A study on energy prices: market analysis & prices

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ABSTRACT:

Energy has become one of the world's most consumed commodities, affecting different agents worldwide. Individuals account it for their cost of living and and nations are strongly dependant on energy for their imports and exports. Therefore, energy has become one of the most important markets worldwide. This paper identifies the sources of energy volatility, namely, organisations such as the OPEC, or nations such as South Korea. Furthermore, empirical research was performed using an OLS and VAR regressions. In this way, identifying the relationship between energy prices, ECB's money supply and the Eurozone's industrial production. The results show Granger causality and a negative relationship for the former and no Granger and a positive relationship causality for the latter. Finally, a life-like virtual shock was induced to money supply and industrial production on energy prices. An increase of money supply and a increase in industrial production both show significant effects on energy prices.

1. Introduction

Ever since the rise in the popularity of combustion engines, energy has become one of the world's most consumed commodities (Pindyck, 1999). Either in the shape of oil, natural gas or coal, energy has placed itself in the most traded markets, generating millions of dollars' worth of wealth. Commodities such as oil and gas specially, are said to play a world-wide role in terms of economic and social activity (Cleveland et al., 2000). The effect of energy has an impact on individuals and also on a bigger scale such as companies or nations.

Firstly, energy has a vital impact on costs for the individual. For instance, costs like gas expenses, the necessary oil to run engines or the electricity used to make a computer work. This, in turn, affects differently the decisions of these agents. For example, regarding commutation (their personal choice on transport means) or asset-purchasing (choice among different energy-efficiency degrees of household appliances). Hence, from the individual perspective energy plays a clear economical role which has a clear impact on its decision-making.

As mentioned before, energy does not only concern individuals but it also plays a vital role for numerous agents on a bigger scale. For a considerable number of nations, GDP is strongly dependent on its energy imports and imports. For instance, an energy-producing country such as Russia, for the years comprehended between 2000 and 2012 originated half of its GDP growth from its energy production (NCPA, 2013). Moreover, energy-intensive industries such as transport, manufactures or commerce are extremely exposed to fuel markets (Europedia, 2017). Therefore, energy prices are crucial not only for individuals, but are also vital on a collective scale. This paper aims to explain energy price variations for one of the biggest consumers, the Eurozone. For which its use of energy in Mtoe (million tons of oil equivalent) ranks third after China and the US (TSPDP, 2014).

Considering the abovementioned factors, it becomes clear that the output and decisions of numerous agents depend on energy prices. Hence, correctly assessing price variations and their relationship with macroeconomic variables has positive outcomes. Namely, it helps this paper making the market of energy more understandable. The focus is specially set on how the ECB's monetary policy and growth can be linked to the energy market.

Finally, it is vital to notice that plenty of research has been performed on the way that energy prices influences a country's growth or its terms of trade. Nonetheless, the literature concerning the sources and reasons for energy price movements is scarce. This paper will therefore pay special attention to the analysis of the market giving a correct assessment about the pricing of energy. Hence, this leads to the following research question:

How do ECB's money supply and growth intervene in the formation and variation of energy prices?

In section 1.2 *'Market analysis'* research on the energy market is performed through the analysis of oil. In section 2 *'Data & Methodology'* the sources of the data are provided as well as the methodology on how the empirical research was performed. In section 3 *'Literature review'* a literature review of the topic of the energy market is performed. Finally, in the sections 4. *'Results'* and 5. *'Conclusions'* the results of the research are presented, discussed and interpreted.

1.2 Market analysis

Energy prices, just like any other good or service are mainly driven by market supply and demand. Nonetheless when comparing energy to more stable commodities it is clear that they present certain market characteristics that make its prices extremely volatile and difficult to predict. This in turn, largely affects individuals, nations and corporations, especially the ones that are heavily dependent on the use of energy. This section *'Market analysis'* aims to obtain a better understanding of this volatility. In order to do that, the price shocks of this paper's main study variable (*EPI*) is analysed. This, in turn, explains which agents motivated the price variation and who was affected by them. Since the variable *EPI* is an index of different fuels and not a real commodity the following analysis focuses on the price variation of one of them. The chosen energy source is oil as it has played the biggest role in terms of price shocks for energies throughout decades. This variable largely explains the whole energy market and therefore the energy index, hence aiming at better interpreting the results of the later sections.

Oil market

Because of its inherent characteristics, the oil market has had a long history of volatility, shocks and periods of consolidations. Smith (2009) already discusses three major characteristics which makes petroleum so unique: (i) extremely high price volatility, (ii) its prevalent impact and creation of major cartels (i.e OPEC) (iii) as well as the prominent size of the oil industry and its direct effects on industrialization and economic growth. Besides the prior aspects that make oil so particular, it is also its main global interest that makes it such a crucial commodity. To grasp an understanding of the involvement of nations for the 'black gold' BP (2008) points that in the case of oil at least 50 nations are current producers. Furthermore, two thirds of this production is globally exported, meaning that most of the oil produced is not consumed at the country where it was extracted.

