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The Impact of Oil Price Shocks on Macroeconomic Activity: *Searching Evidence from Oil Exporting and Importing Countries using Unstructured Vector Autoregressive (VAR) Model*

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Abstract

In the new global economy, oil price shocks have become a central issue for many economists. Very sharp oil price increases cause a slowdown in economic growth. However, it can be argued that, various countries tend to respond to oil price shock differently, especially on whether they are importers or exporters of oil. In this study, an unstructured VAR model is considered to examine the effects of positive oil price shocks on five macroeconomic variables on two oil-importing and two oil-exporting countries. Denmark and Norway are used to represent oil-exporting countries, while Japan and Belgium stand for oil importing countries. The general result found is that oil-exporting countries tend to benefit from positive oil price shocks, with stock market and GDP consistently rising with every shock. However, it was further found that the rise tends to be accompanied by mild inflation and increasing interest rate for the concerned countries. On the other hand, it was found that oil-importing countries are either not affected by oil price shocks or lose out, as GDP and stock market show negative responses to oil price shock for the concerned countries. These Results from the VAR estimate were statistically significant.

Keywords: Oil price, VAR, Oil-Import, Oil export, Macroeconomic activity, Cholesky decomposition.
JEL Classification: Q43.

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Ethical: This study follows all ethical practices during writing.

Contents

Contribution of this paper to the literature
This study contributes to existing literature by examining the effects of positive oil price shocks on five macroeconomic variables on two oil-importing and two oil-exporting countries.

1. Introduction

Oil prices have become an area of interest among many economists, politicians, policy makers, researchers and professionals in the last couple of decades for reasons such as growth of dependence on imported oil in the 1970's, "unprecedented disruptions in the global oil market and poor macroeconomic performance in the US" (Barsky & Kilian, 2004) with the latter being of significance as activities in the US affects the economies in all the countries across the world. A large body of research (Bohi, 1989; Hamilton, 1983; Mork., Olsen, & Mysen, 1994; Raymond & Rich, 1997; Rotemberg & Woodford, 1996) state that oil price fluctuations dramatically impact the economy, as it gives rise to uncertainty about future prices. In view of this, uncertainty in oil prices could be a factor that contributed to the recessions in 1980 and 1982 (Pindyck, 1980). As noted by Guo and Kliesen (2005) uncertainty can also cause delay in investments and involve costly reallocation. Ferderer (1996) also argues that such uncertainty affected output negatively over the period of 1970-1990. As a result, a great deal of previous research (Ferderer, 1996; Hamilton, 1983; Kilian, 2014) and Hamilton.. (2003) among others) have developed a view that supported changes in oil prices affect the development of the economy of countries across the globe. Therefore, it is not a surprise that increasing oil prices cause concern over possible economic downturns worldwide.

1.1. Statement of the Problem

A conventional explanation says that the increase in oil prices triggers a rise in production costs, which causes a decrease in output and inflation in turn rises (Bachmeier, Li, & Liu, 2008). Some of the other popular explanations describe the real balance effect and a transfer of money from oil-importing to oil-exporting countries (Cologni & Manera, 2005). However, it is important to note that no consensus "on the transmission channels of an oil price increase to the economic system" (Lescaroux & Mignon, 2008) has yet been achieved (Brown & Yücel, 2002; Jones & Leiby, 1996; Jones, Leiby, & Paik, 2004). Few recent studies have concentrated on the effects, oil prices tend to have on the macro economy (Blanchard & Gali, 2007; Blanchard & Galí, 2010; Naccache, 2009) and the dissimilarity between oil-importing and oil-exporting countries (Berument, Ceylan, & Dogan, 2010; Filis & Chatziantoniou, 2013; Sturm, Gurtner, & Gonzalez, 2009) therefore, the objectives set for this research are: to investigate the effect of oil price shock on macroeconomic variables and to assess how macroeconomic variables in oil importing and exporting countries respond to oil price shocks. Thus, the questions which this research will be pursing are as follows

1.2. Research Questions

1. How do macro-economic variables respond to a positive shock in oil price?
2. Are there differences and/or similarities between oil importing and exporting countries to the response of macro-economic variables to oil price shocks?

In order to contribute to existing research on this topic, the unstructured VAR model firstly introduced by Sims (1980) is presented in this paper which investigates the relationship between oil price shocks and four macroeconomic variables: gross domestic product (GDP), inflation (CPI), interest rates (monetary policy) and stock markets. The research is focused on two oil-importing and oil-exporting countries: Japan, Belgium; Denmark and Norway respectively.

2. Literature Review

This section reviews existing studies on this topic, to draw out knowledge on behavior of variables of interest in different contexts, which will form the bases of this present research

