also with high inflation. As fuel and other petroleum derivatives are part of the Consumer Price Index (CPI), a drastic and rapid rise in the price of oil directly affects the inflation. Although historical data highlight the fact that oil prices spikes are correlated with inflation, the effects, as the ones relative to the GDP, seem to have decreased over time. The research conducted by Blanchard and Galì (2007) confirms this trend. Indeed, from Table 4, we can see how different oil shocks of the same magnitude (see Table 2) produce different effects on the inflation level according to the time period of reference. Table 4 displays, for each country and episode, the average rate of inflation over the 8 quarters following each episode’s benchmark date (at which the 50 % threshold oil price rise is reached) minus the average rate of inflation over the 8 quarters immediately preceding each run-up.

Table 4

Oil Shock Episodes: Change in Inflation

	O1	O2	O3	O4	AVG (1,2)	AVG (3,4)
Germany	0.1	2.6	1.1	-0.2	1.4	0.4
U.K.	10.2	4.3	0.0	0.5	7.3	0.3
Italy	7.7	5.6	1.0	-0.1	6.6	0.4
Japan	7.9	1.0	-1.7	0.9	4.4	-0.4
U.S.	4.9	4.0	1.7	-0.2	4.5	0.7
OECD	4.9	1.8	0.1	-0.5	3.4	-0.2

***Source**: Data collected, on quarterly base, from OECD’s Economic Outlook Database*

Clearly, the largest impact on inflation on different economies is due to the first shock, namely O1. The effects are reduced, but still harmful, in O2 where different countries experienced a positive change in inflation. Instead, O3 and O4 are not correlated with an increase in inflation. These data confirm again the theory according to which oil price shocks have a much larger effect in the 70's rather than in modern times. This fundamental issue will be discussed later in this paper. In order to understand why oil price shocks effect in the economy changed over time we have to understand the various channels through which an oil shock lead to inflation.

2.3 Modelling the Macroeconomic Impact of Oil Price Shocks

The propagation of an oil shock into the economy will be explained through the New Keynesian Phillips Curve (NKPC). The NKPC finds its roots in the new neoclassical synthesis that has born from the fusion of the neoclassical macroeconomic school of thought and the new Keynesian one. From these two different macroeconomic schools, a new model has formed, namely the Dynamic New Keynesian model (DNK). Its main focus is to explain macroeconomic short-run fluctuations in the economy. Moreover, the DNK model shares many theoretical features from both schools of thought. DNK shares the Real Business Cycle (RBC) methodological approach. The demand side is characterized by the optimal behaviour of households that decide their own level of consumption and of leisure time, in order to maximize their utility. Instead, the supply side is described by the firms' optimal behaviour; firms use the technology of production available in the market and interact with households and consumers. Moreover, both firms and households act having rational expectations and this permits the model to overcome the Lucas's critique[7], as agents can rationally modify and optimize their actions in reaction to change in monetary policies. In addition to the RBS's methodological base, DNK has acquired some of the fundamental concepts of the Keynesian macroeconomic thought: imperfect competition and nominal rigidities. Firms are not price-takers, and each of them produce a different good that can exercise some market power in the economy and thus can, to some extent, decide its price. Moreover, deciding their own price, firms face nominal rigidities, that prevent the general level of prices to flexibly react to different shock hitting the economy.

[7] "Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to decision maker, it follows that any change in policy will systematically alter the structure of econometric models" (Lucas, 1971, p.41)

The DNK influenced also the original Phillips Curve. In response to the new visions and assumptions of the DNK model, the New Keynesian Phillips Curve was developed. Below, is reported one version of the NKPC (1) that was mainly developed by Blanchard and Galì (2007). From the standard curve two modifications are applied. First, oil is considered both as an imputing consumption and as an input in production. Moreover, in this function it is assumed that the country of reference is an oil importer, and that's why the U.S. have been chosen. Instead, the second modification concerns the introduction on nominal wage rigidities.

New Keynesian Phillips Curve

$$\pi_t = \pi^e_{t+1} + \lambda * mc_t \qquad (1)$$

Where:

$$mc = (1-\alpha_m)(w_t - p_t) + [\alpha_m + (1-\alpha_m)\chi]s_t + (1-\alpha_m-\alpha_n)n_t \qquad (2)$$

And:

- α_m : Share of oil in U.S. Production
- w_t : Nominal wage
- p_t : Price level
- χ : Share of oil in U.S. consumption
- s_t : Real price of oil
- n_t : Employment

The above NKPC (1) will be used to explain the main effects on inflation that are transmitted by oil price shocks that pass through two main channels that can be called "first round effects" and "second round effects". I am going now to explain them briefly.

2.3.1 First Round Effects

The first round effects represent the primarily oil shock impact on the economy. As we can see from the New Keynesian Philips Curve, as P_t rises, the marginal cost will increase by an amount proportional to $[\alpha_m+(1-\alpha_m)\chi]$, that represents the shares of oil in production and consumption. Consequently, the increase in the marginal cost is transmitted to the inflation. These effects, refers to the fact that oil and its derivatives, such as fuel, together with good and services with a direct component of oil, are included in the Consumer Price Index (CPI). Therefore, since oil is utilized both as a direct input for many goods and services, (such as gasoline, airfare, utility bills and transports) and as an indirect input, for other costumer items (such as clothing and food), the first round effects can be divided in other two sub-effects, namely the direct and the indirect ones. The direct effects are those which impact the energy components of the index, while the indirect effects are those which influence the components of the index with a high content of energy. The former effects, are directly proportional to the amount of energy components, such as fuels, electricity and gas, in the consumption expenditure. The larger the share, the higher the direct effect on CPI due to an oil price shock. Instead, the indirect effects are those that influence the overall level of prices since they are related to goods and services that strictly depends on oil. These effects are smaller in terms of single impact to the inflation, but are more numerous and widespread.

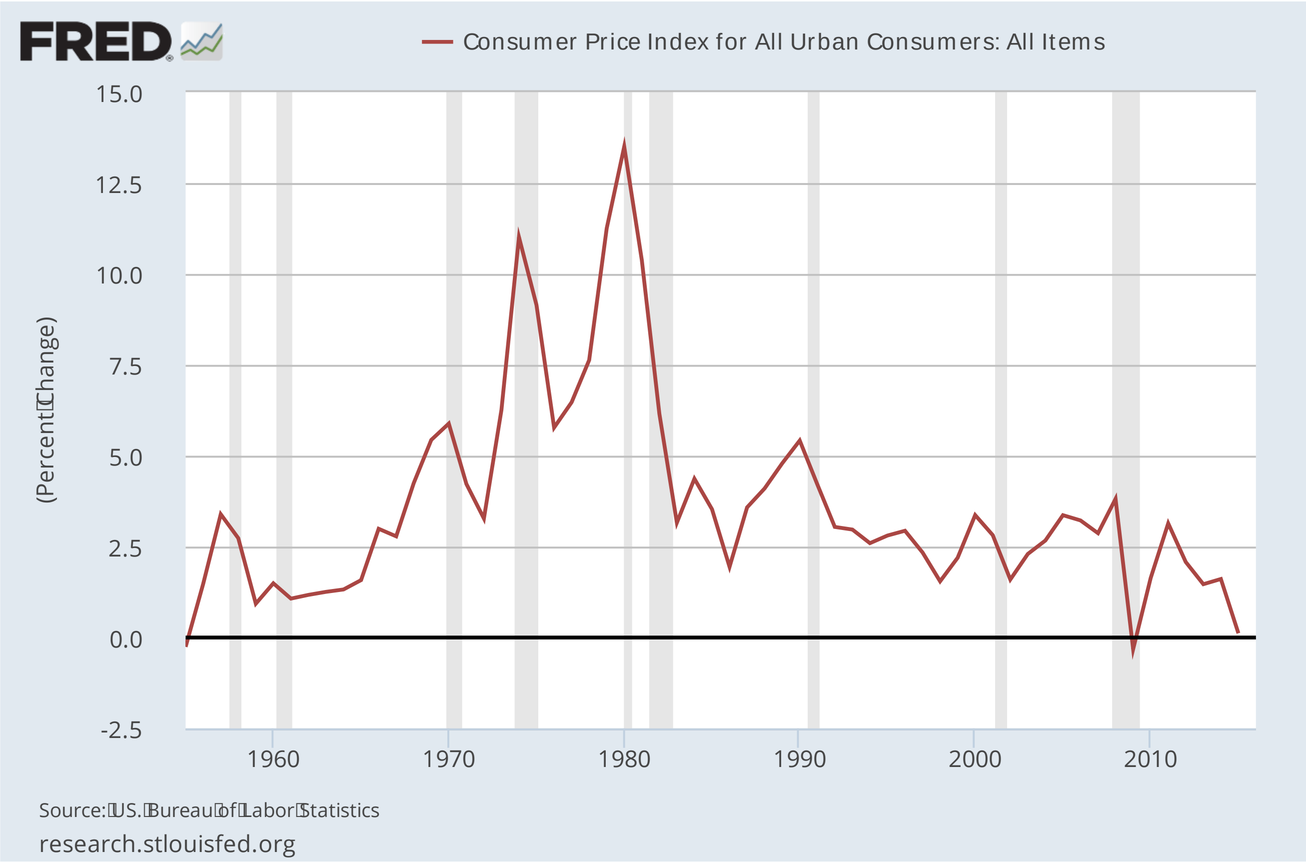
2.3.2 Second Round Effects

As a consequence of the first round effect, an oil price shock increases inflation. This rise can lead to further developments that are related to macroeconomic reaction to a drastic change in the price of oil. The second round effect is triggered by an increase in inflation and is composed of two consequential steps. The first one depends on the degree of nominal wage indexation in the economy and the second on the credibility of the central bank. Wage indexation refers to wages that are linked to a price index representing the cost of living. Incomes are automatically adjusted up or down as the price index rises or falls, in order to maintain constant the purchasing power of workers. According to the New Keynesian Phillips Curve, if the economy has some degree of nominal wage indexation, when inflation have a positive change, wages [w_t] rise and so does marginal cost. This leads to a further contemporaneous, or lagged, increase in inflation. Then, if wages are indexed and then are not fixed to their real level, economy can fall into a wage-price spiral (Inflation affects indexed wages that affect in turn inflation and so on). This spiral can even have a larger impact on the economy if the central banks' decisions lack of credibility. Monetary policy is the essential tool given to central bank in order to prevent inflation to rise above or fall below certain level, after which, economic performances can really be harmed. Nevertheless, to be effective, central banks' actions must be credible. Indeed, the expectation of future inflation [π^e_{t+1}] directly depends on the credibility of the Monetary authorities. If monetary policies are perceived unable to anchor the inflation to the inflation target, as the level of prices increase, the expected inflation rises, giving a further boost to the actual inflation. Therefore, the magnitude of the impact of the second round effects on the economy, and specifically on inflation, relies on the labour market flexibility and on the credibility of monetary authorities.

Nevertheless, we can see from figure 4, that the price shocks are followed by an increase in the level of prices for a certain period of time. Indeed, inflation rose sharply after the 1973 and 1979 oil shocks, but responded much less after the episode of 1999 and the prolonged increase in the price of oil from 2002 till 2009. This evidence further strengths the argument reported in the following section (Section 4): the impact of oil price shocks on both the level of prices and the growth rate of output has decreased over time, becoming much weaker and almost negligible in modern times.

Figure 4

Consumer Price Index



3. Different Effects of Oil Price Shocks Over time

Oil price shocks clearly affects the economy. Many of the oil shocks have been followed by recession, high inflation and an increase in the level of unemployment. Nevertheless, data show that the impact of oil spikes decreased over time. Table 3 and Table 4 highlight this change in the effect due to oil price movements. Both output growth and inflation seem to respond less over time to changes in oil price of the same magnitude. Whereas the first two episodes of oil shocks, O1 and O2, are followed by a consistent decrease in GDP growth rate, with an average decrease in the two shocks for the

OECD countries of minus 8.9, the last two episodes are followed by considerably different results. Indeed, OECD countries, consequently to O3 and O4, on average, have experienced an output growth of 2.1 per cent. The same can be said regarding inflation movements due to oil price shocks. Indeed, while O1 and O2, on average, led the inflation rate in OECD countries to rise by 3.4 per cent, the episodes O3 and O4 have been followed by a decrease, on average, in the level of prices of minus 0.2. Whereas the oil shocks occurred before 1980 seem to have a consistent impact on the economic performance of many countries, the effects of more recent episodes on the business cycles are quite negligible. Data are evident, but the reason behind this changes are still a central topic of discussion between modern economists. This paper will report and analyse two main hypotheses, not mutually exclusive, behind the different economic responses to oil price shocks between 1970's and 2000's. One answer, suggested by Blanchard and Galì (2007), reports that the decreasing impact of oil prices shocks in the economy performance, may be due to fundamental structural modifications, that have occurred over time, and that are responsible to have remodelled the transmission mechanism discussed above. The other answer stems from the nature and the reason behind each shock. Before 2000's, oil shocks were mainly triggered by oil supply disruption due to Middle-East conflicts, such as the 1973 oil embargo on Western countries consequently to the conflict between Saudi Arabia and Israel or the 1979 price shock due to the Iranian Revolution. On the other hand, more recent oil spikes derive from increased demand by emerging countries, such as China and India. These emerging countries were also demanding foreign products and then, many countries, such the U.S, faced an increase in exports that was able to offset the increase in price of oil (Kilian 2007, 2009).