The general price of oil has increased throughout the years as it can be seen in the general trend-line in the *Table 1.1* below. Nonetheless, the oil price fluctuations have not been steady. The first oil-shock (Point A) began in October 1973 when the Organization of Arab Petroleum Exporting Countries proclaimed a petroleum embargo. This rose the stable price from 3$ to quadrupling it to 12$ per barrel. The second oil shock (Point B), increased the prices from 16$ to almost 40$ due to the decrease in oil supply from Iran in the wake of its revolution. For the coming years the price dropped steadily until 1986 when a barrel's price was almost the one before the second oil shock's value. For the years ranging from the end of the eighties to the year 2000 the price consolidated around 20$. Nonetheless, having short price shocks at points C & D as a response to the Gulf war and the Asian economic crisis respectively.

Moreover, from the year 2000 onwards prices have fluctuated enormously, firstly decreasing in 2001 largely as a response to the 9/11 attacks. Then drastically increasing for seven years, among other reasons because of the rise on OPEC (Organization of the Petroleum Exporting Countries) cutbacks and the global increase in petroleum demand. Nonetheless, this increase from 15$ to almost 140$ per barrel took a major hit on 2008 due to the global financial collapse which decreased the price to 40$ in 2009. At the same time the OPEC cut production which decreased its supply and increased prices again. Finally, for the subsequent years (2009-2011) the uprising of Egypt and Libya rose the price to 120$. Nonetheless, the recent excess supply of oil and the OPEC's consistent market interventions among other economic events has decreased the price of oil rounding the 50$ mark in 2016

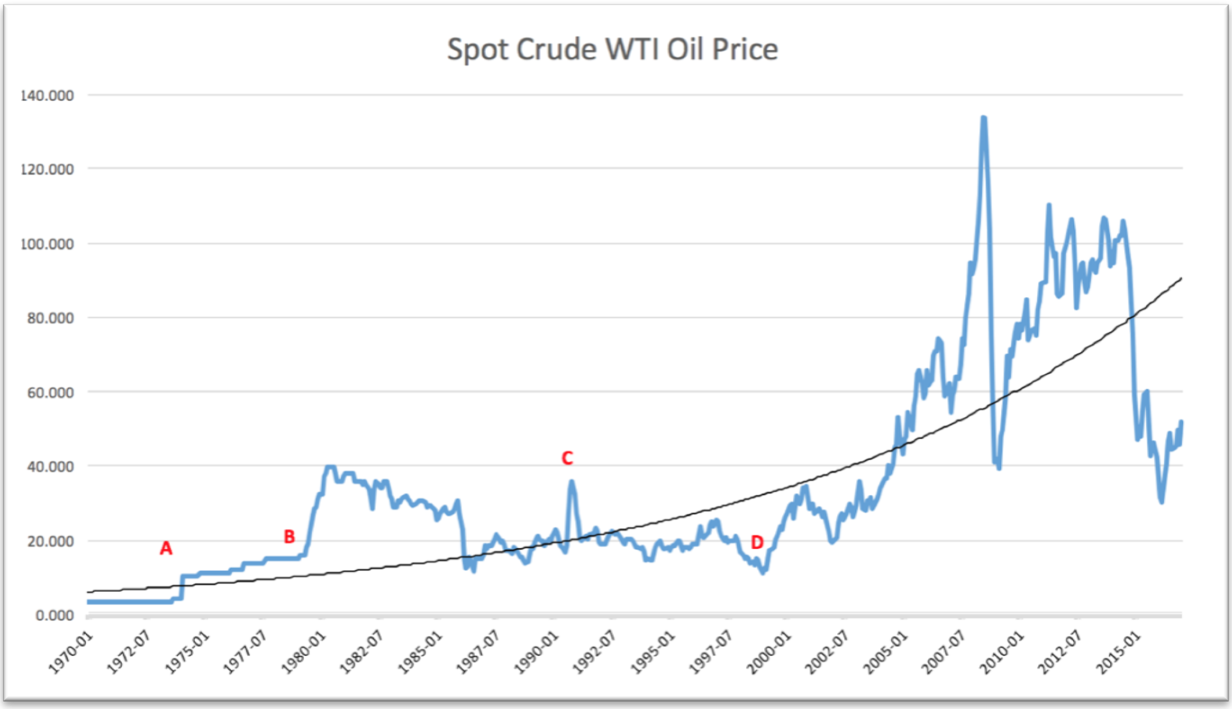


Table 1.1 Price of WTI crude oil (Fred, 2017)

On a whole, petroleum prices have ranged widely throughout the last decades with a range from 3$ to 140$ (44 times higher price). The reasons of this price volatility are the supply and demand of the commodity. The supply has caused strong impacts throughout the years, for instance the first and second supply shock or the OPEC cutbacks. The demand side also has a vital influence on oil's prices which goes in line with the general expansion of the market. Table 1.2 shows the US' monthly evolution of oil consumption for the time range 1980-2015. The figures show that consumption has moved from 15,000 oil barrels per month in the beginning of the eighties, to peaking in 2005 closely to 22,000 and reaching 20,000 barrels in 2015. Such change in consumption represents a 33 percent increase.