2.1. Oil Price Shocks and GDP

A large and growing body of literature investigates the negative relationship between oil prices and the growth of GDP (Carruth, Hooker, & Oswald, 1998; Hamilton, 1983; Rotemberg & Woodford, 1996). As noted by Hamilton (2003) 10 out 11 recessions which occurred in the US were preceded by an oil price increase. Bachmeier et al. (2008) uses the standard out-of-sample (OSS) tests to forecast oil price effects on the economy. The in-sample (IS) approach is used by Lee and Ni (2002) to conclude that there is a substantial negative correlation between oil price changes and the varied macroeconomic variables. Hamilton (2003) also adopts the in-sample approach and argues that an increase in oil prices can be used in predicting a decrease of output in the near future. Narayan, Sharma, Poon, and Westerlund (2014) incorporates a combination of both the IS and OSS approaches on 28 developed and 17 developing countries to affirm whether oil prices foretell economic growth. The authors come to a conclusion that the confirmation of predictability is found for 33 countries according to both the IS and OSS methods. While it has been commonly considered that OSS tests are more accurate than IS tests due to it being less responsive to data-mining (Foster, Smith, & Whaley, 1997) but in terms of reliability, both tests are recommended, and both also lack "size distortions of unknown degree when statistical critical values are used" (Inoue & Kilian, 2002). Moreover, Rapach and Wohar (2005) find that there is no significant distinction between IS and OSS. By contrast, Clark and McCracken (2006) further argue that OSS might not even be as powerful as IS tests, as their relative advantage declines when the horizon of forecast increases. Different scholars have come up with various methods and results, sometimes the results are directly and sharply different. Some three approaches are used to clarify the impact of oil price shocks on GDP: the aggregate production function, multiple equation macroeconomic model simulation approaches, and the real business cycle approach. Rasche and Tatom (1981); Ram and Ramsey (1989) adopts the Production function approach, using linear relationship estimation. McMillin and Smyth (1994) also adopts the Production Function Approach using the Asymmetric estimation. Bruno and Sachs (1982); Hickman, Huntington, and Sweeney (1987); Darby (1982) adopts multiple equations, macroeconomic and Simulations models. While Hamilton (1983); Burbidge and Harrison (1984) etc. adopts the Real Business Cycle (RBC) approach but used linear relationship estimation. Mork (1989); Mory (1993); Mork et al. (1994); Ferderer (1996); Sadorsky (1999); Brown and Yücel (2002); Lardic and Mignon (2008); Cologni. and Manera (2009) adopts the RBC approach with asymmetric estimation which indicates that oil prices "affect countries differently depending on their stage of development" (Narayan et al., 2014) and only an increase in oil prices will affect the economy in a negative way, while a decrease in oil price fails to generate economic growth (Cologni & Manera, 2005). However, it is mainly argued that the relationship between oil prices and the various macroeconomic variables is more complicated. A number of research analyze the impact of oil prices on the GDP growth in terms of the nonlinear relationship, in accordance to that of Davis and Haltiwanger (2001); Herrera and Pesavento (2009); Rahman and Serletis (2011); Serletis and Istiak (2013). However, a recent study conducted by Kilian. (2014) reprimands the conventional method of attributing oil price shocks to the subsequent recessions only because the real GDP reacts to the shocks. According to Kilian (2014) the impulse functions are not enough to complete this. The author further argues that oil shocks is a contributing factor to the variations in US growth only partly (Koop, Pesaran, & Potter, 1996).

2.2. Oil Price Shocks and Inflation

An increase in oil prices proposed by many policy makers and economist causes a concern as to whether these increases contribute to inflationary pressures or not. However, it is largely attested to that prices of oil at least partially contributes to inflation changes Chen (2010). For example, Hamilton (1983) argues that positive oil price shocks are responsible for a higher inflation. Also, Barsky and Kilian (2004) identifies that oil price increases led to "periods of excessive inflation". In addition, a large number of research (Barsky & Kilian, 2004; Hickman et al., 1987; Pierce, Enzler, Fand, & Gordon, 1974) is carried out on the effect oil price increases has on inflation in oil-importing countries which also states that oil price shocks lead to inflationary pressures. This view is also supported by Doroodian and Boyd (2003) as they write that the Fed in the United States concluded oil price rises are inflationary after using the conventional economic theory. According to LeBlanc and Chinn (2004) oil price increase causes firms to raise their cost of production and their products tend to be more expensive. They further state that that, when non-energy prices are held constant, inflation rises and "for a given level of aggregate demand", the economy heads toward a recession. Conversely, a different view has developed on how the changes in the oil price goes through into inflation. For instance, Hooker (2002) uses a Phillips curve to conclude that oil price increases have just had an intangible impact on inflation since 1980. LeBlanc and Chinn (2004) use a similar approach to find out that recent increases in oil prices are not likely to have a significant impact in Japan, Europe and the United States. Gregorio, Landerretche, Neilson, Broda, and Rigobon (2007) use a Phillips curve and VAR for 34 countries, both developing and developed ones. The authors argue that there has been a substantial decline on the effect oil price has on inflation. Chen (2010) estimates time varying oil price pass through for 19 industrialized countries and finds argument of a decline for virtually all the countries taken into consideration.

2.3. Oil Price Shocks and Interest Rate

On how oil price shocks affect interest rates, Bernanke, Gertler, Watson, Sims, and Friedman (1997) use a seven-variable VAR system and by this application leads to a notion that majority of the impact of an oil price shock on the real economy can be associated to the central bank's reaction to the inflationary pressures triggered by the shock. Therefore, one can argue that the larger part of the effects of oil price shocks would not be present initially, if it wasn't for monetary policy adjustments. Bernanke et al. (1997) emphasizes that it is rather the response to inflation that causes declines in output and not a response to oil price shocks. In addition, Herrera and Pesavento (2009) investigate the economy during the pre-Volcker period and affirm that it is the systematic response of the monetary policy that attributed to an apparent volatility that other macroeconomic variables including GDP in response to oil shocks. According to the authors, if there was no monetary policy response for at least one year to a 10% increase in oil price, the inflation would still be staying at a much lower level than in the 1970s. Consequently, according to Herrera and Pesavento (2009) the cut down role of monetary policy during the Volcker-Greenspan years results in toning down oil shocks, as suggested by the impulse response functions and variance decomposition.

Furthermore, Filis and Chatziantoniou (2014) use a structural VAR model on the German economy, the UK and the US to investigate the extent to which monetary policy shocks, as well as fiscal policies have an effect on the stock markets. The authors deduce that it is both the fiscal policy and the monetary policy that affect the stock markets in the aforementioned countries and it is important to interpret the effects of these policies as a group, rather than separate from each other. Also, Kormilitsina (2011) sides with the research of Bernanke et al. (1997) and argues that monetary policy is responsible for the decline of activities in the economy. Kormilitsina (2011) also points out that the optimal policy would include raising the inflation rates and interest rates higher than "what has been seen in the past". Indeed, Bohi (1989) did not discover any relationship between the business cycles of "energy-intensive industries" and higher oil prices, and the author comes to a conclusion that it is the contractionary monetary policy which is carried out by the monetary authorities and higher interest rates, that affect the economic activity in the country. Again, Tatom (1988); Tatom (1993) and Bernanke et al. (1997) argue that it is exactly interest rates that is responsible for the impact oil price shocks has on the economy. Tang, Wu, and Zhang (2010) find that oil price shocks has an effect on interest rates in China. The study aims to examine to what extent and how shocks in crude oil prices impacts the Chinese economy. The paper uses a Structural vector auto-regressive model and data from 1998 -2008. Some more research conducted by Leduc and Sill (2004) who, contrary to Bernanke et al. (1997) make use of a calibrated general equilibrium model which focuses on systematic monetary policy. The authors conclude that monetary policy can be attributed to around 40% of the decline in output after an oil price shock, contrary to findings of Bernanke et al. (1997); Davis and Haltiwanger (2001) as they conduct an empirical research which establishes that oil price shocks accounts for about twice as much variations in employment growth as interest rates does, which implies that monetary policy cannot be singled out as the only factor of economic downturns. More empirical studies have also provided support to the notion that oil price shocks is more important than interest rates in terms of the impact on the economy, which includes that of Hoover and Perez (1994); Ferderer (1996) and Brown and Yücel (2002).