3.1 Structural Changes in the Propagation Mechanism

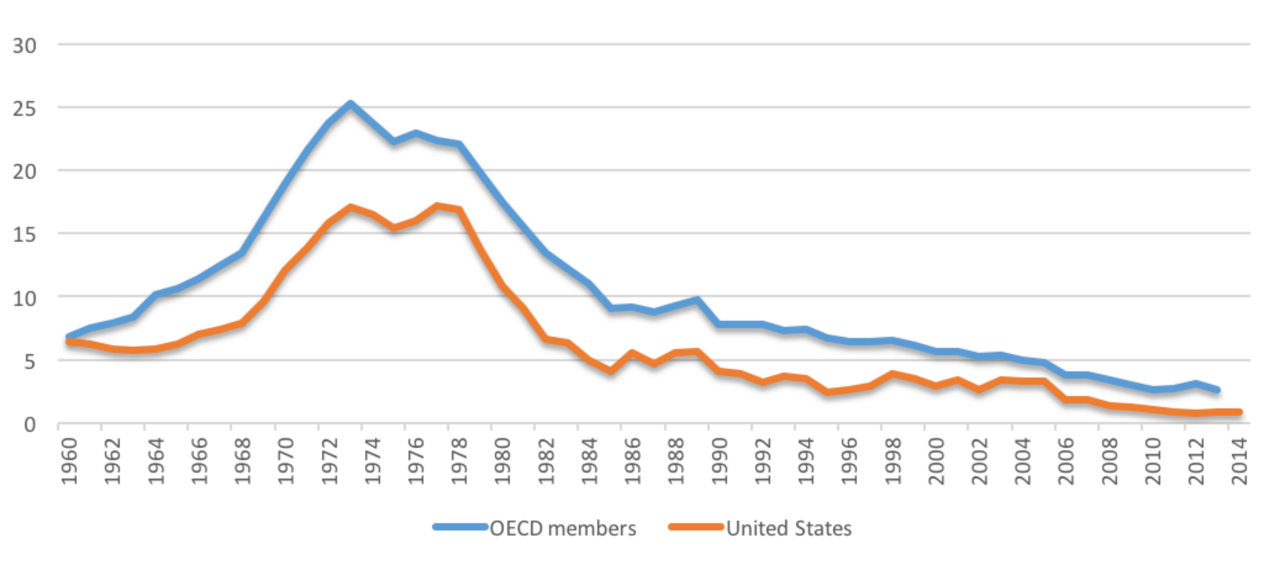
Changes in the channels of oil price shock transmission (explained in section 3) over time could be one of the reason behind the different impact of oil spikes to the economy. According to Blanchard and Galì (2007), there are three changed elements that can be the cause of this difference. The first one is that the share of oil in economy strongly decreased as energy has moved to new alternative resources. The second reason is that in modern economies the degree of nominal wage indexation is much weaker nowadays rather than in 1970's, when unions were strong and numerous. The last reason provided refers to the higher credibility central banks have acquired in the last forty years through their monetary policies.

3.1.1 Decrease in Oil Consumption

One of the reason behind the weaker impact of oil price in the economy may be the decrease in the oil consumption (as a percentage of total[8]). Indeed, as we can see from the Figure 5, in the 1970's oil was a higher component of energy production, counting for around 25 percent for the OECD members and for around 17 percent for the U.S. alone. Nevertheless, the percentage of oil as a source of electricity production decreased significantly over time. Indeed, now oil sources for energy production account for only a small share of the total. In OECD countries only the 2.16 percent and in the U.S 0.96 percent.

Figure 5

Electricity Production from Oil Sources (% of Total)



Source: *World Bank data*

On the other hand, renewable resources, due the global warming alarm worldwide, are being more and more used. Indeed, in the U.S., while energy production was composed only by 0.1 percent[9] by renewable resources around the 1970's, in 2014 it reached the amount of 6.9% of the total energy production.

The decrease of importance of the oil as a source of energy over time, is a strong indicator that oil price changes have a smaller effect on both GDP and Inflation rate. Output growth can significantly

[8] Indeed, whereas the percentage of oil consumption have decreased over time, the total amount of oil consumed is still increasing

[9] Source: World Bank, "Electricity Production from renewable resources, excluding hydroelectric (% of total)

respond less to an oil price shock in modern times as the oil is becoming a less and less important input in the production process. Since oil is not the only source of input in the economy, oil price shocks can be less effective. Firms can opt for alternative energy resources, paying lower switching costs respect to what firms had to pay in the past. Reallocation of resources is less costly, and after an oil price shock, industries can continue producing by using more efficient and less-fuel consuming machines. Moreover, as the oil and its derivatives are included in the Consumer Price Index, a reduction in the consumption of oil[10] can explain the decrease in correlation between oil price shocks and inflation.

3.1.2 Weaker Nominal Wage Indexation

Another reason that can explain the decrease in the impact to the economy brought by oil price shocks may be the fact that the degree of nominal wage indexation has decreased over time, and it is almost vanished nowadays. The way in which wages are set is a crucial indicator of whether or not the economy will face any trade-off between inflation and unemployment. In presence of nominal rigidities, wages are adjusted by the level of inflation, and, as explained before, this leads to a further increase in the general level of prices. Empirical data[11] presented in Table 5, reports the different elasticity of nominal wages of different countries with respect to oil price changes before 1984.

Table 5

Elasticity of Nominal Wages to Oil Price Change

(1970-1984)

U.S	U.K	Japan	Italy	Germany
1.00	0.95	0.93	0.96	0.88

Source*: OECD Economic Outlook*

These results, emphasize the impact wage indexation had until 1984. Indeed, for a given change of 1 percent in the level of prices, U.S. wages used to increase by 1 percent. The same can be said about the other countries where the degree of wage indexation was very high. The degree of indexation was a very burning issue in the middle 1980’s and may economists in different countries agreed that wage indexation was a dangerous tool for the economy. For example, in Italy, until 1983, wages were

[10] In the U.S. the consumption of oil itself is increasing, but the share of oil consumption in the GDP is decreasing over time.

[11] Reported by David T. Coe in “Nominal Wages. The NAIRU and Wage Flexibility”

adjusted to the actual price level every three months. Afterward, the degree of indexation was reduced in 1986 by semestral adjustments and, in July 1992, was completely abandoned. The same applies for the U.S. According to the research of Blanchard and Riggi (2011) the degree of indexation in the U.S. in the period 1984-2007 is almost zero. This is due also the increase in market competition and the loss of power by unions. This change in the structure of the economy clearly undermines the second round effects discussed in Section 3.2.3. Indeed, as nominal wage rigidities vanished over time, an increase in inflation cannot directly alter the level of wages and the loss of their mutual effect can be one of the explanation behind the different impact of oil price shock in modern times. Indeed, while in the 1970's, after an increase in the general level of prices, workers claimed and obtained higher nominal wages, in the 2000's, a same increase in inflation did not lead to the same increase in the level of nominal wages.

3.1.3 Higher Central Bank Credibility

Central banks' credibility is an essential determinant of the second round effect. And the third reason according to which oil price shocks have now a less effective impact than in the past, is that central banks credibility strongly increased over time. It is commonly agreed between economists that, the first oil price shock, at the beginning of the 1970's, was followed by a too flexible monetary policy. The inability of central banks, in many countries, to control the level of inflation, together with the high degree of nominal indexation, let the level of wages be unstable and this in turn led to a high level of unemployment. As a consequence, monetary policy by central banks loss credibility and this caused further inflation. Across the years, central banks acquired more credibility that has been acquired thanks to transparency. Central banks in modern times, such as the Federal Reserve or the European Central Bank (ECB), publicly state their goal and how they intend to reach it. This transparency is then followed by credibility as actions taken are in line with what has been communicated by central banks. Nowadays, central banks' targets are very clear. For example, ECB has defined price stability as "a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2%. In the pursuit of price stability, the ECB aims at maintaining inflation rates below, but close to, 2% over the medium term"[12]. The same transparency is in line with the FED communication that clearly aims at sustainable economic growth, full employment and stable prices.

[12] Source: Official European Central Bank website

The increase in the credibility of central banks is confirmed by empirical results. The level of credibility is a crucial determinant for expected inflation. Indeed, expected inflation can be determined by the following equation.

$$\widehat{\pi}^{e}_{q,t+1} = (1-\lambda)\,\widehat{\pi}_{q,t} + \lambda E_t \widehat{\pi}_{q,t+1} \qquad (3)$$

The above equation states that the expected inflation is determined by the level of central bank credibility [λ]. The higher λ, the closer will be the actual inflation to the target level. Nowadays, and more specifically between 1984 and 2007, according to Blanchard and Riggi (2011), the benchmark estimates of the level of monetary policy credibility, expressed by λ in the above equation, is equal to 1 with standard deviation of 0.18. On the other hand, in the period 1970-1984, the value of λ was approximately zero with standard deviation of 0.32. These results are a further confirm that, together with the decrease in nominal wage indexation, the second round effect has a small, if any, effect in the economy nowadays.

Altogether, these three structural changes in the economy can be an element that can explain the decrease in the impact of oil shock in modern economies, but might not be the only one. Indeed, according to Kilian (2009), there are no strong evidence that the decrease in oil share consumption, nor the reduced real wage rigidities nor the improved credibility of monetary policy can be the main explanation of the reduced importance of the oil price shocks. "Rather this phenomenon can be primarily explained by changes in the nature of the oil price shocks" (Kilian 2009).

3.2 Different Source of Oil Price Shocks

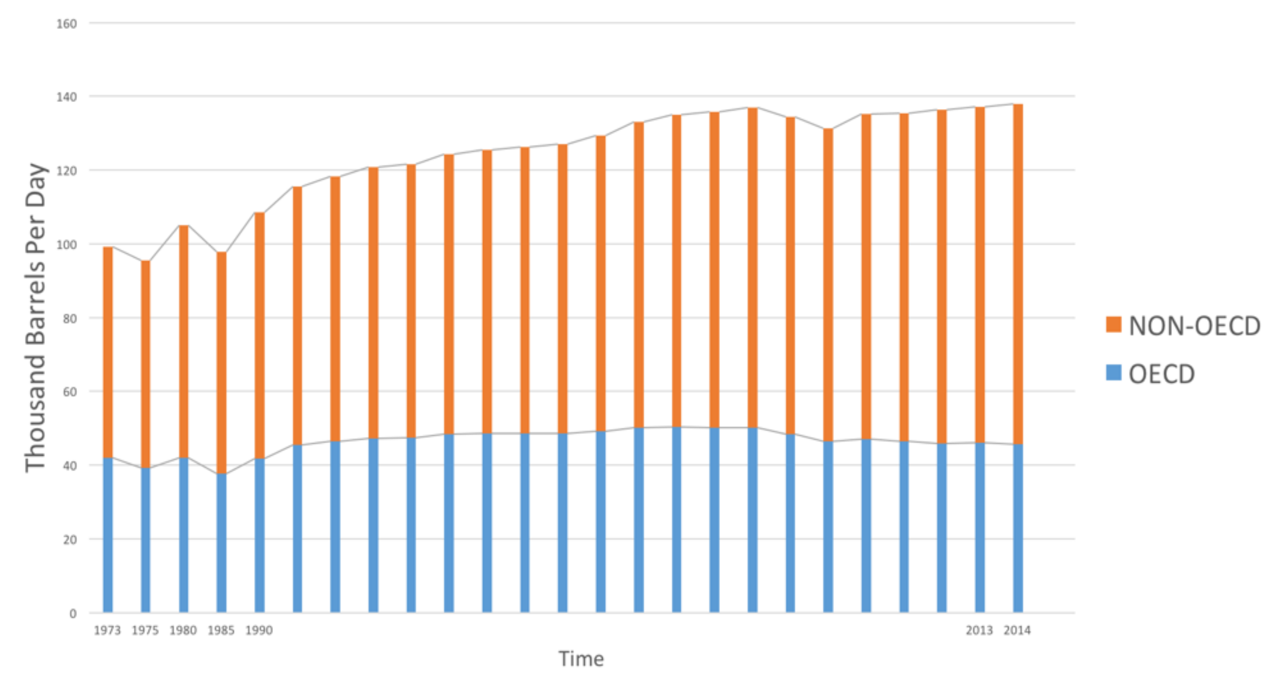
As we have seen for Table 3 and Table 4, the first two shocks (O1 and O2), led to both an increase in inflation and a decrease in output growth. Indeed, on average, OECD countries experienced a decrease in the GDP growth rate of -8.9 and an increase in the level of prices of 3.4 during the first episodes. On the other hand, the last two episodes, O3 and O4, led to a completely different result: GDP growth, on average, resulted to be positive and inflation rate increased by a small percentage, and in some case decreased. The output growth of the OECD countries, on average, was 2.1, while inflation level experienced a decrease of -0.2, on average. Therefore, while many countries, experienced a period of stagflation during the first two episodes, they faced a positive growth during the last two, especially in the last one. Moreover, from Figure 6, we can see that also the impact of oil consumption is changed. Indeed, the table report the average yearly world oil consumption[13],

[13] Source: U.S Energy Information Administration, Monthly Energy Review, March 2016.

divided into OECD and non-OECD countries' oil consumption. We can see that another difference between the 1970's and 2000's appears. While the average oil consumption decreased, on average, after the shock occurred in 1973 and 1979, the opposite happens during the 1999 and 2003 oil shocks, when the oil price rise again. Therefore, data reports drastically different economic performances following different oil price shock. According to Kilian (2009), the main reason behind these different impacts on the economy is rooted in the source of different oil price shocks. Oil shocks can be classified according to three different sources. The first are supply shocks. They stem from oil supply disruption that causes shocks to the flow supply of crude oil. When an unexpected reduction in the oil production occurs, the price of oil sharply rises.