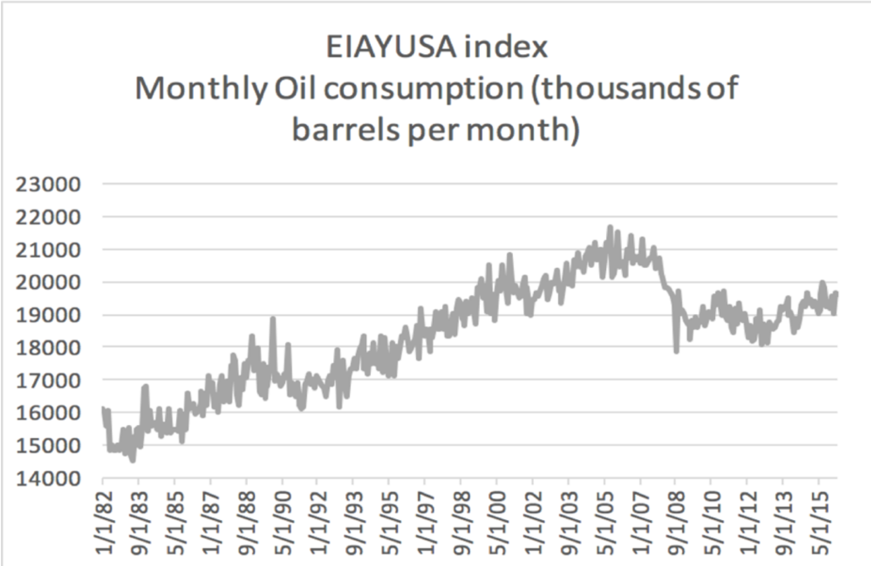


Table 1.2 Oil consumption (Bloomberg, 2017

The shocks to demand and supply are ultimately originated by actions of different agents in the economy; private entities such as organizations, Al-Qaeda in 2001 or the OPEC. Or by countries, for instance Malaysia, South Korea or Thailand in the Asian financial crisis. This analysis shows why oil is regarded as a highly volatile commodity. The significant price variations over the course of six decades, the numerous origins for shocks in the market and its ever-increasing price demand makes oil an unstable market. Finally, the energy price index is understood from this analysis as most of the events previously characterised have an impact on the price variation (below) too. It can be seen in figure 1.3 that the evolution of the energy index moves closely with oil prices, its relationship is indeed highly correlated (0.94).

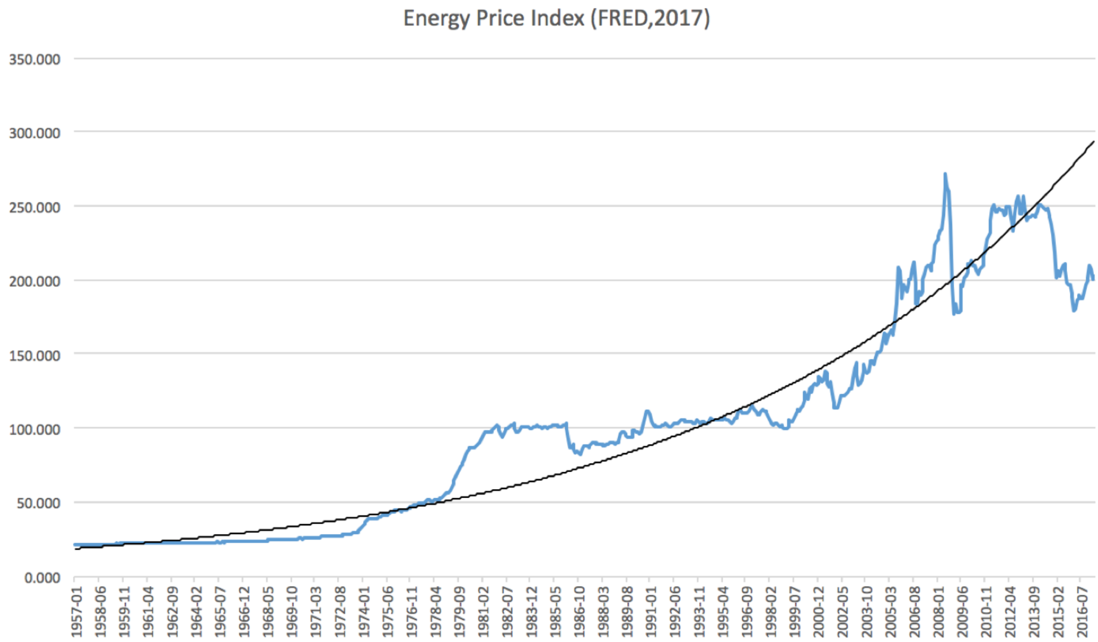


Figure 1.3: The Evolution of the Energy Price Index (FRED, 2017)

2.Data & Methodology

2.1 Data

The dataset collected and presented in this paper takes the form of a time series. A time series is a sequence of equally spread points in time, showing the evolution of variables such as industrial production or money supply over a specified time span. This type of data can be used in various ways, from observing simple trends over time to finding correlation and causality between selected variables. The whole dataset used follows the same time frame, starting from January 1999 up to December 2016. It is important to note that the data points are collected on a monthly basis, adding up to 217 observations per variable. The main variable of study, the energy price index *'epi'* originates from the database of the U.S. Bureau of Statistics, however retrieved through a secondary source: the Federal Reserve Bank of St. Louis (FRED, 2017). The elements that form this index (among others) are the respective weights of certain energy sources. The two most important ones are oil and gas, which combined, become the main weight in the index. Nonetheless, oil prices (Figure 1.1) have a heavier weight than gas in the energy index (Figure 1.3) because of its higher importance and correlation.