According to Ferderer (1996) the interest rates were only partially responsible to any impact that oil price shocks brought about throughout 1970 to 1990s. Likewise, Hamilton and Herrera (2004) argue that interest rate has a very minimal effect on GDP arising from oil price shock as the shock still reduces GDP even when no changes are made to the interest level. Also, Akram (2009) argues that's oil prices will only have a negative effect on interest rate when prices of commodities are treated as "flexible asset prices" in an efficient market scenario. The paper investigates whether oil price increases leads to a decline in interest rates and the US dollar. He uses the VAR model with quarterly data between the periods of 1990q1 to 2007q4. Gausden (2010) finds that fluctuations in oil prices has no direct effect on short- term interest rates in the U.K. The study examines the relationship between oil prices and macroeconomic performances in the U.K. including GDP, long and short-term interest rates, wages, and inflation rates. The study uses VAR model and data is in quarterly basis. Malhotra and Krishna (2015) examine the time-varying correlations between crude oil prices and two major macroeconomic variables, inflation and interest rates in India. In using a GARCH model, they find that global oil price has no direct effect on interest rate. However, results from Granger causality test indicate that oil prices can affect interest rates at appropriate lag levels. The data they use in this empirical study is monthly data from period April 2004 to September.

Furthermore, the work of authors such as Hamilton and Herrera (2004) is consistent with the argument of little impact of interest rates on GDP. They criticize the work of Bernanke et al. (1997) which found a contrary result to this on the basis that the method of lag selection used on the paper and the Lucas critique may have contributed to these contradicting results. The work of Carlstrom and Fuerst (2006) which uses the standard new Keynesian model also goes to argue against the notion that interest rate makes large contribution to GDP as argued by Bernanke et al. (1997). They assert that the decline in GDP cannot be attributed to interest rate rather; it all depends on oil price shocks.

Frankel (2006) finds an inverse relationship between the real interest rate and oil prices employing the linear bivariate regression models estimated by ordinary least squares (OLS). In addition, he added that this relationship does not seem to hold after the 1980s.

2.4. Oil Price Shocks and Stock Market

The impact of oil price shocks on stock markets is still an ongoing debate among economists as there has not been a consensus on the nature of the relationship between the two. Many studies such as Sadorsky (1999); Jones and Kaul (1996); Wei (2003); Lardic and Mignon (2008) and Basher, Haug, and Sadorsky (2012) argue that increase in oil prices has a negative impact on stock markets. In particular, Sadorsky (1999) finds that positive shocks to oil prices results in a decline in real stock returns. Ciner (2001) states that there is a statistically significant relationship between oil futures and stock market returns. Furthermore, Chen (2009) uses a Markov-switching model to establish that higher oil prices increases the probability of a bullish market shifting to a bearish one, which goes in line with the common view. Also, Cifarelli and Paladino (2010) use a multivariate CCC-GARCH model to establish that oil price fluctuations impact stock prices negatively. In addition, Lee and Chiou (2011) use a univariate regime switching GARCH to establish that fluctuations in oil causes a negative impact on the stock market. The authors emphasize that these effects are not that pronounced when the fluctuations in oil prices are low.

However, studies by Huang, Masulis, and Stoll (1996); Miller and Ratti (2009) and Apergis and Miller (2009) suggest that there is no significant negative relationship between stock market returns and oil price shocks. Particularly, Huang et al. (1996) argue that the use of oil futures would even help diversify stock portfolios, as no correlation is found between them and stock market returns. Thus, it is important to point out that most studies mainly focus on the US data, which means the results presented may not represent the whole picture, as the US is a major importer of oil, while the results for oil-exporting countries could be dramatically different. Thus, Research by Park and Ratti (2008); Jung and Park (2011) and Wang, Wu, and Yang (2013) draw a distinction between oil-importing and oil-exporting countries when estimating the effect on stock market returns caused by oil shocks. Similarly, Cong, Wei, Jiao, and Fan (2008) argue that oil price shocks do not show any obvious effect on Chinese stock returns. The study uses monthly data from 1996:1 to 2007:12 and variables such as consumer price index, short-term interest rates, exchange rate, and industrial production are used to investigate the interactive relationship between oil price shocks and the Chinese stock market. However, they ascribe to the belief that the stock returns of manufacturing index and some oil companies are increased as a result of shocks in oil price. In addition, they maintain that the asymmetric effect of oil price shocks on oil companies' stock returns is not supported by statistical evidence. Nevertheless, authors like Park and Ratti (2008) has come up with empirical evidence that that oil shocks impact stock market returns significantly "in the same month or within one month". Further stating that the impact on oil exporting countries like Norway is positive while negative for importers oil. Although the study of Wang et al. (2013) take that idea further differentiating between supply and demand shocks and argue that oil shocks have different effect on stock market returns in different countries, this present research has a little different objective which centers around the effect of any type of oil price shocks on variables depending on whether a country imports or exports oil.