Figure 6

World Oil Consumption



***Source**: U.S Energy Information Administration, Monthly Energy Review, March 2016.*

The second type of oil shock derives from a long-lasting change in oil demand. These shocks are driven by an unexpected change in the trend of some countries' economic performances. When countries face an intensive economic growth, many commodities, crude oil inclusive, are demanded, and consequently the price of oil rises. The last type of oil shock can be referred as speculative oil shocks (Kilian 2009). The nature of the latter, stems from the fact that crude oil is a storable good, and as such is considered to be an asset, whose price is determined by the market. Nevertheless, all assets' price in the market are subject to expectations. Therefore, if oil price demand is expected to increase, the demand for oil will rise, and in turn the price of oil will face an upward change. The same can happen when an oil supply disruption is expected: the price of oil will immediately rise. Only few years ago, it was commonly agreed in the literature that the source of oil price shocks were exogenous with respect to the OECD economies, and that these oil hikes were mainly consequences of oil supply disruption generated by political conflicts in the Middle East. Nowadays, the common opinion between economists is that only the first two oil shocks were caused by supply disruption, namely the 1973 oil shock caused by the Yom Kippur War, and the 1978 one, due to the Iranian revolution. The attention, in recent years, has shift to the effects in the economy triggered by the demand shocks. Indeed, the oil shock occurred in 1999 and 2002 are not consequent to any oil disruption, but are due to an increase in the demand for oil from emerging countries such as China and India. In addition, some other shocks are due to speculative demand shocks. The oil spike occurred in 1990, following the Kuwait invasion, and the one in the late 2008, during the global financial crisis, are examples of this kind of oil shocks.

In the next subsections, I will report the characteristics of the different sources of oil shocks, and the reason that can explain why they can be the real reason behind the different impact that oil shocks caused to economic performances over time.

3.2.1 Oil Supply Shocks

Shocks in the flow of oil supply, are usually triggered by a reduction in the production of oil by oil exporters countries. Indeed, many of the shocks that are classified as supply oil shocks, are the direct consequences of political conflicts of Middle East countries that are the main oil exporter in the world. An exogenous increase of the oil price, can be very harmful for importing countries. As we have seen in Section 3, an increase in the price of oil can bring effects both on the aggregate supply and on the aggregate demand. The former is affected since oil is an input in the economy, and as its price increases, the production cost rise as well, leading the profit of industries to decline. On the other hand, the aggregate demand is affected in many ways. As the energy is more expensive, after paying for energy bills, the rest of the households' income to be spent on other goods and services is reduced. Moreover, the increase in the price of oil can bring uncertainty, and households may decide to postpone their purchases and their investments.

Overall, an increase of oil price can be seen as an increase in taxes from the point of view of households, and as a net loss for the country's economy as this is a tax that flows only to oil exporters countries. Therefore, an oil price increase is followed by decrease in consumption, investments and then in GDP growth rate. Inflation rises as well as explained in section 3.2, and, together with the decrease in the output growth rate, economies can fall in a period of stagflation. This situation is consistent with the economic performances that followed the oil shocks in 1973 and 1979, but is not consistent with more recent oil spikes. Indeed, the last shocks seem to stem from oil shocks driven by an increase in the demand of oil from emerging countries.

3.2.2 Oil Demand Shock

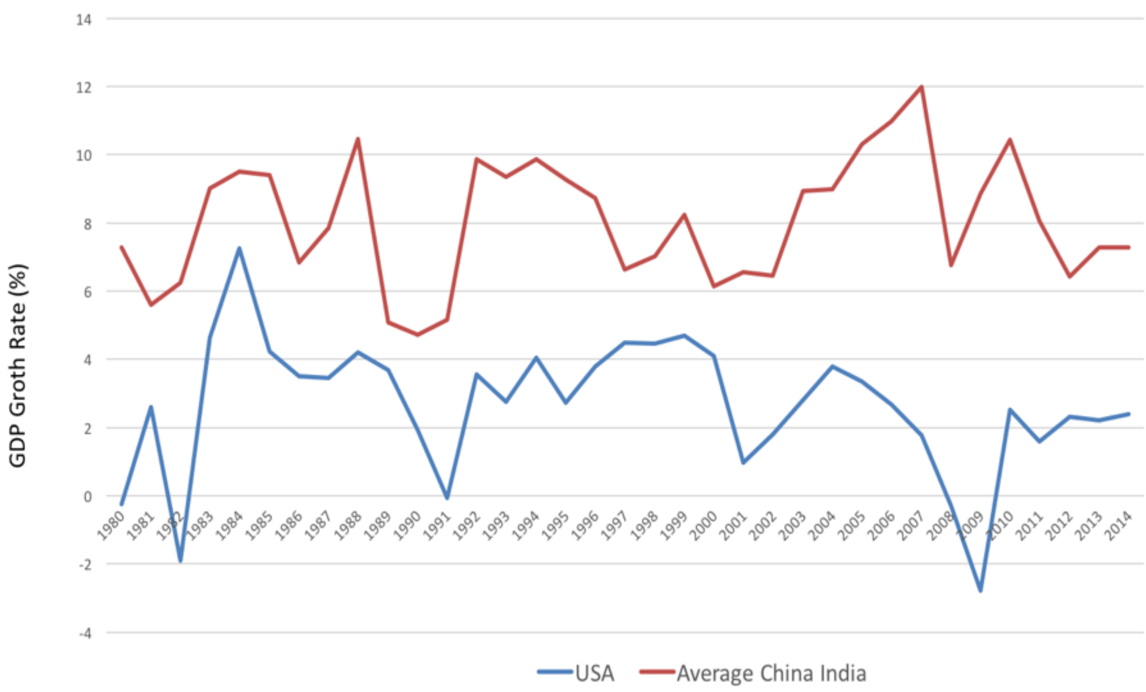
An oil price shock can be triggered by a productivity shock in oil importing countries. Indeed, an increase in the output growth of a foreign country can lead to a rise in the oil demand for crude oil. This kind of oil price shock is referred as oil demand shock. Whenever a country faces a positive and persistent period of productivity growth, it will demand more oil and more goods from other countries (that we can call home countries). This, in turn, will lead to an increase in the price of oil. From the point of view of home country (not the one that is experiencing a very positive growth), this type of oil price shock can lead to many changes in the economy. On one hand, the increase in the price of oil has the same effect of an oil supply shock, marginal cost will increase, inflation will rise as well and output growth and employment rate will decrease. This effect is also known as the headwind effect, and it is not different from the consequences brought by a reduction in the supply of oil. Nevertheless, on the other hand, when the oil price increases due to a rise in demand for oil, the headwind effect is counteracted by another effect, namely the tailwind effect. Given the increase in the productivity of the foreign country, their goods' prices are lower and, from the point of view of the home country, importing goods becomes cheaper. In turn, the general level of prices may decrease, and offset the rise in the level of prices brought by the increase in the oil price and, consequently, the real value of wages increases. Moreover, due to the increase of the economic performance of the foreign country, there will be an increase in the demand for home produced goods from foreign consumers and so the GDP growth rate will increase.

Therefore, the headwind effect is mitigated by the tailwind effect, but which of them prevails is still an open question. According to Lipinska and Miller (2012), when an oil price increase is driven by an increase in productivity of emerging economies, this could lead to the advanced countries to a decrease in the CPI inflation. While it not sure whether of the two effects prevails over the other, data confirms that the more recent shocks in the price of oil are consistent with the dynamics of the demand oil shocks. We can see from Figure 7, that the average growth in the GDP from emerging countries[14] is much higher than the growth rate experienced by the US economy.

[14] In this case I take in consideration the two most significant emerging countries, namely India and China

Figure 7

GDP Growth Rate



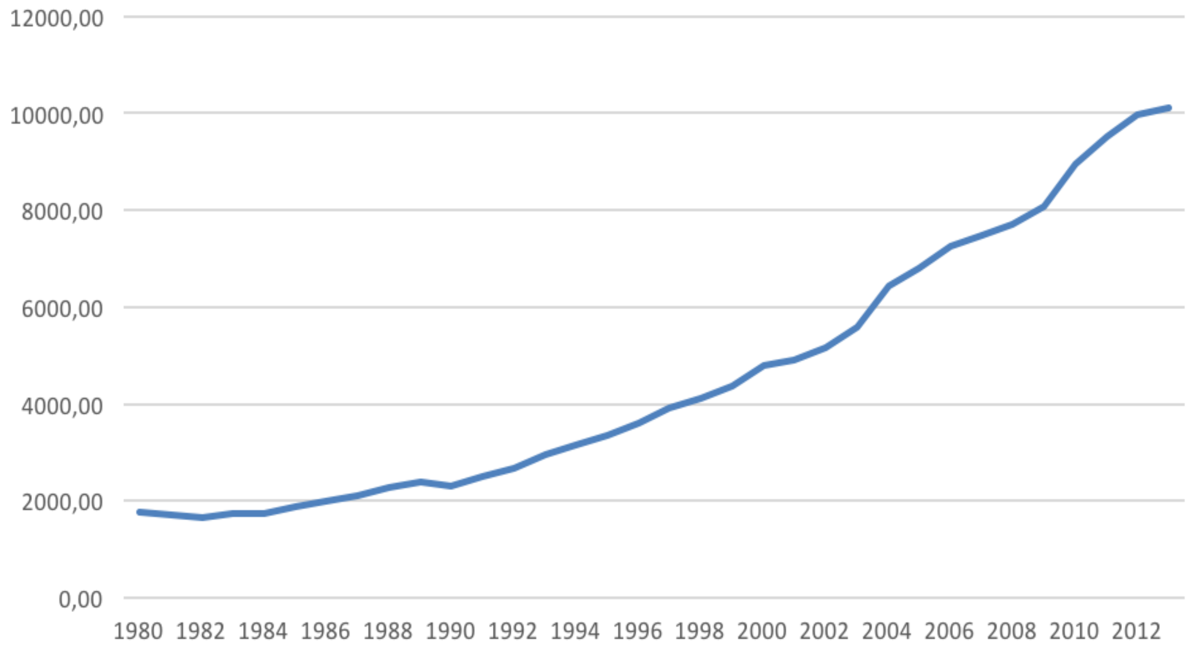
Source: *World Bank National Accounts Data, and OECD National Accounts data files*

Moreover, the increase in the GDP growth rate tends to increase more in the period associated with the two recent oil price shocks, the ones occurred in 1999 and 2002.

This graph is then in line with the fact that recent oil price shocks were triggered by an increase in the demand of oil from emerging countries, such as China and India, that faced an enormous increase in the GDP growth rate, with minimum growth of 4.5 percent in 1990 and maximum of 12 percent in 2007. Moreover, other empirical data highlights the growth of China. Indeed, Figure 8, reports the increase in the oil consumption, in thousand barrels per day, occurred in China over the past thirty years. The amount of oil consumed increased by five times, and this further confirms that the reason behind the change in the effect of the last two shocks can be attributed to the increase in oil consumption of emerging countries. The sources of oil shocks seem to be a very plausible reason that can explain why the first two episodes of 1973 and 1979 led to dramatic consequences to the world economic performances while last ones, occurred in 1999 and 2002 were not followed by recession or inflation.

Figure 8

China Oil Consumption



Sources: *United States Energy Information Administration*

This theory has been analysed by many economists[15], and the results conducted have led o positive results. In the research conducted by Alessia Campolmi (2008), the effects of two different oil price shocks, one driven by demand shock and another by supply shock, are analysed through a two-country model. This model is composed by two countries, home and foreign, and none of them, for simplicity, is assumed to be an oil producer. Oil is treated as a good and therefore, its price is determined in the market and depends on the demand of both countries. Firm's pricing decision are subject to Calvo staggering and, wage mark-up fluctuations are endogenised by allowing for wage rigidities. Moreover, the model is developed under the assumption of perfect symmetry among countries and a simple interest rate rule is applied to each country in order to target a specific level of CPI. Under this model, two shocks are simulated. The first one is a shock of oil supply, set so that the real price of oil increases by 100 percent, so to simulate the same circumstances occurred in the first two oil shocks. On the other hand, the second shock is determined by an increase in the productivity of the foreign country, calibrated to simulate the real increase in China's GDP growth rate between 2001 and 2005. These two kinds of circumstances are developed in order to analyse their effects on the real oil price, GDP, CPI inflation and real wages. The shock triggered by the

[15] Among them Clarinda, Galì and Gertler (2002), Lapinska and Millard (2012) and Kilian (2009)

reduction of the oil supply, under the model, leads to a contraction in the production growth, an increase in the general level of prices and a decrease in the level of real wages. These results are consistent with the period of stagflation experienced in the U.S. during the 1973 and 1979 episodes, but are not consistent with those happened in 1999 and 2001. In the second experiment, the increase in the price of oil is simulated to match the circumstances that derives from the increase in the production of the Asian countries. While the results of this simulation are not consistent with those occurred in the first two oil price shocks, they are very similar to those happened in modern times, so during 1999 and 2002. As explained above, as the production of the foreign country strongly increases, the price of foreign goods goes down. Consequently, the demand for those goods from home consumer will increase as well as the demand for home products from foreign consumers, as they are richer. Therefore, as exports increase and imports are cheaper, output grows. At the same time, as production and output growth increases, oil is demanded and its price rises. This leads to an increase in the general level of prices, but this increase is offset by the fact that now imported good are cheaper. These economic changes match with the results conducted in the second experiment[16]. The level of inflation decreases and the output growth increases in consequence of an oil price shock. The model further confirms that the reason behind the difference between the oil price shock occurred in the 1970's and the more recent ones stems from their origin. Moreover, it is worth mentioning that the oil shock occurred in 1990 cannot be justified by a real oil supply disruption nor by an enormous increase in the demand of oil, then the source of that can be a speculative reason.