In order to investigate the relationship between growth and energy prices data on industrial production for the countries in the Eurozone was retrieved (ECB, 2017). This data takes the form of an index of industrial production and creating this paper's variable '*ecbindpro'*. The index is called Euro Area Industrial Production. The lowest value is 90.4 for the observation of April 2009 and the highest observation happens exactly 12 months before at 114.8.

The rest of the variables were obtained from the Bloomberg terminal (Bloomberg, 2017). These are; (i) *'ecbbs'* the total assets of the ECB's balance sheet as a measure for monetary policy. The units are accounted in billions of euros. The observations range from 944616 to 6193683, because of the size of the numbers the natural logarithm of this variable was used instead. This new *'lnecbbs'* ranges from 14.57 to 15.64 allowing for a much easier interpretation. (ii) the variable *'oil'* which describes the price of the Western Texas Intermediate oil. This later serves as a control variable for an OLS regression.

Finally, the difference at time (t) and (t+1) is taken for most variables, which is denoted as *'D(variable)'* (i.e. 'D(epi)' is the difference in energy prices between two successive months). The same notation is applied for '*D(lnecbbs)*' or *'D(oil)'*, following the same logic. These *'D(variables)'* are used as a method to correct for non-stationarity with respect to the level variables. More about this correction is explained in the following section.

3.2 Methodology

As mentioned above, the data used in this paper takes the form of a time series, therefore the first vital step of this paper was to ensure stationarity. Non-stationary data implies that lagged values have no predictive power and cannot be used for forecasting. The results of using non-stationary time series can be spurious and show a certain relationship when it does not actually exist. The variables were tested for stationarity at first difference (thus D(variable)) using an Augmented Dickey- Fuller test, as proposed by Dickey & Fuller (1981)*(Appendix, Table 1).* As it can be seen, all the results are significant, rejecting the null hypothesis meaning that every variable is stationary. Hence, ensuring that the data revolves around a constant long term mean (Rao et al., 2010). Moreover, the lag length was chosen following the 'Akaike Information Criterion' as proposed by Akaike (1981). Following this criterion 3 lags were selected for the VAR model. Multicollinearity was also examined, the correlations among all the variables gave pleasant results as all of them were below 0.65, therefore confirming no significant multicollinearity. (*Appendix Table 2*)

In order to understand the link among energy, monetary policy and growth, an OLS regression was performed. This regression takes '*D(epi)'* as the dependent variable (Y) and *'D(lnecbbs)', 'D(ecbindpro)'* as independent variables. Furthermore, the variable *'D(oil)'* was included in order to partly control for omitted variable bias. The independent variables take the values from X1 to X3 in this model. The complete regression is presented in the appendix *Table 3*. The general regression formula is presented below in order to obtain a better representation of the way the model interacts with each variable:

$$Y =+ \alpha(X1) + \beta(X2) + \gamma(X3)$$

Nevertheless, in order to assure that the results from the OLS regression are unbiased, three assumptions must hold. Firstly, the 'zero conditional mean' assumption, to prevent omitted variable bias (OVB). This assumption states that the mean of the error term is zero and that the independent variable is uncorrelated with the error term. Secondly, the data has to be representative of the analysed population, implying that the independent and the dependent variables have to be independently and identically distributed. Thirdly, large outliers should not form part of the sample because an OLS regression would be sensitive to them. The second and third hypothesis were tested; the dataset compiled is considerably large and randomly sampled. Large outliers and skewness were checked for, in order to ensure the quality of the data.

In order to further understand the link among energy prices, monetary policy and growth a vector autoregressive model (VAR) was performed. A VAR was chosen as this paper wanted to explain the variables' evolutions based on past values. Therefore, a solid interpretation was obtained on how lagged values of the ECB's money supply and the Eurozone growth affect the present value of the energy price index (*Appendix Table 4*). The lag selection for the VAR *(Appendix Table 5)* was decided upon the information criterion developed by Akaike (1981). The selected time lag (3) is represented between brackets.

To assure the validity of the vector autoregressive model this paper checked for cointegration. This would explain a long-run-equilibrium relationship among the variables. If such long run exists, the results of the VAR would not have been correctly interpreted. One of the main reasons why cointegration is suspected is that the VAR variables are non-stationary at level and stationary at its first difference. Therefore, the *'Johansen test of* *cointegration'* was performed *(Appendix Table 6)*. This indicates no cointegration at the 0.05 level for the trace and rank test. Nonetheless, when regressing the dependant variable *'epi'* on *'lnecbbs'* and *'ecbindpro'* (*Table 7)* the coefficients are significant at a 5% level. Therefore, there still could be a long –run relationship among the variables that the previously performed test of cointegration was not able to show. Hence, in order to assure no cointegration, the Engle-Granger two-step method was performed following Engle & Granger (1991). A new variable *'longruneq'* was created, taking the values of the residuals from the OLS of *Table 7.* Following Engle & Granger (1991) these residuals have to be tested for stationarity. If there is cointegration the residuals should be stationary, on the contrary if the residuals show no-stationarity it can be assumed that there exists no cointegration. *Table 8* represents the Augmented Dickey-Fuller test, showing a t-statistic of '-1.74'. Nonetheless, in order to correctly interpret the result, the t-statistic should not be compared to MacKinnon (1996) p-values. Instead it should be compared to the adequate values of Davidson & Mackinnon (1994). The value taken is, m=3 (variables) at 5% level is -3.74. Since the Augmented Dickey-Fuller returned a higher value (-1.74), it fails to reject the hypothesis that *'longruneq'* has a unit-root. Therefore, the two-step Engle-Granger test shows along with the Johansen test no signs of cointegration. Therefore, no cointegration is assumed for the remaining of this paper's research.