2.5. Differences in Results Between Oil-importing and Oil-exporting Countries

As research conducted by Hamilton (1983); Hamilton (1996); Hamilton (2005); Hamilton (2009) that oil price shocks have a negative impact on macroeconomic development of countries more research has also been conducted which is in line with this view, like that of Darby (1982); Burbidge and Harrison (1984); Gisser and Goodwin (1986) and Hickman et al. (1987). However, volatility in oil prices are likely to affect oil-importing and oil-exporting countries differently. Thus, Jiménez-Rodríguez and Sánchez (2005) argue that the relationship between oil price shocks and the macro economy in the US and Europe is indeed negative, while oil price shocks impact Norway, which is an oil exporting country, in a positive way and has no effect on the economy of Japan, an oil-importing country. Also, Jimenez-Rodriguez (2013) uses a multivariate VAR analysis to prove nonlinear effect of oil price on real GDP distinguishing between oil-importing and oil-exporting countries. The research concludes that there is a negative impact on GDP of oil-importing countries in response to a rise in oil price, with the exception of Japan. Moshiri (2015) also argues that positive and negative oil price shocks generate asymmetric and independent effects on GDP growth in oil-exporting countries. The study used VAR and a sample of both developing and developed countries with different economic structure and institutional qualities to investigate the oil price shock impact on economic growth in oil-exporting countries for nine major oil-exporting countries for the period 1970–2010. In the study, the results also confirmed that the effect of oil price shocks on economic growth is conditioned by institutional quality. Adding that, while oil shocks do not affect economic growth of oil-exporting countries with good institutional framework they in fact do have adverse effects on economic performance of oil-exporting countries with poor institutional framework but sometimes, not statistically significant. Moreover, the case of oil exporting countries seems like a clear cut when it comes to the response of GDP to oil price shocks. For instance, Jimenez-Rodriguez (2013) report that the GDP of Norway responds positively to oil price shocks however, the paper also found negative response from the GDP of UK which is a little odd. Perhaps this could be because to some extent, UK still imports crude oil products and thus, not a major importer of oil. According to Mason (2013) UK got 43 per cent of its fossil fuels from abroad last year, as domestic reserves from the North Sea are dwindling. This means that the result for UK is fact not a surprise.

Nevertheless, the work of Bjørnland (2009) focuses on importers of oil in the analysis of oil price shocks of economic activities. The papers reviews that there are actually two way through which positive oil price shocks affects oil exporting countries which are, a negative and a positive channel. The paper noted that a positive chanell is by investing back into the local economy, the revenue which is generated through oil exports while the negative channel has to do with a cut down in both international demand for goods and services and in oil itself. This is because, as oil prices increases, local currency appreciates and goods and services become expensive in the international market and thus uncompetitive (Korhonen & Ledyaeva, 2010). Thus, Bjørnland (2009) argue that the reason why Norway Benefits from oil price increase while UK loses out could be found in differences in the exchange rates of the both countries. Stating that the exchange appreciation in Norway during oil price increase cannot match up with that of the UK.

In addition, the work of Korhonen and Ledyaeva (2010) which studies the direct and indirect effects of positive oil price shocks on the economy of importers and exporters of oil using VAR models points out that consistent with Bjørnland (2009) oil exporters benefit from oil price increase as the papers reviews a significant positive effect on the GDP of Russia which is a net-exporter of oil although the direct effect still is in the lower demand associated with the increase. Sturm et al. (2009) is of the view that the increase in GDP of oil exports in response to a positive shock in oil price places so much pressure on inflation and in response to this, expansionary monetary policies have been used by countries to try to reduce the effect. Finally, other authors such as Berument et al. (2010) and Mohaddes and Raissi (2013) also support the view that oil exporting countries benefit from positive oil price shocks while oil importers loose out.

3. Methodology and Data

3.1. Introduction

This paper attempts to compare and contrast the relationships between macroeconomic variables and oil prices in oil-importing and oil-exporting countries using a Vector Autoregressive approach (VAR), which was initially introduced by Sims (1980). In this analysis two oil-importing countries represented by Japan and Belgium, and two oil-exporting country represented by Norway and Denmark. The variables used for each country in the VAR model are, Brent crude oil (oil prices), Consumer Price Index (inflation), 3 month or short-term interbank interest rates (interest rates) and Stock market prices (index). Bernanke and Blinder (1992); Bernanke. and Mihov (1995); Friedman and Kuttner (1992) and Bernanke et al. (1997) argue that it is acceptable to treat the interbank interest rate as an indicator of monetary policy. The exchange rates for Norwegian Krone/USD, Danish krone/USD, Japanese yen/USD and Euro/USD are also used to convert oil prices from USD into a corresponding local currency. The data for all countries are obtained from DataStream. The data is quarterly, with a sample period of 1995:Q1 - 2015:Q4. The data for each variable is initially collected as current prices- seasonally adjusted and then converted into constant values by choosing 2005 as a base year for the CPI index. Interest rate and the stock market prices is also adjusted for inflation by subtracting the consumer price index from each of them. However, it is important to ensure stationary and normal distribution of the data before it is used in the model. Stationarity of data is key here as it produces constant variance and a long-term constant mean, while non-stationary data will likely generate results which are inaccurate. In particular, Villar and Joutz (2006) argue that the VAR model requires the data to be stationary, due to the spurious results that non-stationary data produces. Normality implies a mean value of 0, a standard deviation of 1 and a symmetric bell-shaped distribution. Thus, the model is bound to produce inaccurate results if the data is not normally distributed. The analyses of skewness, kurtosis, the Jarque-Bera Statistic, the plot statistic, as well as the Augmented Dickey-Fuller (ADF) Statistic provide visual and numerical interpretation in terms of the normal distribution and stationarity of the data.