3.2.3 Speculative Oil Demand Shocks

Commodities financialization faced a very high popularity in the last decade. This phenomenon refers to enormous amounts of money that flew into commodities future markets. This trend led the economists to wonder whether these investments could or could not lead to price bubbles. Indeed, as expectations are immediately reflected into prices, the actual price of commodities could diverge from the real one. Between these commodities oil is surely the most relevant one. As mentioned before, oil is a storable good, and as such its price is determined by the expectations of the agents involved in the market. When the oil price is expected to rise due to an increase in the productivity of a country or due to a possible shortage in the supply of oil, the market will react in the same direction of these expectations and the price of oil will be affected. Speculative demand shocks, differently from the ones driven by demand and supply shocks, may have large and immediate effects

[16] In the second experiment the only exception with respect to the real data is that while in the model the wage inflation increases, the real data shows that it actually decreases.

in the real price of oil. The effects associated with this type of oil shock are similar to those brought by oil supply shocks, but are temporary, and are not driven by changes in the oil production, but rather by expectations of future oil production disruption. An example of the speculative oil shock is the one occurred in 1990 in correspondence of the Kuwait invasion. In this occasion, the price of oil almost doubled, reaching 40$ per barrel[17], but the reason behind this sharp increase in the oil price is not only the invasion of Kuwait and its reduction in the oil supply. Indeed, there was and emerging concern that Iraq could also invade Saudi Arabia, causing a further decrease in the production of oil and a consequent increase in its price. Therefore, the expectations, rather than a real oil disruption, led the price of oil to skyrocket. This hypothesis is justified also by the fact that as U.S. Army moved to Saudi Arabia in order to prevent an invasion, the price of oil suddenly decreased.

3.3 Petrodollar Recycling

Until now, we have analysed the effects that oil price shocks have on oil importers economies, but to understand another reason why oil price shocks have a different effect on oil importers countries nowadays rather than in the past, it is important to understand what happens in the economies of oil exporters countries. Whereas an increase in the price of oil means a loss for an oil importer country, it leads to gains for oil exporters countries. The petrodollar recycling refers to the reflows to the rest of the world of the revenues gained by the supply of oil. "*Petrodollar surpluses* may also be defined as the net U.S. dollars earned from the sale of oil that are in excess of internal development needs"[18]. Indeed, the dollars earned from oil exporters may reflow to oil importer economies through the purchase of oil importers' goods. This recycle of dollars can be a further explanation of the decrease of the impact oil price shocks have on the oil importers' economies nowadays. As dollars earned by OPEC countries, and other oil exporters countries, reflow into the economy, the trade deficit of oil importers countries may be hurt much less. As oil is more and more demanded, oil exporters countries earn higher and higher revenues. According to data provided by the Federal Reserve, the total export revenues of oil exporters have increased over time. While in 1972 revenues counted for 24 billion dollars, the amount earned in 1980 was 275 billion dollars and in the period 2002-2006 the amount of revenues of oil exporters increased from 300 to 970 billion dollars. The way petrodollars are recycled into the economy is not easy to control. Revenues from the sale of oil could be spent for importing goods from oil importers countries or could be invested in the purchase of foreign assets

[17] Source: West Texas Intermediate (WTI)

[18] Dr. Ibrahim M.Oweiss (1990), "Economics of Petrodollars"

in the international capital markets. Indeed, many petrodollars have been invested in US treasury securities and in other major financial markets. Moreover, revenues from oil exports have flowed into many European commercial banks. According to Higgins, Klitgaard, and Lerman (2006), for every increase of one dollar in the price of oil they computed the amount of dollar that reflows into different economies. For every dollar in increased purchases from oil exporters, 20 cents come back directly to the United States in the form of higher purchases of U.S. goods, 41 cents to Euro area and 60 cents directly to China. There data reflects the impact of petrodollar recycling to the economy and gives another possible explanation on the decreasing impact of oil price shock to the economic performances around the world in modern times.

Chapter 2

Correlation of Oil and Stock price changes

1. Effects of Oil Price on Stock Market

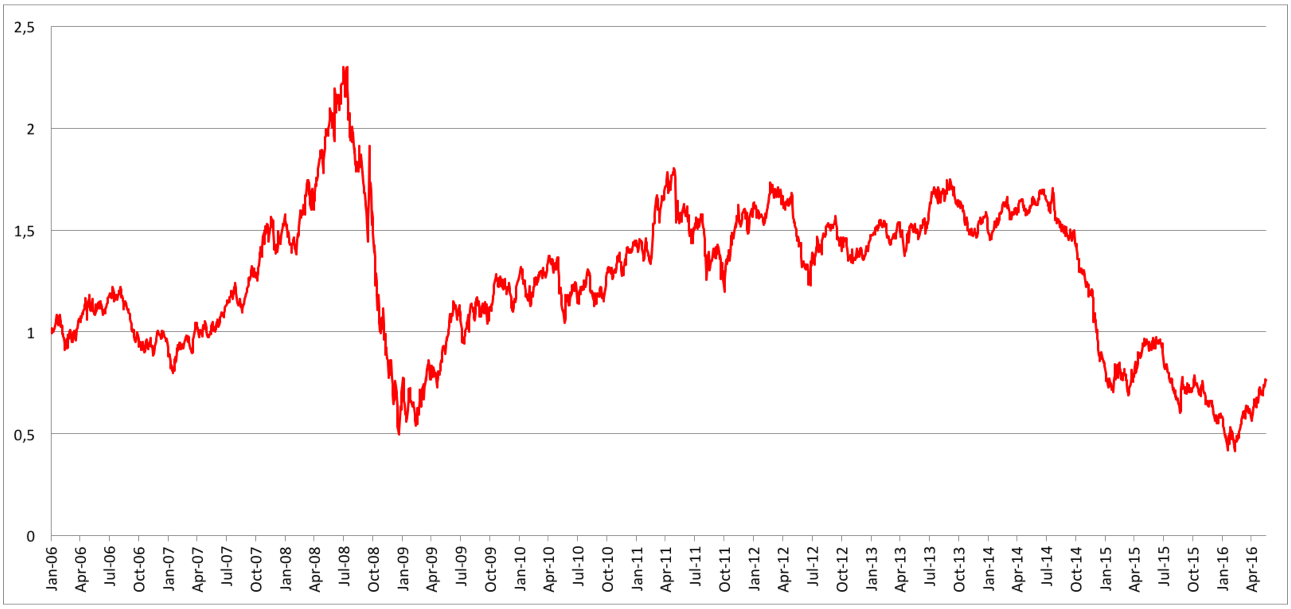
The effect of an oil price change on global economic performances have been studied by many authors. As reported in the previous sections, the impact of an oil price shock has dramatic effects on the economy, hurting the level of output and the general level of prices. Moreover, it has been proven that the impacts of unexpected spikes in the price of oil strongly changed over time. While until the 70's, an oil price shock was followed by serious changes in global economic conditions, afterward, a same shock of similar magnitude led to changes so small to be negligible. The impact of an oil price increase or decrease was analysed in terms of change in GDP, Inflation rate, unemployment and production growth rate. All these factors have been studied by many economists, and their conclusions, even with some exceptions, follow the same line. Nevertheless, the effect of an oil price shock in the stock market is very trivial. On a theoretical point of view, it should be intuitive to assume that a given change in the price of oil should be correlated with a change in the stock prices in the opposite direction. Since oil is an essential input into the economy, as its price rises, many elements in the production chain should turn to be more expensive. An increase in the price of fuel translates into higher costs of transportation, production and heating. This, in turn, leads to the households' disposable income to decrease both in terms of consumption and investment. As a result, both the increase in many input factors and the decrease in revenues, coming from households' expenditures and investments, lead the corporate earnings to fall. When corporate revenues decrease, their stock returns face a downward change. These hypothesises are in line with the common knowledge of negative correlation between changes in oil and stock prices, but empirical data show that sometimes oil price and stock price move in the same direction. Then, in order to analyse this phenomenon, in the following sections are reported researches that I have conducted. I have followed the work of Ben Bernanke (2016), testing whether the positive correlation between oil price changes and stock returns can be caused by a decrease in global demand and by a contemporaneous increase in the stock market's volatility. The results obtained are in line with the work conducted by Ben Bernanke and are reported in the following sections.

2. Oil price and Stock Market Return Movements

In this section I want to analyse the relationship between oil price movements and changes in the returns of market stock, focusing on the USA. As regards the price of oil, I have decided to report the West Texas Intermediate (WTI) price index. On the other hand, the stock market index under consideration is the Dow Jones Industrial Average (DJIA), a stock market index that reports how 30 large publicly owned companies[19] in the United States have traded during different standard trading sessions in the stock market. In the first part of my analysis, I will be reporting the main trends and statistical features of oil and stock changes over a ten-year period. In the figures below, are reported the evolution of both oil price (Figure 9, red line) and stock market index return (Figure 10, blue line), from January 2006 to April 2016. In order to get a broader view of the two paths and to compare the two trends on the same level, the data are adjusted with respect to the first available data of the sample, namely the observed price on 03/01/06. Through this relative measure, it is easier to see upwards or downwards movements of the two prices over time.

Figure 9

Crude Oil-WTI Spot Price ($ per Barrel)



Source: *West Texas Intermediate (WTI) Cushing Crude Oil Spot Price, data from Bloomberg*

[19] The 30 companies are: 3M, American Express, Apple, Boeing, Caterpillar, Chevron, Cisco System, Coca-Cola, Du Pont, ExxonMobil, General Electric, Goldman Sachs, The Home Depot, IBM, Intel, Johnson & Johnson, JPMorgan Chase, McDonald’s, Merck, Microsoft, Nike, Pfizer, Procter & Gamble, Travelers, UnitedHealth Group, United Technologies, Verizon, Visa, Wal-Mart and Walt Disney.

Figure 10

Dow Jones Industrial Average Price Index

Source: *Dow Jones Industrial Average Index, INDU index. Data extracted from Bloomberg.*

Firstly, figure 9 shows a non-constant path. During the first two years, the price of oil steadily increased, reaching its peak during the summer 2008 (almost $145/BBL). When the crisis hit, the price of oil, together with the global economy, dramatically started to decline. In particular, it can also be inferred that also the price of oil has been strongly influenced by the 2007-2008 credit crisis, which has been caused mostly by the housing bubble and the US credit crunch. Obviously, when firms have difficult access to credit and they do not trust the future, they stop investing and producing more and more. The demand for oil decreased dramatically: by the law of supply and demand, oil suppliers have been forced to lower the price of the oil. However, slowly over time the price of oil started to increase again (likely because of the "re-bouncing" effect after-crisis), and it kept a constant price of around $75/BBL from 2010 to 2014. From this period on, the oil price started to fall again, and the causes of this decline are not so clear among economists (monetary policies, aggregate demand, new technologies, etc.). The aim of this work is to discover the causes of it (thus, we will see more in depth these causes later on). If in one hand the oil price recently declined again, on the other hand the price of stocks is continuing to grow. The blue line in figure 10 shows the trend of Dow Jones Industrial Average's trend over the last 10 years. As it is shown, the price of the index declined during the 2007-2008 crisis. The worst data is registered at the beginning of 2009, where its value was almost halved with respect to its value at the beginning of the period under scrutiny. Therefore, the comparative analysis of figure 9 and 10 can be analyzed in two different phases: the first one is from the beginning to the end of 2010; the second one covers the period from 2011 until the last data available, namely April 2016. The former phase is almost tying both the trends through the same reasoning, in the sense that they followed the global movements (eg. Negative growth rates during the global crisis). On the other hand, from 2011 the two variables have different paths. While oil price stayed almost constant, with a decline in the last months, the price of the Dow Jones Industrial Average increased incessantly. Still, even if oil and stock prices have taken different paths through the last years, data highlight a positive and persistent correlation between the changes in the two variables. In order to deeper analyze the relationship between oil and stocks prices movements, in the following section are reported the statistical features of the two variables that I have computed.

2.1 Statistical Analysis of Oil and Stock Prices

In the following table, Table 6, are reported the statistical data I have computed using data collected from Bloomberg. Before computing the statistical calculations, in order to reduce the length of the data and to deal with percentage change, I took logarithms to both the data series, as usual in economics. I have obtained the basic statistical computations in order to have a broader view of both the trends. In the table are reported the mean, standard deviation, skewness and autocorrelation[20] for both oil price and stock price index[21].

Table 6

Summary Statistics of Daily log Changes of The Oil and Stock Prices

	Oil Price	Stock Price
Mean	0.0411	0.0109
Standard Deviation	2.4720	1.9610
Skewness	0.1260	-0.3016
Kurtosis	4.9477	9.7356
Autocorrelation	-0.0559	-0.1007

Source: *Data from Bloomberg, daily log changes. My computation. Period 2006-2016*

[20] Mean, standard deviation and autocorrelation are in percentage terms. skewness and kurotis are unitless.