In order to further analyse the link between the variables of interest causality was revised. Therefore, a Granger causality test was performed *(Appendix Table 9)* as proposed by Granger (1969). In addition, a series of impulse response functions were created in order to grasp a better understanding of how energy prices respond to shocks in demand and money supply *(Appendix Figures 2 & 3).*The shocks where 'user specified' meaning that the impulse units are not standard deviations for instance but specified shocks. The criteria under which the selected shocks were chosen is discussed in a later part of this paper.

Finally, a significance level of 5% is be used to test the validity of the parameters, meaning that there is a 5% chance of committing a Type I error. The aforementioned error is the probability of rejecting the null hypothesis when it is actually true. Using a smaller significance level leads to a lower probability that the null hypothesis is falsely rejected and it allows a more stringent interpretation.

3. Literature review

There exists abundant literature regarding energy prices, although authors mostly prefer to study the different markets individually. Their analysis is centred on oil and gas because of the major role they play in the energy market. Most of these studies have been performed in the last decades due to the increasing volatility of energy commodities. They pay special attention to forecasting and identifying the exact origin of price shocks. Pindyck (1999) in his article *'The long-run evolution of Energy-Prices'* already remarked the importance of oil, gas and coal prices in the long-run. Following the line of this paper, the author already reasoned the importance of energy prices for strategic planning and its effect on investment decisions. In an effort to forecast future values Pindyck concluded that energy prices shift continuously and unpredictably over time. Furthermore, specifying that each market follows a multivariate stochastic process.

Three years later Brown & Yucel (2002) made a significant contribution to the understanding of this paper's topic. The authors linked fluctuations in energy prices to macroeconomic factors to then offer related monetary policy suggestions. The article discusses a clear link between energy prices (focusing on oil) and GDP. Reasoning that increasing oil prices preceded eight of the night recessions after WWII. Nonetheless, as concluded by the authors the exposure of the US economy to energy price volatility has decreased throughout the past two decades. The authors' great effort to link energy to macroeconomic activity is nonetheless outdated. As it can be observed in Table 1.1, the important price movements have happened right after the article was published. In the same line of thought Amano & Norden (1998) documented the interaction between domestic price of oil and the exchange rates of the US, Japan and Germany. Hence, effectively being able to relate energy prices to another vital macroeconomic variable. Hooker (1996) defies the existence of the aforementioned relationships between oil prices and macroeconomic variables. Through the the use of VAR equations he was able to show that such link does not exist for the period 1973 to the end of the century. This study gave an opposing result when comparing it to his contemporaneous researchers. The author also focuses on the fact that it is rather difficult to prove that macroeconomic variables Granger-causes oil price movements

Hamilton (2008) reviewed the behaviour of crude prices that produced the high price of oil in 2008. Numerous influences were analysed, namely, commodity price speculation, the world's demand, different limitations on production or the role of OPEC in the price setting of energy. All these factors had an influence in this paper's market previous market assessment. Influencing the motives for price variations through the scope of the aforementioned variables. Regnier (2007) extensively studied the origin of the unique volatility of energy prices. In her analysis Regnier pointed that the volume of demand plays a crucial role in oil and gas volatility. In addition, the author theorised that interventions in order to regulate the volatility of the market should influence the quantity of oil consumed instead of trying to target the market volatility.

4. Results

Firstly, this paper made use of an OLS regression to study the 1^{st} difference relationship between oil prices and the macroeconomic variables of study. Thus, taking the variable of study *'D(epi)'* as the dependant variable and the variables *'D(lnecbbs)'* (money supply), *'D(ecbindpro)'* (industrial production) and *'D(oil)'* as the independent variables. The 1^{st} difference for oil was included as a control variable as oil prices suppose the major weight of the dependent variable. This regression aimed at giving a satisfactory link between the direction of the relationship of the variables. The regression *(Appendix Table 3)* yielded interesting results. It shows that when taking a 5% significance *'D(ecbindpro)'* and *'D(oil)l'* can be considered significant for this regression.

The first variable *'D(lnecbbs)'* returned a t-statistic of 0.72, therefore it could not be considered significant. The second variable *'D(ecbindpro)'* returned a significant coefficient of 0.90. Meaning that an increase in the monthly difference of the Eurozone industrial production by one point increases the difference in the energy price index by 0.90. The variable *'D(oil)'* was included as a control variable. The significance of its coefficient comes as no surprise as oil prices are a component of the dependent variable. An increase in the price of oil, as one would expect, leads to an increase in the energy price index by almost 0.70 points. This first regression has given a general impression of the direction of changes in the independent variables with respect to the dependent variable. All the independent variables which are significant have a positive relationship with the dependent one.

Nonetheless, this paper aims at offering an economic interpretation of these relationships. This was done through the following vector autoregressive model *(Table 4)*. This model takes into account up to three time lags (months) following the Akaike information criteria *(Table 5)*. Only the variable *'D(epi)'* was considered as dependent variable as the effects that the variables have on *'D(lnecbbs)'* and *'D(ecbindpro)'* is out of the scope of this paper.