3.2. Distribution of Data

The graphs in Figure 1, 3, 5 and 7 below show the evolution of data for the countries of interest while Figures 2, 4, 6, 8 which follow that show the histogram and corresponding descriptive statistics. From the graphs showing evolution of series, a glance shows that all the variables have undergone periods of peaks and troughs. However, a common observation is that interest rate has shown a considerable fall for all the countries of interest. For Belgium, while other variables seem to be rising from 1995q1 through to 2015q4, stock market and interest rate have taken an opposite direction. That is, showing a considerable fall. Histogram and descriptive statistics for all the variables show that all the variables are far from being normally distributed. This is because; the mean values are different from zero. In addition, skewness and kurtosis are also different from zero and 3 respectively. Again, a visual inspection of histograms also shows that all the variables are far from having a bell-shape which signals normality. Nevertheless, some authors Sims (1980); Granger and Newbold (1974) believe that data can be brought closer to normally by differencing them.

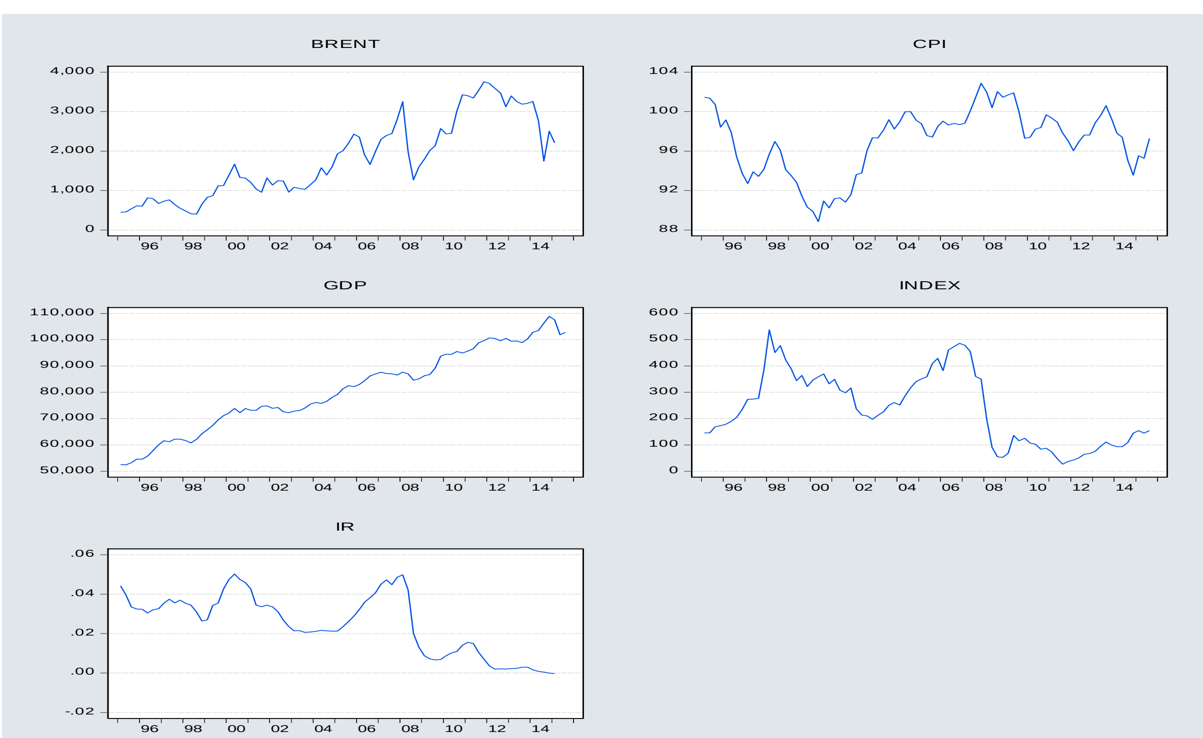


Figure-1. Evolution of Series for Belgium.