[21] The indexes of reference are again the Crude Oil-WTI Spot Price and the Dow Jones Industrial Average

As can be seen from the table above, both the means of the two distributions are very close to zero (0.04 percent for the oil price daily log change and 0.01 percent for the daily log change in the Dow Jones Industrial Average index). As regards the standard deviations, the one related to the oil price (2.4 percent) is a bit larger than the one of the stock index (1.9 percent). The values for the mean and the values for the standard deviations indicate that the two variables tend to average to zero during the observed period and, in addition, that there are huge daily variations in prices of oil and in the prices of the Dow Jones Industrial Average Index. These results can be interpreted as the positive variations tend to compensate the negative ones. Indeed, this seems reasonable since the period under consideration includes both the 2007-2008 crisis and the recovery just after it. Moreover, the fact that standard deviations are both close to zero indicate that the data are not so far from the mean. As regards the skewness, the one referred to the oil price (0.126) indicates that the tail on the right side of the probability density function of the oil price index is longer or fatter than the left side, and conversely the negative skew of the distribution of the market stock index (-0.301) indicates that the left side tail is longer or fatter than the opposite side. Moreover, the positive values of both variables with respect to the kurtosis suggest that both distributions are more peaked than a Gaussian distribution. Indeed, the data show that kurtosis is positive. Nevertheless, the distribution's tails of the stock market index (9.73) are fatter than the ones of the oil price index (4.94), meaning a higher frequency on outliers of the stock market returns than those of the oil prices, that in turn is a rough measure of volatility and risk. Finally, I computed the autocorrelation of the two variables. As reported in the table above, there is no significant autocorrelation among the values of the oil price index (-0.05) and there is a slight negative autocorrelation between the values of the stock market index (-0.10). This means that a positive stock market return for one observation increases the probability of having a negative return for another observation and vice-versa. This fact tends to strengthen the inferences made from the analysis of the kurtosis described above.

In order to really understand the relation between oil price and stock price changes, a further statistical element must be analysed, namely the correlation. The correlation between the variables let us understand how the change of one is linked to the change of the other. It is worth saying that correlation does not mean causation. A significant positive or negative correlation between two variables does not always mean that one change is the cause of another, as they could both respond to another third variable not taken in consideration. In order to compute the correlation between the change in oil price and in the stock price, data have been collected from the period corresponding to 28/07/2011-19/05/2016[22]. In order to have a broader understanding of the correlation between oil and

[22] This period has been chosen in order to compare the relative correlation with different correlation computed in the next sessions, as some data are not available for precedent periods.

stock price movements, I have computed the correlation between the daily log change in oil price (West Texas Intermediate) and the daily log change in the price of many sectorial indexes of the Dow Jones further than Dow Jones Industrial Average, namely the Dow Jones Transportation, Dow Jones Construction & Materials, Dow Jones Automobiles & Parts, Dow Jones Food & Beverage and Dow Jones Total Stock. In the following table, Table 7, are reported the correlation between the daily log change in the price of oil, specifically the West Texas Intermediate (WTI) Cushing Crude Oil Spot Price, and the daily log change in the different stock indexes.

Table 7

Correlation: Oil and Stock Price Change

Index	Correlation
Dow Jones Industrial Average	0.3710
Dow Jones Total Stock	0.3822
Dow Jones Construction & Materials	0.3720
Dow Jones Transportation	0.1783
Dow Jones Automobiles & Parts	0.2692
Dow Jones Food & Beverage	0.2836

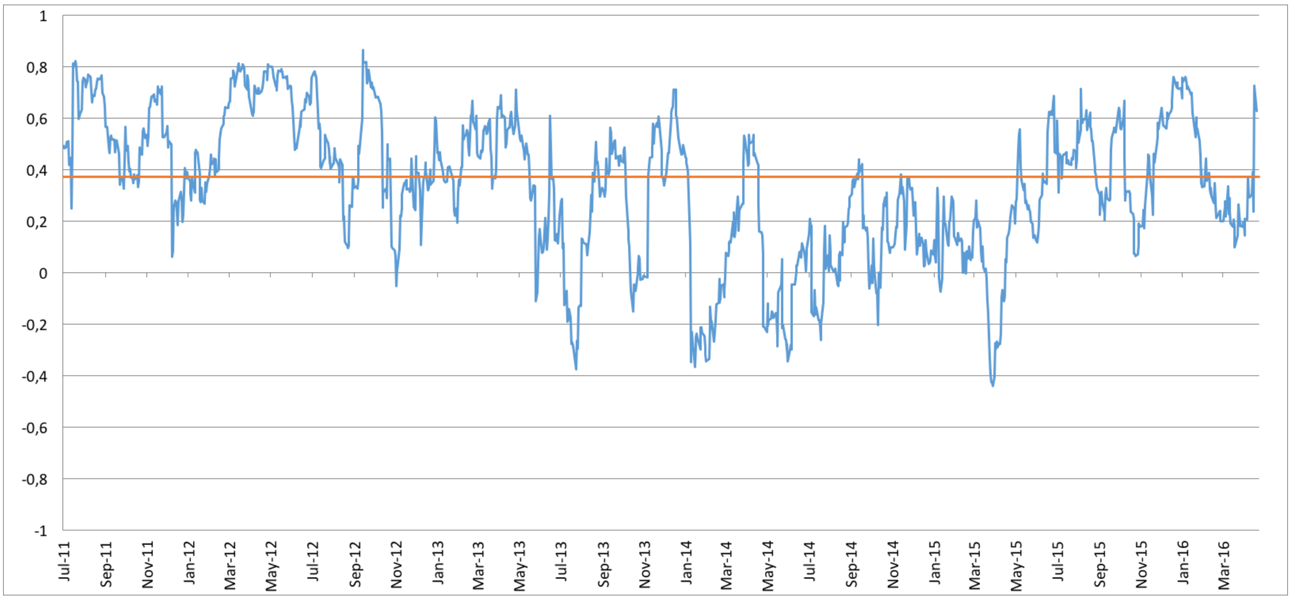
Source: *Data from Bloomberg, my computation on excel, period 2011-2016*

The table above, reports correlations between oil price and various indexes in a five-year period. All of them, are not very significant. On average, only in 37 out of 100 cases oil price and Dow Jones Industrial average index return move together, and only in 17 times over 100 Dow Jones Transportation index return move in the same direction of oil. The latest data reflect the fact that oil price and Transportation return should move in opposite directions, but still, even if the correlation is lower than the others, it is not negative. Nevertheless, the striking evidence that can be highlighted is the fact that all of the indexes are positively correlated with the change in the price of oil. This should be unusual and is not in line with what economic theory states. Indeed, from an economic analysis, we should have expected negative correlations, as very often oil is used as a production function in most of the business processes. Correlation is a rough measure of dependence between two variables, but still a positive correlation is something unusual. Moreover, the correlations reported above are only the average level of correlation of the five years taken in consideration. The trend of each of the correlations between different indexes and oil price has not been constant at all.

Indeed, as we can see from figure 11, the correlation between the oil price change and the change in return of the Dow Jones Industrial Average Index[23] is itself very volatile.

Figure 11

Time-Varying Correlation between DJ Industrial Average and WTI Crude Price



Source: *Data from Bloomberg. Log changes, 20-busienss-day rolling window, my computation*

Figure 11 reports the time-varying correlation computed using the rolling window of 20 business days. For each unit of time under analysis, it is measured the correlation between a sample of 20 days of daily log change in the price of oil and in the Dow Jones Industrial Average index. The red line in the figure sets the average correlation (0.3710) of this period, already reported in table 7. As we can see, the correlation is very volatile, values oscillate between positive and negative values in short periods of time. The blue line in the figure above is taking a very volatile path and it does not follow a clear pattern, suggesting that the correlation over sample of 20 days between oil prices and stock prices approximates to zero, or in other words, that is relatively poor. As we mentioned before, correlation does not imply causation, meaning that is not oil price changes that influences the return on market stock, but may be the case that both are responding to the same factor. This factor may be the decrease in the global demand, reflecting a slowdown in the world economy production. Indeed, both oil and stock market return are clear indicators of the economic wellbeing. As demand increases, more and more oil is demanded and its price rises together with the returns in the stock market.

[23] The figure reports only the time-varying correlation between oil and Dow Jones Industrial Average for a matter of space.

Nevertheless, the opposite case it is likely to be occurring in this period. Demand, especially from the Asian countries, is decreasing so hurting corporate profit and, consequently, returns on market stocks. At the same time, as demand is decreasing oil price falls. This analysis is in line with real data but in order to state that the positive correlation between the stock market and oil prices is due to the fall in global demand, further analysis must be conducted. In order to answer this question, the following section will report statistical feature that, at least partially, links the positive correlation to a decrease in the global demand.

2.1.1 Stocks and Oil Estimated Price Demand Effect

In order to further investigate on the relation between the oil price and the stock market returns, in this section is reported the application of an oil decomposition proposed by Hamilton in 2014. The following methodology applied is similar to the one used in the work published by Ben Bernanke in 2016. The American economist focused his attention on the relation between oil price movements and the S&P 500 index, while this paper analyses the relation between the change in the price of oil and the change in return of different sectorial Dow Jones indexes. The results obtained are statistically significant and very similar to those reported by Bernanke and this provides further validity to the work computed in this thesis. Hamilton built a model able to estimate an equation (4) that relates changes in the price of oil with changes in copper price, changes in the ten-year Treasury interest rate, and changes in the Eurodollar exchange rate. The value of the forecasted price obtained by the equation are then used to measure the effect of demand shifts in the price of oil.

$$\Delta \boldsymbol{p}_{\boldsymbol{oil,t}} = \boldsymbol{c} + \Delta \boldsymbol{p}_{\boldsymbol{copper,t}} + \Delta \boldsymbol{p}_{\boldsymbol{dollar,t}} + \Delta \boldsymbol{r}_{\boldsymbol{10,t}} + \in_{\boldsymbol{t}} \qquad \textbf{(4)}$$

Δ stands for daily log change, and the equation states that the daily log change in the price of oil can be estimated by the sum of the daily log change in the price of copper and the exchange rate Dollar/Euro and the daily log change of the ten-years Treasury interest rate.The idea is that copper, long-term interest rates, and the dollar tend to be a mirror of the investors’ expectations of world demand, in this case of the U.S. demand, but do not reflect changes in the supply of oil. Indeed, the price of copper has long been considered a leading indicator of global economic health[24]. Copper is highly related to the production process of information technology sector, electrical engineering sector, etc. This is why an increase in the price of copper indicates an improvement in the global economy. Hence, this is tied to an increase in the demand of crude oil, which is, in a sense, a

[24] Gabby, “Copper and Oil price: a look at the correlation”, 2015

complement production factor for firms with respect to copper. Moreover, the exchange rate Dollar/Euro is deeply connected with the price of oil. That is because when the exchange rate Dollar/Euro rises, Dollar depreciates and the relative price of oil becomes relatively more attractive to foreign investors. This is due to the fact that oil is traded in Dollars. In addition, for the same reasoning, a change in the Treasury interest rate can reflect a change in the health of the economy, as the interest is low, the economy is strong and it means that it is safe to invest in it. So even if the decomposition proposed by Hamilton is not perfect, it is still a good approximation for the prediction of the demand related changes in the price of oil. In table 8 are reported the regression results obtained through the equation (4) written above. Then, the values obtained from the regression reported in table 8 below are multiplied by the change in the variables mentioned above in order to predict the price of oil so to measure the effect of demand variations on the price of oil.

The regression takes into account data collected on a daily base from the date 28/07/2011[25] until 02/06/2014, the date in which, approximately, oil price started to decline. Data are reported in percentage change, more precisely in daily log change.