From the VAR model it can be observed that past values (up to two months) of the variable *'D(epi)'* have enough statistical significance to explain its present values. The relationship is positive for the first lag and negative for the second one as their coefficients are 0.46 and -0.30 respectively. This difference in direction from period to period is rather ambiguous. Nonetheless, this paper does not entertain this thought, as its main interest is the other two variables. The variable *'D(lnecbbs)'* has enough statistical explanatory power to explain the effect on the price index on one lag. Its coefficient is -24.11 meaning that an increase in money supply from the ECB leads to a decrease in oil prices, which contrasts, with the OLS regression above. In order to economically interpret the result, the oil market is used as an example. An increase in money supply from the ECB is accompanied by a decrease in interest rates. This leads to an outflow of money from Europe as the interest rates are not as high as before. The outflow of capital consequently leads to a depreciation of the Euro. It is vital to remark that most of the energies forming the energy price index (including oil) are internationally purchased in dollars. Therefore, European consumers see their purchasing power decrease against the dollar. Since prices of energies suddenly became more expensive for the Eurozone, its demand consequently decreases, driving down oil prices.

Finally, the variable *'D(ecbindpro)'* is significant at two time lags *'D(ecbindpro(-2))'* with a coefficient of 0.76. The lack of significance for one period lag could be justified if compared to the previous case of money supply. A change in money supply could have a direct impact in the economy, much quicker than a change in industrial production on prices. For the former, agents see a direct influx of money when its supply is increased, therefore being able to influence energy prices immediately. Whereas for the latter, this change affects the same agents through changes in wages which can take longer time to be economically noticeable. Furthermore, the economical interpretation of this coefficient is related to growth. An increase in industrial production (ceteris paribus) means a general growth for the Eurozone. If nations and industries grow the demand for energies from Europe is prone to increase. This increase in demand drives up energy prices.

Moreover, this paper aims to prove causation from the independent variables to the energy price index. The results of the Granger causality tests are presented in *Table 9.* The first hypothesis is *'D(lnecbbs) does not Granger Cause D(epi)'.* At a 5% significance level one can reject that first hypothesis inferring that changes in money supply from the ECB Granger cause changes in the general price level of energies. On the other hand, the hypothesis *'D(ecbindpro) does not Granger Cause D(epi)'* cannot be rejected, therefore one cannot imply Granger causality here. The other two hypothesis cannot be rejected either. Namely, changes in energy prices do not Granger cause changes in money supply nor industrial production.

In order to further examine the data, two impulse response functions were generated. The first one *Appendix Figure 2* represents how a shock on the variable '*D(ecbindpro)'* affects *'D(epi)'.* The shock selected was a negative shock of -4.2. This specific shock was selected, as it was the biggest decrease in industrial production of the whole sample. This shock took place from the observation 2008 October to November 2008, which coincides with the 2008 credit crisis already described in the *'Market analysis'* section. By using the units of a real shock, this paper aims at representing a more lifelike scenario. The -4.2 unit shock significantly affects the variable 'D(epi)' at the third month after the shock only. This shock affects *'D(epi)'* by decreasing it by -4 points at t=3. Therefore, a decrease in the level of industrial production of the size of the 2008 crisis has a negative impact on the energy price index after 3 months.The case of a shock of the variable 'D(lnecbbs)' on 'D(epi)' is represented in Figure 3. The shock is on the first variable, specifically the one that happened from May to June 1999, an increase in the ECB's total asset balance sheet by 432813 billion which represents a change in *'ln(ecbbs)'* by 0.35. In this case, an increase in money supply also decreases the energy price index in line with the VAR predictions. The impact on the energy price index is significant for the second third and sixth period, where the impact is -6, -3 and -2 points respectively. Nonetheless, none of these shocks can be compared to the real data to check the validity of the results. This is because this virtual shock considers every other variable being equal; however, this is never the case in Macroeconomic data as all the variables are interrelated. Therefore, even if the same pattern could be seen, one could not infer any deductions, especially for the turmoil period of the economic crisis

5. Conclusion

The results presented in this paper provide clear evidence about the volatility of the energy market and furthermore about the strength of the relationship between energy prices, monetary policy and a nations' growth. Firstly, through a market analysis the evolution of the price of energies was reviewed. Discovering that through the last decades prices have tended to move in more dramatic swings. One of the reasons for this volatility is in part the high susceptibility of the oil market to numerous agents. These can potentially have a strong impact on energy prices. Namely, private organisations such as the OPEC influencing the supply of crude or nations such as Thailand in the Asian crisis. The significant price variations over the course of six decades, the numerous origins for shocks in the market and its ever-increasing price demand makes energy an unstable market.

Furthermore, through the use of empirical research this paper aimed at giving an insight about the role that monetary policy and growth have on oil prices. Firstly, the relationship between changes in energy prices and past changes of money supply was found negative. The economic intuition behind it is that an increase in money supply from the ECB is accompanied by the depreciation of the home currency. This makes energy commodities (most of them quoted in dollars) less affordable for European consumers. Thereby reducing their demand and consequently its price. Secondly, the relationship between changes in energy prices and past changes in industrial production showed positive. A higher industrial production from the Eurozone increases demand for energies therefore driving up prices. Moreover, through the use of a Granger causality test, this paper could affirm that changes in money supply Granger cause changes in energy prices. The same causality could not be proven for industrial production.