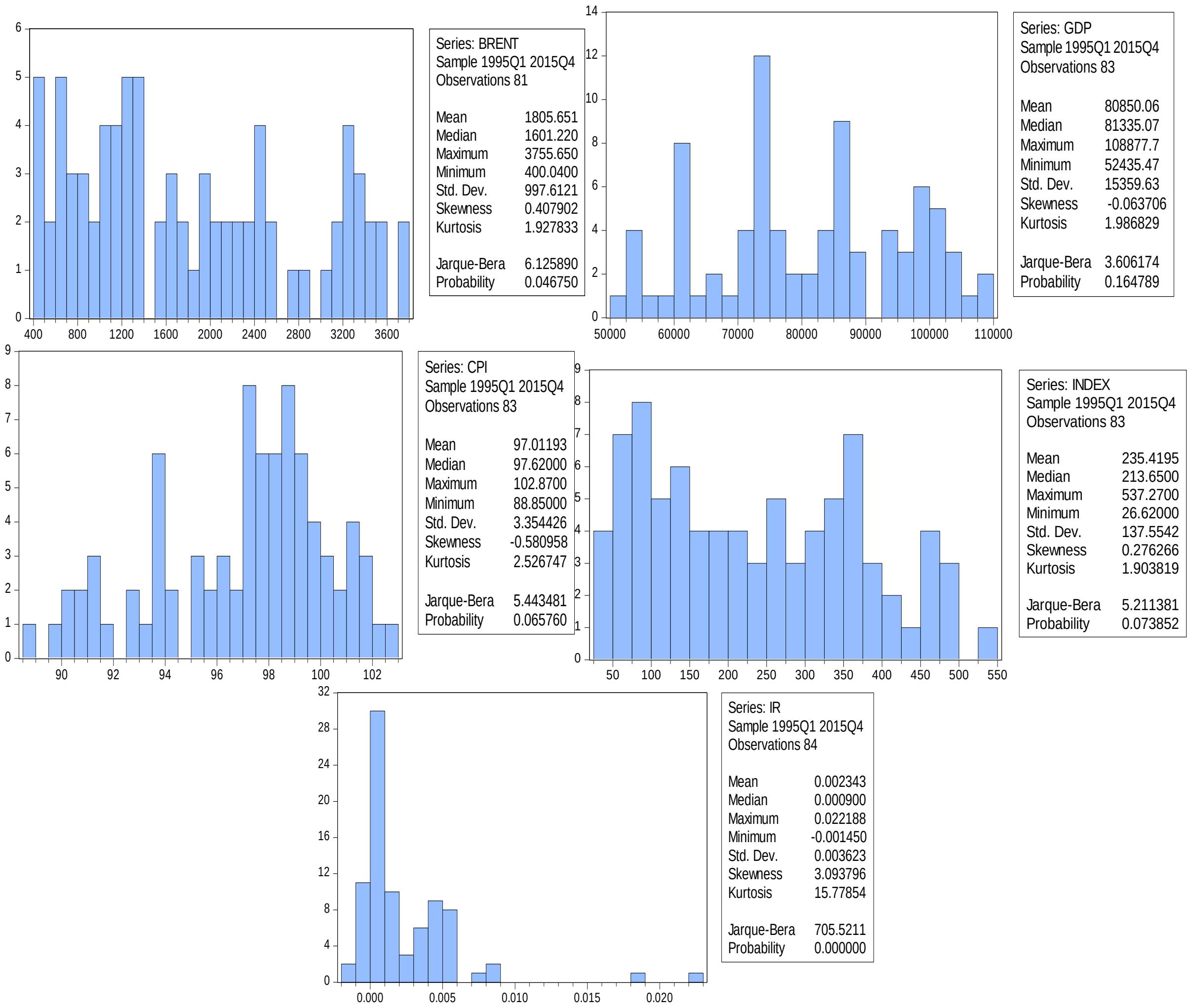


Figure-2. Histogram and Basic Descriptive Statistics for Belgium.

Figure-3. Evolution of Series for Japan.

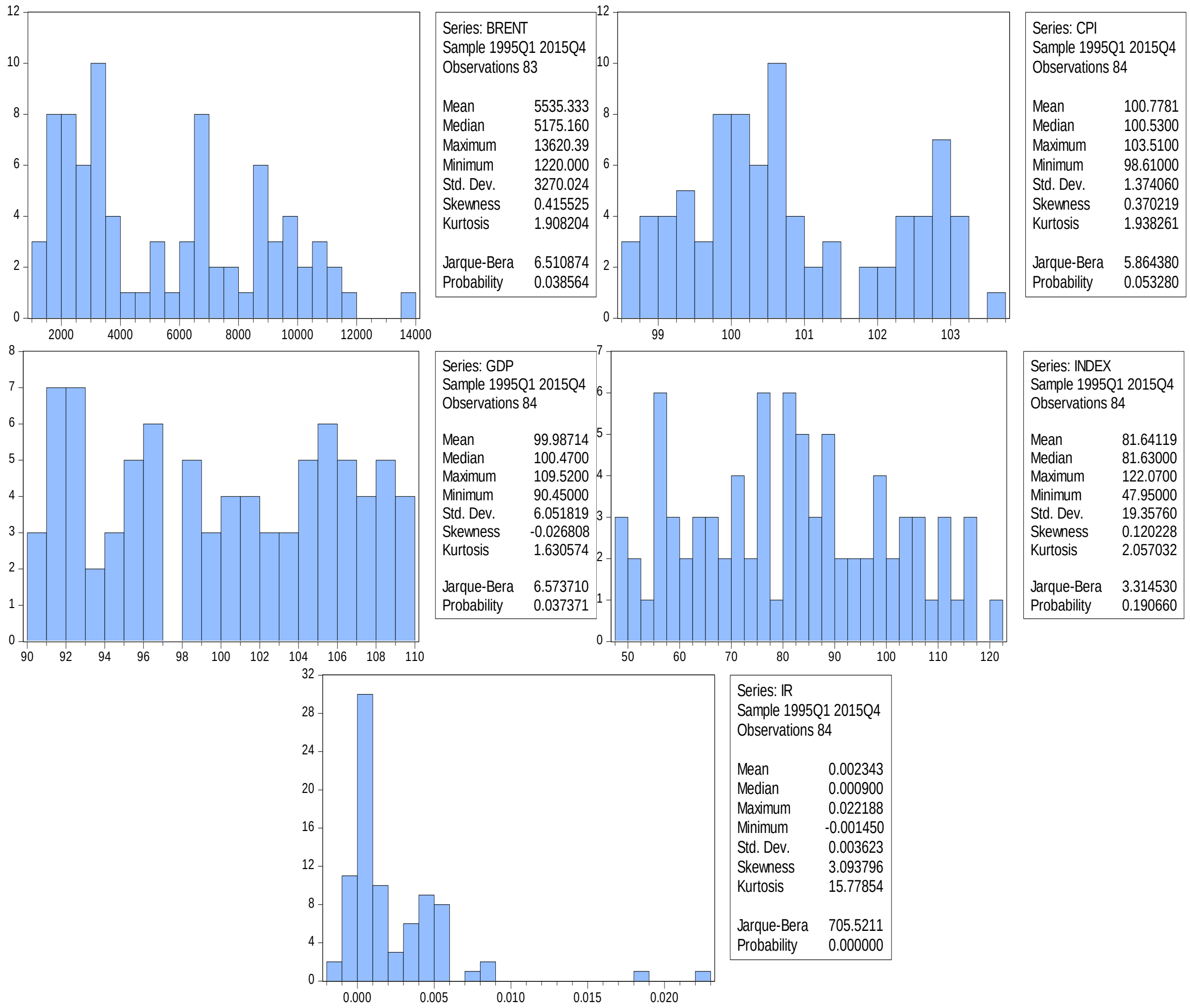


Figure-4. Histogram and Basic Descriptive Statistics for Japan

Figure-5. Evolution of Series for Denmark.