Table 8

Regression of Log Changes in Oil price against Log change in copper price, log change in the dollar, and log change in the ten-year Treasury Yield

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,561062803
R Square	0,314791469
Adjusted R Square	0,311879818
Standard Error	1,291911065
Observations	710

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	541,3400151	180,4466717	108,1144242	1,32611E-57
Residual	706	1178,338146	1,669034201		
Total	709	1719,678161			

	Coefficients	*Standard Error*	*t Stat*	*Significance Level*	*Lower 95%*	*Upper 95%*
Δcopper	0,40125323	0,037832249	10,60611613	1,73364E-24	0,326976047	0,475530413
Δxrate	-0,33739511	0,099939697	-3,375986941	0,000775791	-0,533609696	-0,141180525
Δinterest10y	0,147237139	0,02089171	7,047634682	4,336674E-12	0,106219822	0,188254456

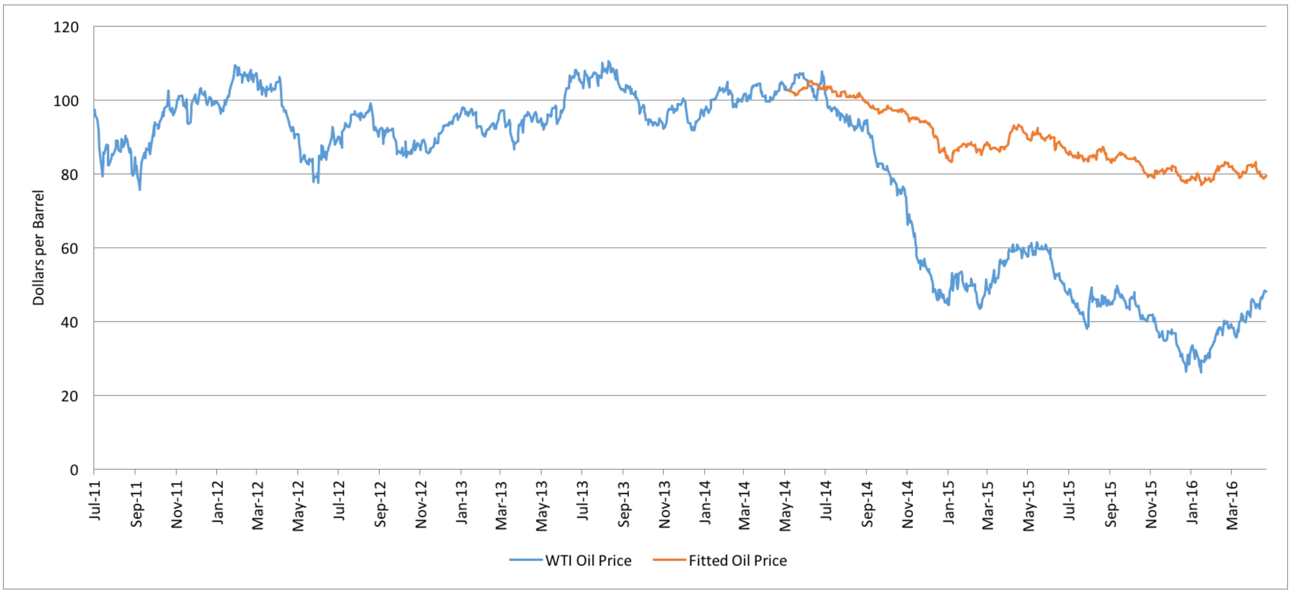
Source: *Data collected from Bloomberg on a daily log change base. Regression (4) run on excel, my computation.*

[25] The date has been chosen for reason of data availability

From the table above, we can see the results and the coefficients of the regression. All of them are statistically significant, but their signs vary depending on the effect they have on the price of oil. The coefficient on copper log change measures 0.401, meaning that an increase of one percent in the price of copper causes an increase or around 0.4% in the price of oil, ceteris paribus. Moreover, the coefficient results to be statistically different from zero (t-value = 10.606), meaning that the result is very robust. As regards the coefficient on the exchange rate, it is also very significant (t-value = -3.37) but has opposite effect on oil price with respect to the change in copper. Indeed, a one percent increase in the exchange rate between Euro and Dollar leads the price of oil to decrease by 0.33%. Finally, the coefficient on the change in Yield U.S. T-bond measures 0.14 meaning that an increase of one percent in the ten-years Treasury bond interest rate is related to an increase in the price of oil by 0.14%, ceteris paribus, and it also statistically significant (t-value = 7.04). According to the model proposed by Hamilton (2014), the coefficients obtained by the regression are multiplied by the actual daily change of each variable taken into consideration in order to forecast what the price should have been from 2014 on, if the oil responded only the variation in the global demand for oil. In figure 12, is plotted the actual price of oil[26] (Blue line) from 27/07/2011 until the latest data available, namely 19/05/2016, and the Fitted price of oil (Orange line) that have been forecasted from June 2014 if the only shock to the price of oil had been caused by a decrease in the demand for oil.

Figure 12

WTI Oil price and Fitted Oil price



***Source**: WTI oil price collected from Bloomberg, Fitted oil price from my computation*

[26] West Texas Intermediate oil price index

As we can see, the difference between the actual and the fitted price of oil is very high. While the predicted forecast decreased by a small amount, the real price of oil dramatically fell. The difference can be interpreted as follows: almost 45-50 percent of the fall in the price of oil since the middle of June, can be caused by an unexpected decline in global demand. Then, the regression obtained by the decomposition is in line with what the real economy is facing, a softening the global demand. The decomposition computed can separate the demand effect from the supply effect on the changes in the price of oil. The demand effect is represented by the fitted oil price change described above, while, the residual portion, can be interpreted as the supply effect on the price of oil change. In order to find some explanations on the positive correlation between market stocks and oil price changes, down below are reported, in table 8, the correlations computed between the various daily log changes of indexes returns under consideration and both the demand related changes in the price of oil and the residual change in oil price, both difference are on a daily log change base.

Table 8

Correlation: Fitted and Residual Oil Change and Stock Price Change

Index	Demand-Related Corr.	Residual Corr.
Dow Jones Industrial Average	0.5233	0.0490
Dow Jones Total Stock	0.5315	0.2112
Dow Jones Construction & Materials	0.6320	0.1594
Dow Jones Transportation	0.3129	0.0723
Dow Jones Automobiles & Parts	0.4974	0.0991
Dow Jones Food & Beverage	0.4459	0.1132

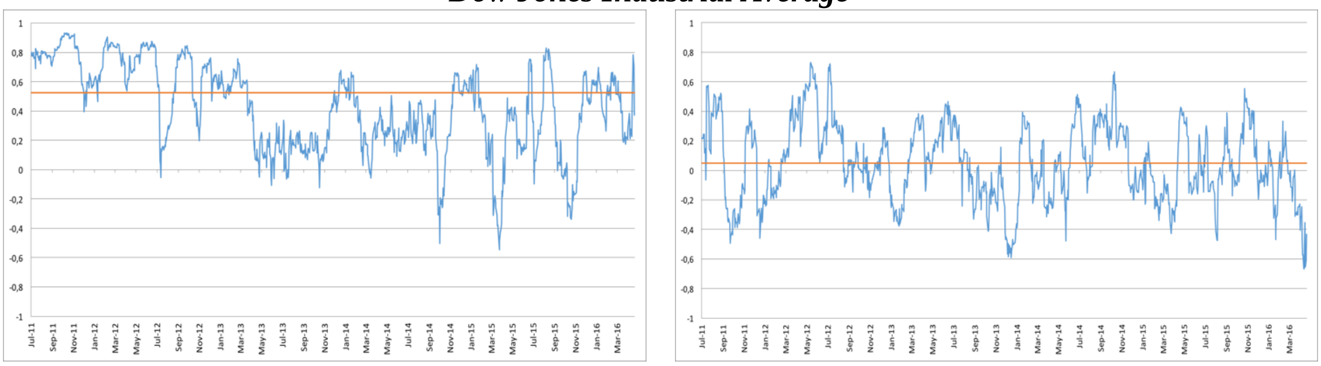
Source: *Data collected from Bloomberg, my computation*

As we can see from the table above, the results computed confirm the hypothesis that stock market indexes returns and oil price changes move in the same direction because they both respond to the same factor, namely a softening in the global demand. Indeed, the correlations between the stocks and the demand related change in the price of oil is much higher than the ones reported in table 7. The correlation between stock and oil strongly increases if we consider the change in oil driven only by a decrease in demand. Nevertheless, also in this case, the lowest correlation is related the one of the Dow Jones Transportation index, that is much lower than the other correlations with respect to both the demand-related and the residual change in the price of oil. Overall, the correlation between stock market returns and demand related change in the price of oil is much more significant and positive. For example, in 63 out of 100 cases, the demand-related change in the price of oil and Dow Jones Constructions & Material move in the same direction. That is consistent with the hypothesis that oil price tends to move together with expectations on global economic conditions rather than due to real change in the oil conditions. On the other hand, the correlations between daily change in market stock index return and the residual change in the price of oil is much lower than the average correlation reported in table 7. This in line with the fact that residual change should represent the supply-related change in the price of oil. Nevertheless, even if correlations with the residual change reported in table 8 are much lower than the average correlation reported in table 7, they are still not negative as it should be expected. It is worth noting that the correlations reported above represents only the average correlations regarding the period of analysis. The correlations between different stock indexes and the demand and residual related change in the price of oil are not constant at all. Indeed, as we can see from the figures below, correlations oscillate between positive and negative values. In figure 13 are reported the correlations between the various indexes taken into consideration and the demand-related change in oil price (figures on the left) and the residual change (figures on the right). Figures show time-varying correlation on daily log change on a 20-business-days rolling window. The red line in each of the figures represents the average correlation

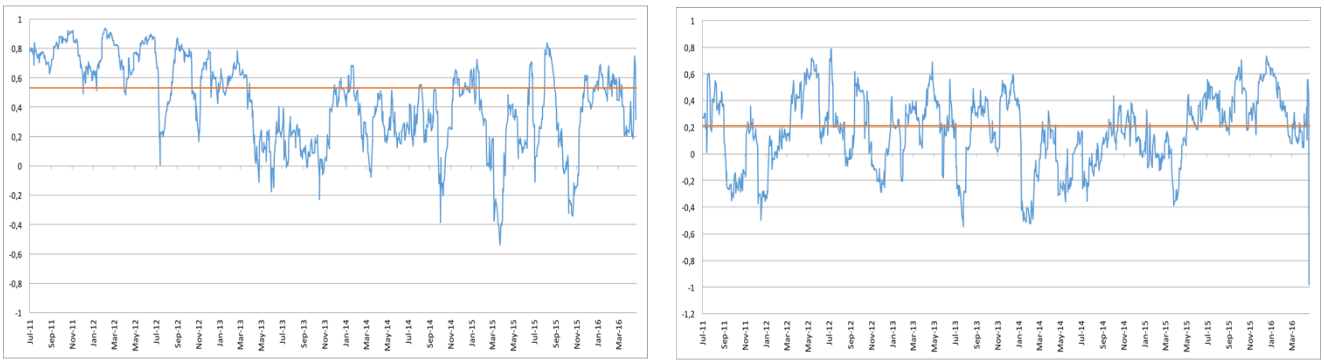
Figure 13

Time-Varying Correlation of Change Dow Jones Indexes and Demand-Related Change (left) and Residual Change (right) in WTI Crude Price