Finally, using an impulse response function this paper assessed the impact of two different shocks on energy prices. The first one, a dramatic drop in industrial production of -4.2 points (a life-like scenario of the 2008 credit crisis) affects changes in energy prices negatively. This shock impacts the energy price index at the third period decreasing changes in energy prices by -4 points. For the shock in money supply, an increase of 432813 billion euros (as what happened on June 1999) impacts energy prices negatively. The impact on the energy price index is significant for the second third and sixth period, where the effect on the energy index is -6, -3 and -2 points respectively.

Although this research was carefully prepared, this paper still counts with some limitations and shortcomings. First of all, the OLS regression could have given more accurate results if more control variables were included. In addition, a longer time frame could have also been retrieved in order to obtain more reliable regressions. The study of the effect of different economical agents (other than the Eurozone) would have also given this paper a more rounded assessment of the energy market. Analysing the supply of oil from an exporting country such as Saudi Arabia or Russia and its interaction with prices would have given a more complete interpretation of the energy market. Finally, there exists contradictory results of the Engle-Granger and Johansen test pointing to no cointegration and the *Table 7* inferring a level relationship. The variables show to have a unit-root at level and stationarity at the first difference and significant values of the OLS regression, altogether pointing to a possible cointegration. This could have been caused because of the mix between real and nominal variables throughout this paper's research. This paper took the results of the Engle-Granger and Johansen test as a reference for research, concluding no cointegration among the variables. Nonetheless, it could be assumed that the variables presented cointegration and therefore use a VECM model to give a different estimation. Because of the aforementioned limitations future research could be performed on the topic of energy prices.

Appendix

Table 1. Augmented dickey fuller test (unit-root)

Null Hypothesis: Variable has a unit root			
		T-statistic	**Probability**
Augmented DF test statistic			
Critical values	1% level	-3.461178	
	5% level	-2.874997	
	10% level	-2.574019	
Variable			
D(lnecbbs)		-7.602179	0.0000
D(epi)		-9.989395	0.0000
D(ecbindpro)		-4.854118	0.0001
D(oil)		-9.622487	0.0000
D(gas)		-14.91544	0.0000

Table 2. Correlation

	D(epi)	**D(lnecbbs)**	**D(ecbindpro)**	**D(oil)**
D(epi)	1.00	-0.07	0.25	0.62
D(lnecbbs)	-0.07	1.00	-0.02	-0.15
D(ecbindpro)	0.25	-0.02	1.00	0.18
D(oil)	0.62	-0.15	0.18	1.00

Table 3. OLS regression

Dependent variable D(EPI) Method: Least Squares Sample adjusted 1999M02 2016M12				
Variable	Coefficient	Std.Error	t-Statistic	Probability
D(lnecbbs)	5.120095	7.209718	0.720918	0.4784
D(ecbindpro)	0.904606	0.323039	2.800295	0.0052
D(oil)	0.699112	0.063441	11.01985	0.0000
Adjusted R-squared: 0.404				

Table 4. VAR

Vector Autoregression estimates Included observations 212 after adjustments Standard erros in() & t-statistics in [ ]			
	D(epi)	**D(lnecbbs)**	**D(ecbindpro)**
D(epi(-1))	**0.465868** **(0.07180)** **[6.48831]**	-0.000844 (0.00057) [-1.47340]	0.019512 (0.01209) [1.61406]
D(epi(-2))	**-0.300526** **(0.07618)** **[-3.94500]**	0.000433 (0.00061) [0.71172]	0.003860 (0.01283) [0.30093]
D(epi(-3))	0.022216 (0.07216) [0.30787]	0.000620 (0.00058) [1.07623]	0.011164 (0.01215) [0.91886]
D(lnecbbs(-1))	**-24.11212** **(8.56069)** **[-2.81661]**	0.009625 (0.06832) [0.14089]	-2.228418 (1.44135) [-1.54607]
D(lnecbbs(-2))	-4.197551 (8.56069) [-0.49222]	-0.183478 (0.06805) [-2.69603]	-3.234464 (1.43581) [-2.25270]
D(lnecbbs(-3))	-2.421635 (8.69150) [-0.27862]	0.215686 (0.06936) [3.10961]	-2.772651 (1.46337) [-1.89470]
D(ecbindpro(-1))	0.371179 (0.39741) [0.93401]	0.001316 (0.00317) [0.41503]	-0.158539 (0.06691) [-2.36942]
D(ecbindpro(-2))	**0.765575** **(0.38618)** **[1.98241]**	-0.001724 (0.00308) [-0.55939]	0.181623 (0.065202) [2.79330]
D(ecbindpro(-3))	0.414255 (0.38859) [1.06605]	-0.000414 (0.00310) [-0.13340]	0.332291 (0.06543) [5.07890]
C	0.513191 (0.41138) [1.24748]	0.007556 (0.00328) [2.30160]	0.087026 (0.06926) [1.25645]
Adjusted R-squared	0.244861	0.101585	0.2337793

Table 5. Lag length criteria (Akaike information criterion)