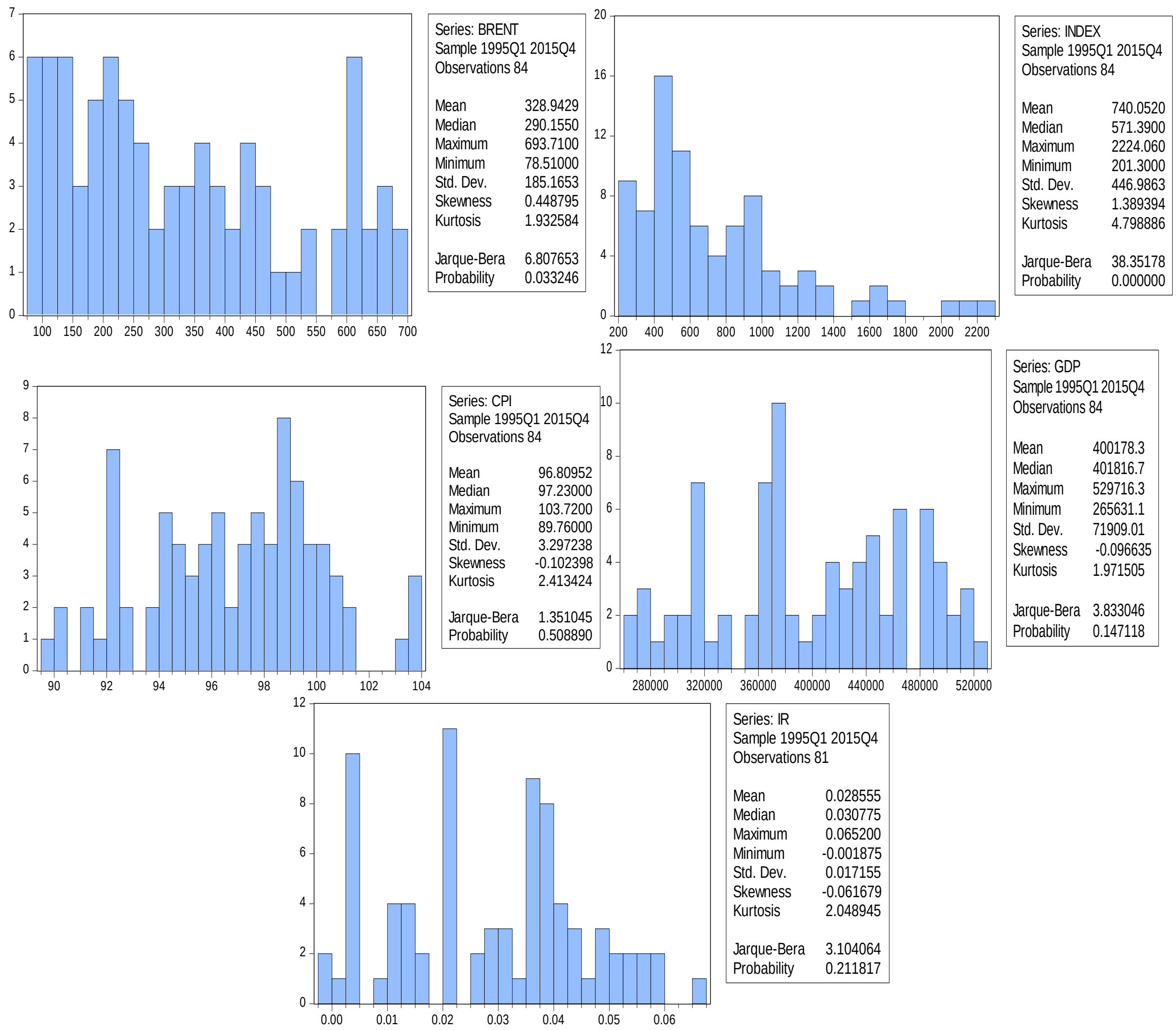


Figure-6. Histogram and Basic Descriptive Statistics for Denmark.