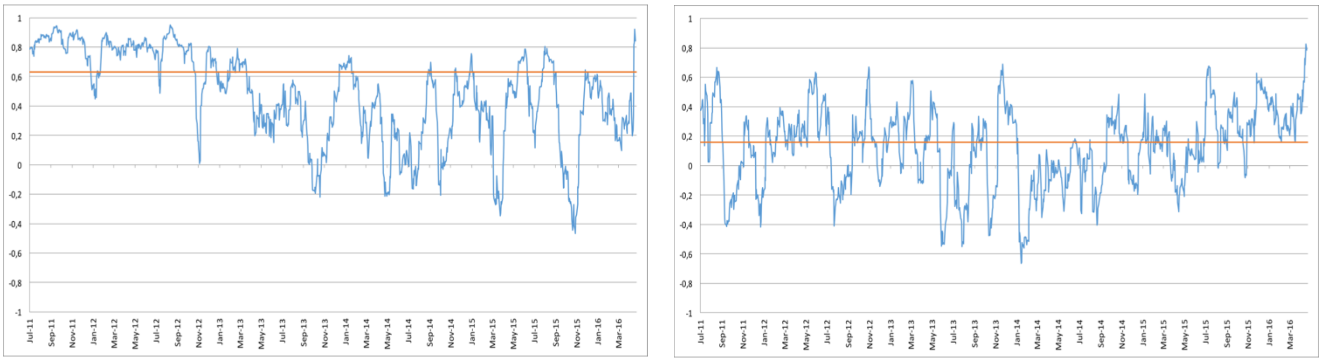
Dow Jones Industrial Average



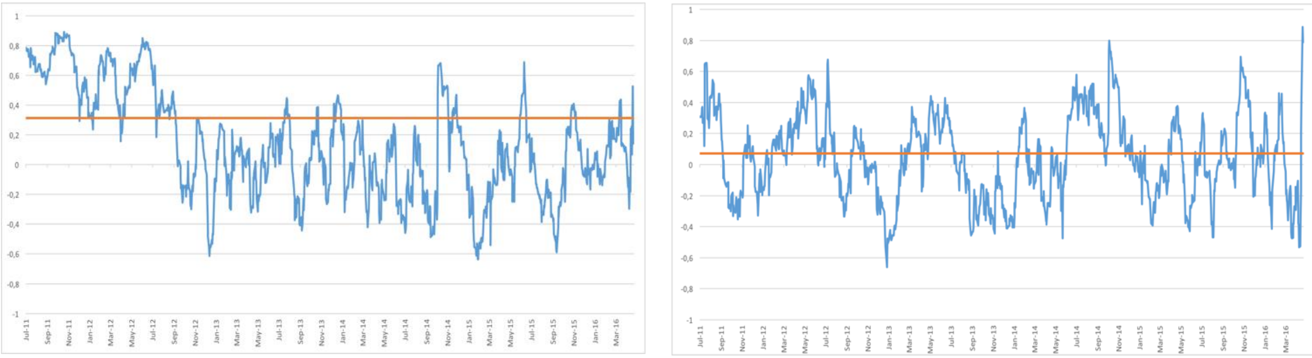
Dow Jones Total Stock



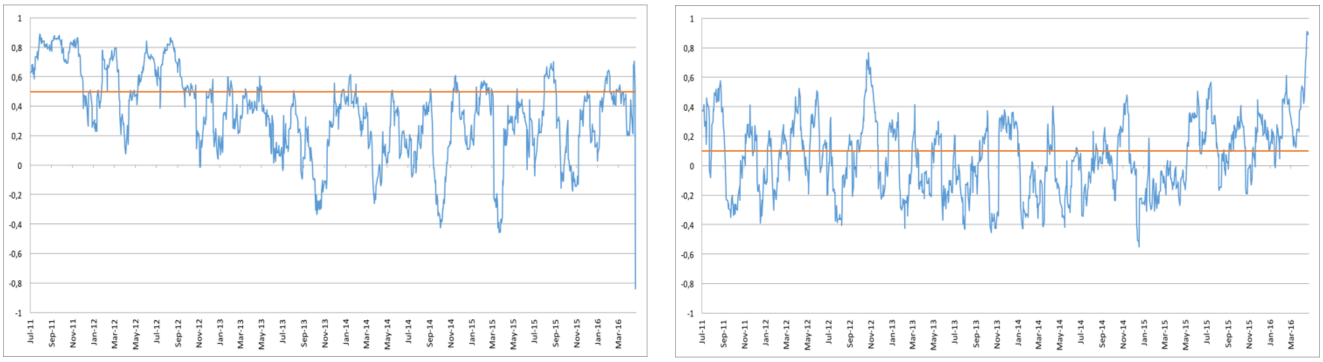
Dow Jones Constructions & Materials



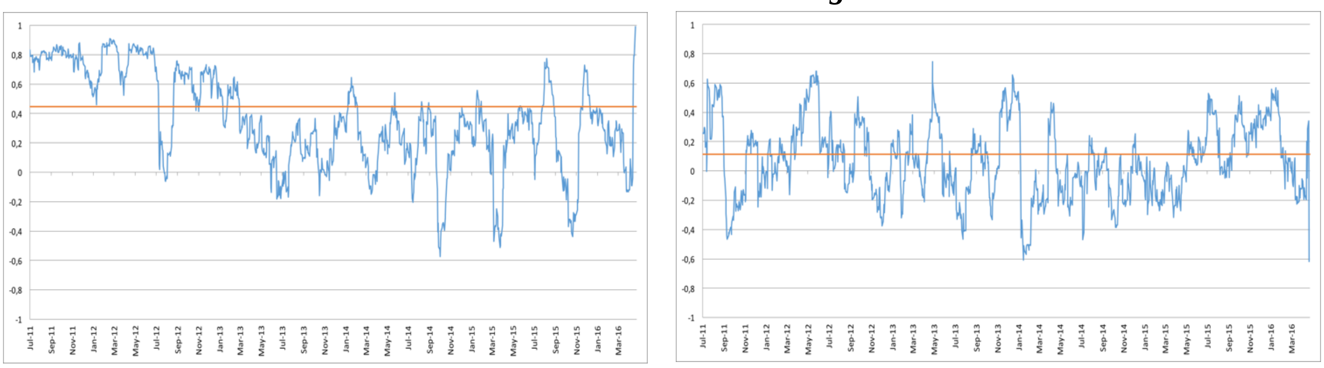
Dow Jones Transportation



Dow Jones Automobiles & Parts



Dow Jones Food & Beverage



Source: *Bloomberg data. Correlations (20-business-day rolling window) between the daily log changes in the Dow Jones indexes and the demand-related (left) and the residual (right) daily log changes in the West Texas Intermediate Oil Price. My computation*

As we can see from the figures above, the correlations are very volatile. They oscillate between very positive values and very negative one. Overall, it can be inferred that while the decomposition suggested by Hamilton can partially explain that the positive correlation between change in stock market returns and change in the demand related price of oil, it cannot explain why oil price changes are not negatively correlated with residual changes that represents the supply-related change in the price of oil. Indeed, while the average correlation between demand-related oil price change and stock is quite high, so suggesting that one of the possible reasons behind the positive correlation is due to a decrease in the demand for oil, the correlation between residual-related change in the price of oil and stock is low, but it is not negative as should be expected. Then, if the decrease in the global demand can be a valid reason behind the positive correlation, it is not exhaustive.
A further possible explanation of the positive correlation is suggested by Ben Bernanke (2016). Recently, markets have been characterized by high levels of volatility. Indeed, if investors, during periods of great uncertainty stop investing in commodities and stocks, then the change in volatility levels can be inferred to be a further explanation for the propensity of stocks and oil prices to move in the same direction. In order to test this hypothesis, in the following subsection is reported the regression (4) proposed by Hamilton with a further variable, the daily log percentage change in the VIX, a market index used to measure the volatility of market stocks.

2.1.2 Stocks and Volatility Related Change in the Price of Oil

In order to test whether the volatility in the stock market can explain the positive correlations between stock returns and oil price changes, the variable VIX is introduced into the equation for the oil decomposition. The idea behind is the following: as the economy face a period of instability, risk rises, and so investments are delayed and, consequently, stocks face a decline in return. The same applies for the oil price. As oil is a storable good, it is subject to expectations and so as the market faces a period of high uncertainty, its price is expected to fall and then, less and less barrels are demanded thus decreasing the oil price. Therefore, the augmented version of equation (4), which comprehend the measure of the volatility in the market represented by the daily log changes in the VIX index, is the following:

$$\Delta \boldsymbol{p}_{\boldsymbol{oil,t}} = \boldsymbol{c} + \Delta \boldsymbol{p}_{\boldsymbol{copper,t}} + \Delta \boldsymbol{p}_{\boldsymbol{dollar,t}} + \Delta \boldsymbol{r}_{\boldsymbol{10,t}} + \Delta \boldsymbol{VIX}_{\boldsymbol{t}} + \in \qquad \textbf{(5)}$$

Then, in order to estimate the effects of the four independent variables on the change in oil prices (dependent variable), below, in table 9, it is reported the regression run on excel (also in this case the period under analysis is 27/07/2011-02/06/2014[27]).

Table 9

Regression of Log Changes in Oil price against Log change in copper price, log change in the dollar, and log change in the ten-year Treasury Yield and log change in the volatility Index VIX

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,56961061
R Square	0,32445625
Adjusted R Square	0,32062338
Standard Error	1,28367703
Observations	710

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	557,960329	139,490082	84,65094138	1,03502E-58
Residual	705	1161,71783	1,64782671		
Total	709	1719,67816			

	Coefficents	*Standard Error*	*t Stat*	*Significance Level*	*Lower 95%*	*Upper 95%*
Δcopper	0,38252756	0,03805073	10,0530942	2,60414E-22	0,307821252	0,457233878
Δxrate	-0,25172448	0,10290143	-2,44626797	0,014677683	-0,453754418	-0,049694536
ΔInterest 10y	0,12851792	0,02157914	5,95565635	4,08673E-09	0,086150852	0,170884979
ΔVIX	-0,03107647	0,00978516	-3,17587827	0,00155892	-0,050288016	-0,011864933

Source: *Data collected from Bloomberg on a daily log change base. Regression (5) run on excel, my computation.*

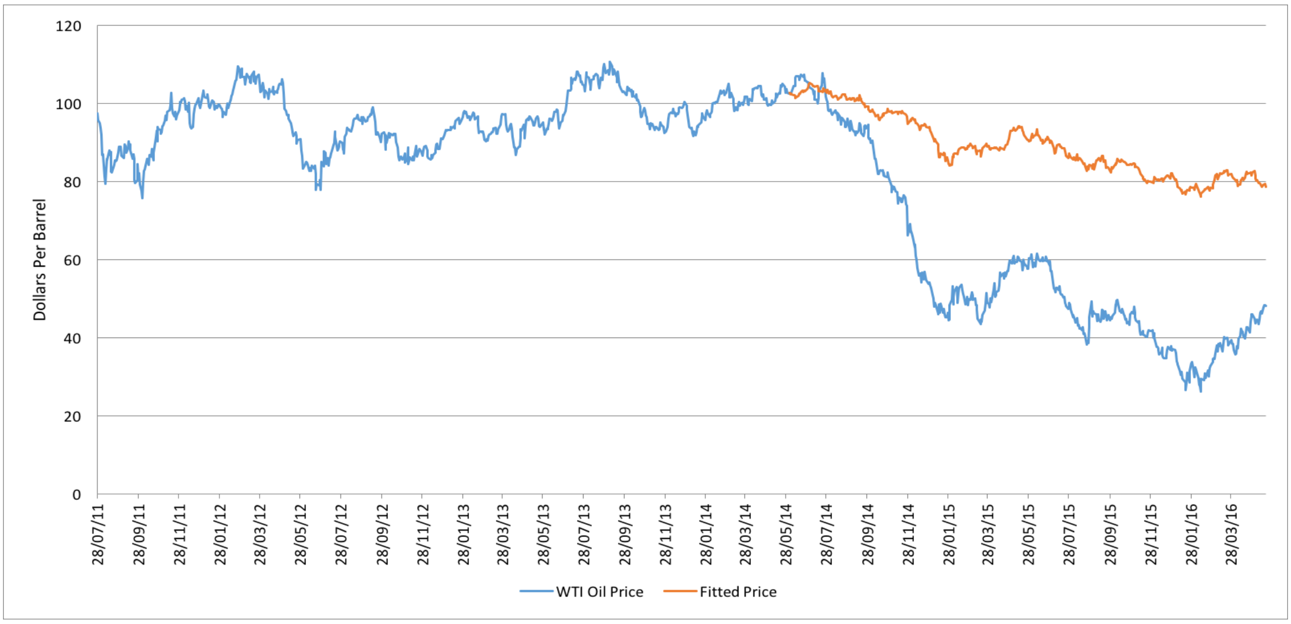
From table 9 we can see that the three variables considered before, namely the change in the price of copper, change in the exchange rate and the change in the interest of Treasury bonds are again statistically significant. Moreover, the VIX is statistically significant (t-value = -3.175) and, as expected, is negatively related to the price of oil. The coefficient related to the VIX states that one percent change in the volatility index is associated with a negative change of 0.03 percent in the price of oil. As it has been done before, also in this case the coefficients obtained by the regression are used in equation (5) in order to compute the forecast of the price of oil from June 2014 until March 2016.

[27] Also in this case the period has been chosen to start from 2011 for reason of data availability, and to end at the beginning of June 2014 as that is the period in which oil prices started to fall.

As we can see from the 14, the predicted oil price (orange line) is higher than the actual price of oil (blue line). This is in line with the fact that oil prices have been affected by an unexpected weak demand and are also linked to the high level of volatility

Figure 14

WTI Oil Price and Demand/VIX-Related Fitted Price



Source: *Data from Bloomberg, Demand/VIX component estimated by applying regression coefficients over the period 7/2011-6/2014. My computation*

Figure 14 does not differ so much by figure 12, where the fitted price of oil did not take into account the change in volatility. As can be seen, the difference between the real and the fitted oil price is very high. The figure shows a difference on average of around 20 dollars per barrel in each period. So also in this case the graph is in line with the hypothesis that the decrease in the price of oil linked to the decrease in the global demand and the rise in the uncertainty in the global markets. Nevertheless, even if the forecast of oil price computed by equation (4) seems to be very similar to the prediction of oil price computed by equation (5), the correlation between stock market returns and the fitted price changes accounting for risk strongly increase our capacity to explain the positive relationship between stock indexes returns and price changes. Once again, in order to test whether the new regression produced a forecast that can strength our analysis, new correlations between different stock indexes returns and both the new VIX/demand fitted price changes and the relative residual change in the price of oil are computed. The results are reported below in table 10.

Table 10		
Correlation: Fitted and Residual Oil Change and Stock Price Change		
Index	**VIX-Demand-Related Corr.**	**Residual Corr.**
Dow Jones Industrial Average	0.6228	0.0391
Dow Jones Total Stock	0.6375	0.1660
Dow Jones Construction & Materials	0.6813	0.1368
Dow Jones Transportation	0.3284	0.0647
Dow Jones Automobiles & Parts	0.5372	0.0807
Dow Jones Food & Beverage	0.5354	0.0751

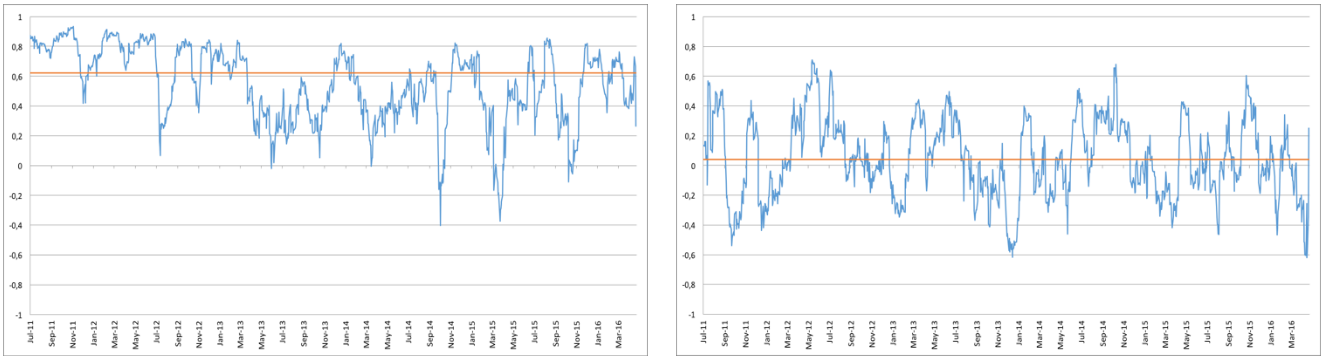
Source: *Data collected from Bloomberg, my computation*

Results from table 10, strength our hypothesis: taking into account the volatility of the stock market helps explain the positive correlation between stock indexes returns and oil price changes. Indeed, overall, the correlations between different stocks and the VIX/demand related change in the price of oil are higher than the correlations computed in table 9, where volatility was not introduced into the regression. Nevertheless, the increase in the correlation is not the same for all the indexes taken into consideration. While the Dow Jones Industrial Average, the Dow Jones Total Stock and the Dow Jones Food & Beverage face an increase in terms of correlation of approximately 0.1, and Dow Jones Construction & Materials and Dow Jones Automobiles & Parts of 0.05, the Dow Jones Transportation Index increased its correlation with the VIX/demand related change by only 0.01. So if introducing the volatility index VIX into the equation proposed by Hamilton helps explaining the trend of oil price and stocks to move together, it does not explain why the correlation between the various indexes and the residual change in the price of oil is still not negative. Indeed, comparing the results from table 10 to the one reported in table 9, we can see that all the correlations that take into account the volatility are lower than the ones without, but still, they are close to zero but are not negative. Nevertheless, also in this case the results reported in table 10 are only the average of the correlations obtained. The actual trends of correlations are reported below in figure 15. On the left are reported the time varying correlations between each Dow Jones stock index and the demand/VIX related change in the West Texas Intermediate Oil price, and on the right the time varying correlations of each Dow Jones stock index and the residual change in the price of oil. The graphs are computed, as the one in figure 13, using the time-varying correlation using the rolling window of 20 business days. For each unit of time under analysis, I measured the correlation between a sample of 20 days of the daily log change in the various indexes taken into consideration and the daily log change in the VIX/demand related change (left) and the residual related change in the price of oil (right). The time varying correlation is represented by the blue line, while the average correlation is represented by the straight orange line.