Lag	Akaike IC
0	5.674
1	5.493
2	5.405
3	5.208*
4	5.257
5	5.305
6	5.271
7	5.309
8	5.340
*indicates lag order selected by the criterion	

Table 6. Johansen test of cointegration

6.1 Unrestricted Cointegration Rank Test (Trace)

Trend assumption; Linear deterministic trend
Series; epi ecbbs ecbindpro
Lags interval: 1 to 3

Hypothesized o. of CE(s)	**Eigenvalue**	**Trace statistic**	**0.05 Critical Value**	**Prob.****
None	0.068339	18.65420	29.7909	0.5180
At most 1	0.016244	3.647532	15.49471	0.9299
At most 2	0.000828	0.175600	3.841466	0.6752

Trace test indicates no cointegration at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level

6.2 Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Trend assumption; Linear deterministic trend Series; epi ecbbs ecbindpro Lags interval: 1 to 3				
Hypothesized o. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None	0.068339	15.00667	21.13162	0.2884
At most 1	0.016244	3.471933	14.26460	0.9104
At most 2	0.000828	0.175600	3.841466	0.6752
Mat the 0.05 level *denotes rejection of the hypothesis at the 0.05 level				

Table 7. OLS on levels

Dependent variable EPI Method: Least Squares Sample adjusted 1999M02 2016M12				
Variable	Coefficient	Std.Error	t-Statistic	Probability
lnecbbs	57.75872	2.640720	21.87233	0.0000
ecbindpro	3.511215	0.352454	9.962178	0.0000
C	-1012.781	49.93379	-20.28248	0.0000
Adjusted R-squared: 0.746919				

Table 8. ADF-test on longruneq

Null Hypothesis: Variable has a unit root			
		T-statistic	**Probability**
Augmented DF test statistic			
Critical values	1% level	-3.46	
	5% level	-2.87	
	10% level	-2.57	
Variable			
longruneq		-1.743622	0.4079

Table 9. Granger causality test

Pairwise Granger causality tests Lags:3			
Null hypothesis	**Obs**	**chi2**	**Prob.**
D(lnecbbs) does not Granger Cause D(epi) D(epi) does not Granger Cause D(lnecbbs)	212	8.5935 5.4313	0.035 0.143
D(ecbindpro) does not Granger Cause D(epi) D(epi) does not Granger Cause D(ecbindpro)	212	6.0141 4.6922	0.111 0.196

Figure 2. Impulse response function (D(ecbindpro) shock=-4,2 on D(epi))

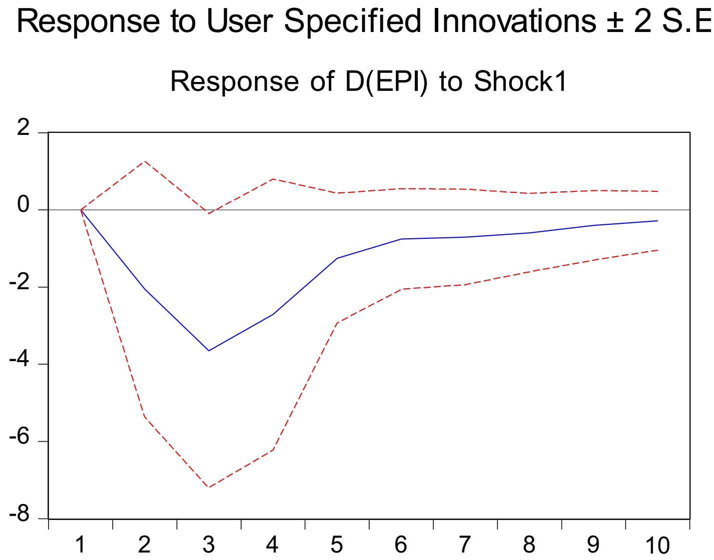
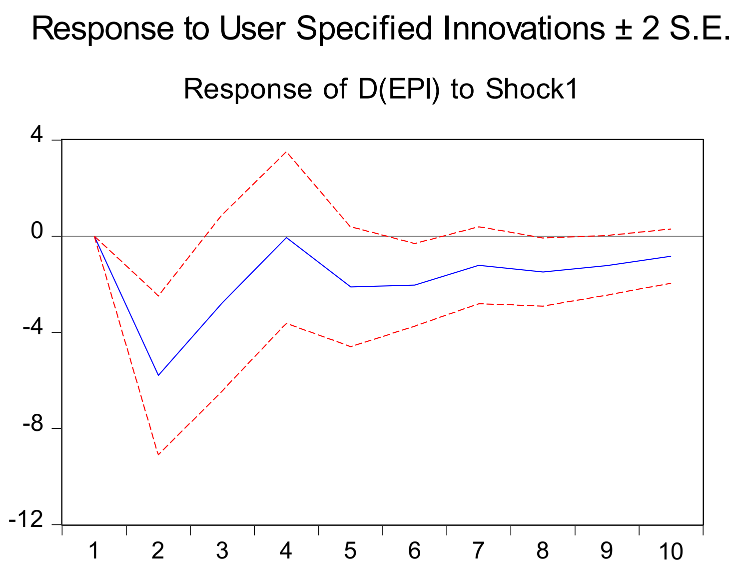


Figure 3. Impulse response function (D(lnecbbs) shock=0.35 on D(epi))



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