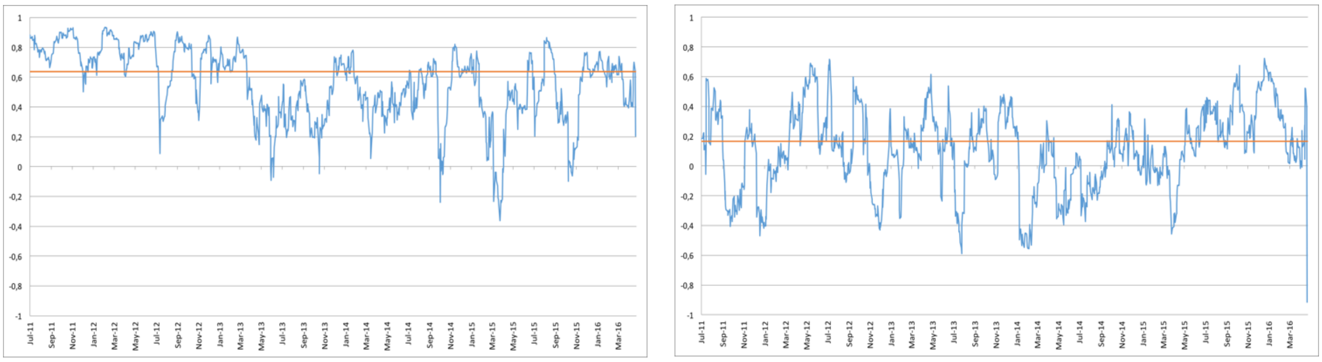
Figure 13

Time-Varying Correlation of Change Dow Jones Indexes and VIX/Demand-Related Change (left) and Residual Change (right) in WTI Crude Price

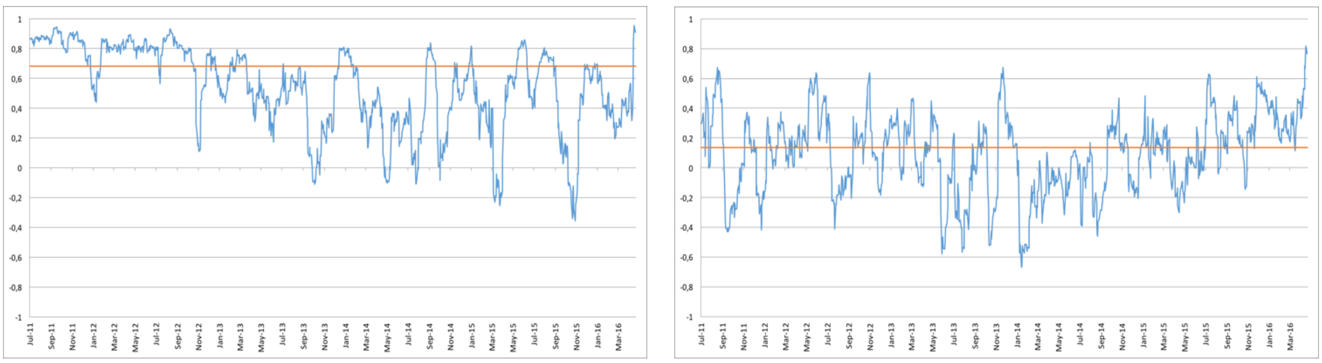
Dow Jones Industrial Average



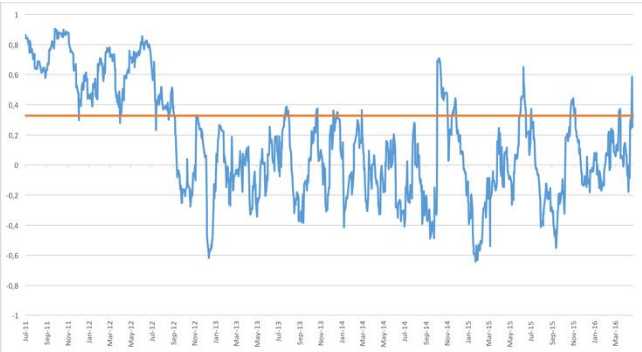
Dow Jones Total Stock

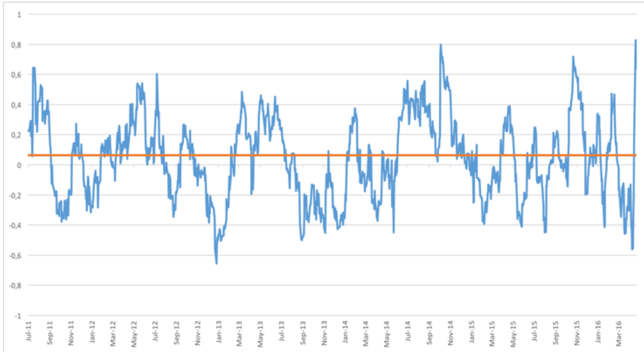


Dow Jones Constructions & Materials

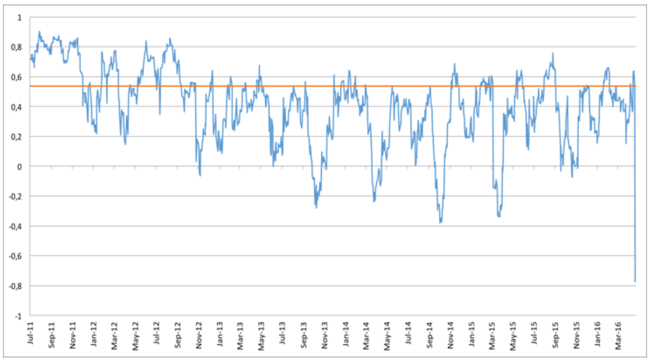


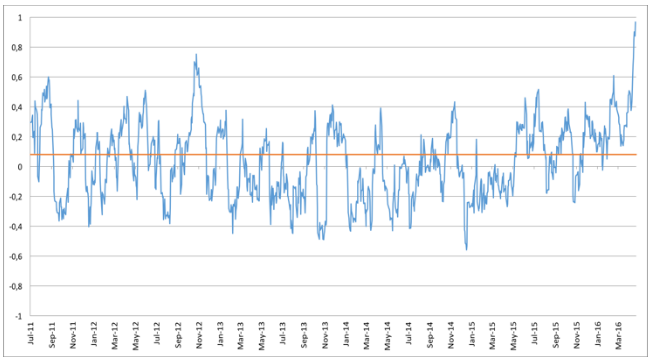
Dow Jones Transportation



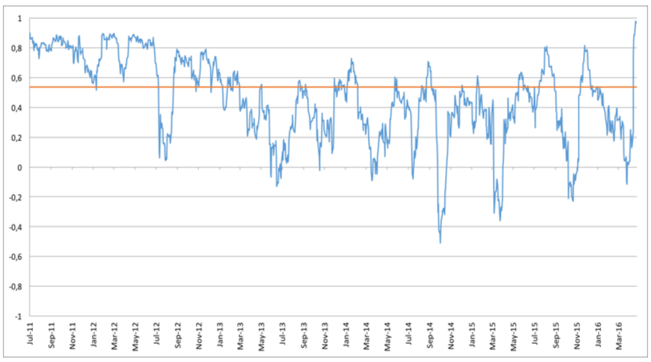


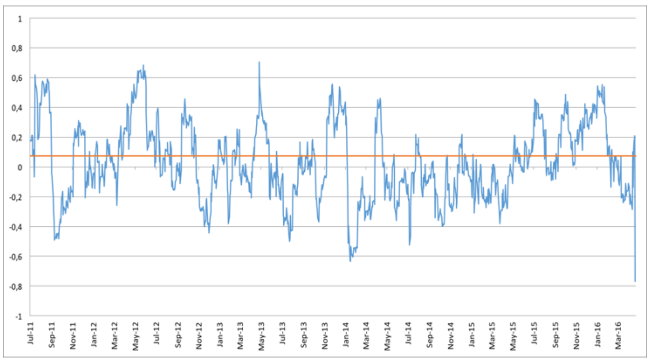
Dow Jones Automobiles & Parts





Dow Jones Food & Beverage





Source: *Bloomberg data. Correlations (20-business-day rolling window) between the daily log change in the Dow Jones indexes and the VIX/demand-related (left) and the daily log residual change (right) in the West Texas Intermediate Oil Price. My computation*

3. Conclusion

This thesis started asking mainly two questions, why oil price shocks have had different effects on the economy over time and why during the last five years the change in the price of oil have moved in the same direction of the stock market returns. The answer to the first question is developed through the first chapter. This thesis proposes two hypothesises. The first one is linked to the structural changes in modern economies while the second one is related to the source of the oil price shock. As regards the first one, after having analysed each effect that an unexpected rise in the price of oil causes to the economy through the first and the second round effects, it has been explained why these effects are much weaker nowadays rather than in the past. Indeed, the three main changes in the structure of the economy can be considered to be a valid explanation of the different and lower impact that oil shocks have in modern times. The first change is related to the fact that the consumption of oil as a percentage of the GDP has decreased over time, thanks to the introduction of new renewable resources. The second change refers to the decrease in the level of nominal wage indexation. Finally, the last structural change in the economy is represented by the increase in central banks' credibility. Their monetary policies are much more effective nowadays since they are accompanied by a higher level of credibility. This, in turn, lets consumers and investors be less worried of any oil price shocks as monetary authorities will target level of inflation and output growth to restore economic stability. The second hypothesis finds the reason of the decrease in the strength of the impacts of oil price shocks to the economy in the source of the shock. If the shocks are caused by an unexpected decrease in supply of oil, like the ones occurred in 1973 and 1979, the economy can face dramatic consequences when the price of the commodity sharply rises. On the other hand, when the price of oil increases due to an increase in the global demand, the negative effects are offset by the positive ones, related to the increase in the production, increase in exports and to the decrease in the cost of imports that are consequent to an increase in demand from emerging countries, such as China or India in the past years.

The Second question of this thesis is analysed in chapter 2. Recently, in the last five years, and probably more, oil price changes and changes in stock market returns have moved in the same direction. In order to analyse this phenomenon, I have followed a work proposed by Ben Bernanke. He worked on the correlation between the price of oil (WTI oil price) and the S&P500, while I have focused my analysis on the correlation with different stock indexes, namely the Dow Jones Industrial Average, Dow Jones Total Stock, Dow Jones Constructions & Material, Dow Jones Transportation, Dow Jones Automobile & Parts and the Dow Jones Food & Beverage index. To test whether the positive correlation between changes in these indexes returns and changes in the price of oil could be attributed to a decrease in the global demand, I have used an oil decomposition proposed by Hamilton.

The equation developed by Hamilton is used to regress the daily log change in the price of oil against changes in copper prices, changes in the ten-year Treasury interest rate, and the changes in dollar. Afterwards, the coefficient values obtained by the regression (Table 8) are multiplied by the actual daily change in the price of each variable in order to measure the demand component of the oil price. The fitted value obtained are then used to measure the correlations with daily log changes of the indexes taken into consideration. The results obtained are very similar to those published by Ben Bernanke. The correlations between the demand related changes in the WTI oil price and the changes in market indexes returns are higher than the correlations' values obtained between the actual WTI oil price and the changes in the Dow Jones indexes. This confirms that both variable are responding to the same factor, a decrease in global demand. Then, in order to find a further explanation of the positive correlation between the two variables, a volatility index (VIX) is introduced into the equation mentioned before. The coefficients obtained by the new regression (Table 10) are again statistically significant and are used to further decompose the price of oil. Then, new correlations are computed between the stock indexes returns and the new predicted component of oil associated with both demand and volatility. Once again the results obtained are very similar to those computed by Ben Bernanke. The average correlations between the Dow Jones Indexes and the demand/VIX related change in WTI oil price are even higher than the ones obtained before. Therefore, the positive correlation can be attributed to both an increase in the volatility of stocks and a decrease in the global demand. Nevertheless, the correlation between the changes in stock indexes returns and the residual change in the WTI oil price, that should represent the supply component of oil price, with and without the volatility index, approaches zero, but are not negative.

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