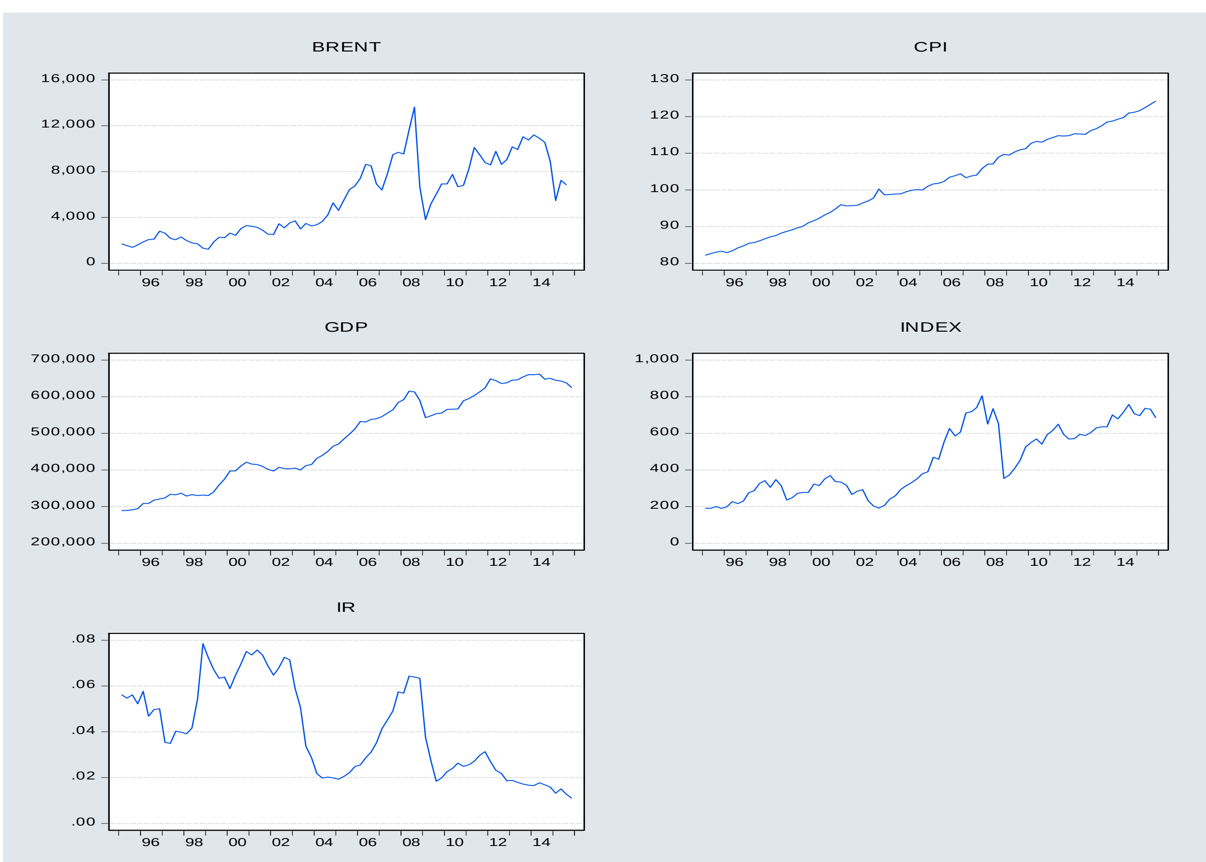


Figure-7. Evolution of Series for Norway.

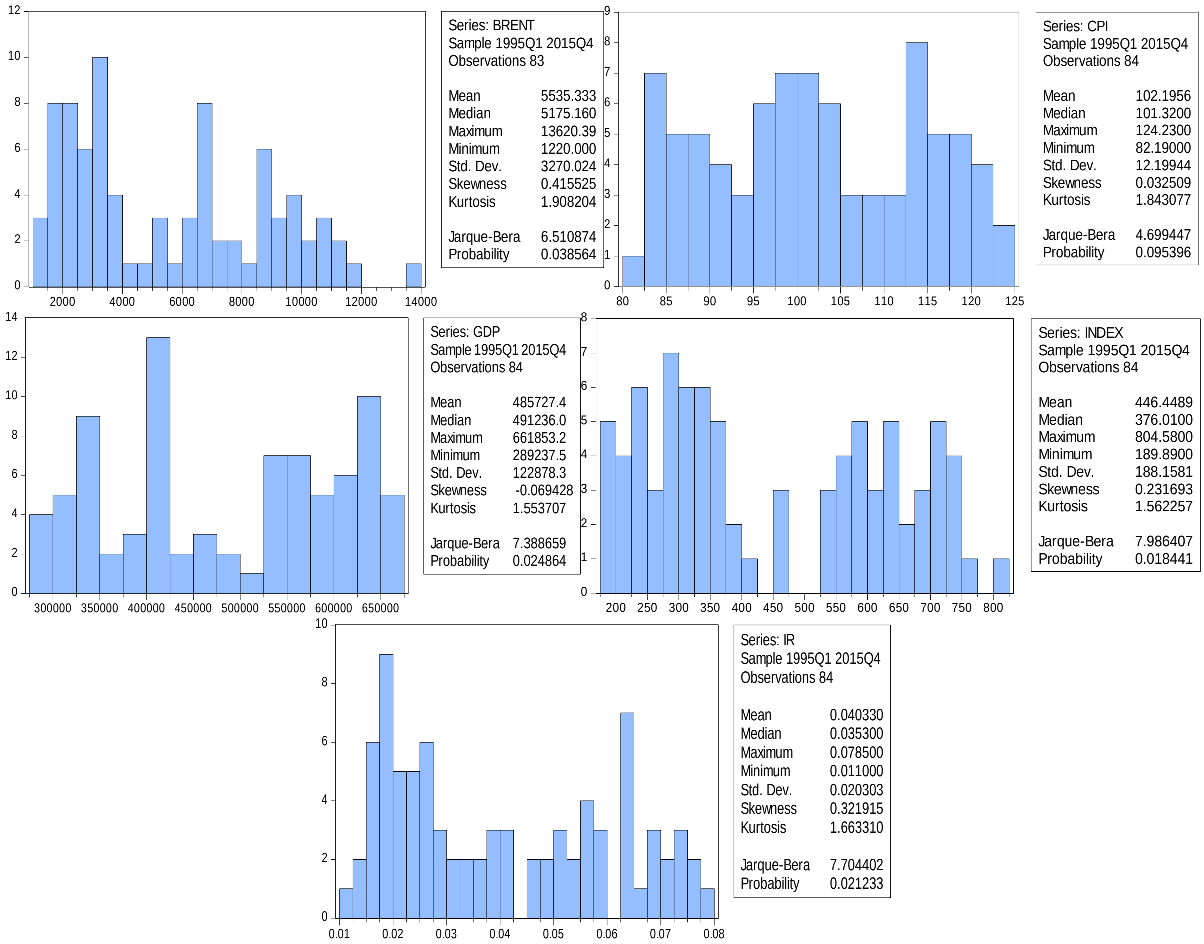


Figure-8. Histogram and Basic Descriptive Statistics for Norway.

3.3. Unit Root Tests

Differencing data makes it stationary, which makes the data to exhibit constant means and eliminate the threat of spurious regression. However, Sims (1980) is not in support of differencing the data to make it stationary due to some information being missing in differencing. However, a more common view, supported by Granger and Newbold (1974) argues that differencing should be used, as non-stationary data can produce spurious results. The data in this paper is transformed using logarithmic differences, in order to get rid of non-stationarity and make it normally distributed. For this transformation to take effect, the Augmented Dickey Fuller test also used in Harris (1992) is used to assess the presence of unit root in the variables.

The null hypothesis, H0: states that variable has the problem of unit root

While the alternative hypothesis Ha: states that variable possess no such problem.

The rule of thumb is that a significant probability value at 5% should lead to the rejection of null hypothesis and acceptance of alternative hypothesis and vice versa Leybourne, Mills, and Newbold (1998). See Eviews output in the figure.

Table-1. ADF test results at level.

Country	CPI_P-value	Interest Rate_P-value	GDP_P-value	Stock Market_P-value	Brent_P-value
Belgium	0.1855	0.0975	0.0286	0.1904	0.2835
Japan	0.9725	0.4297	0.4950	0.2723	0.0197
Denmark	0.5163	0.1928	0.0256	0.8810	0.5086
Norway	0.1809	0.2238	0.6267	0.0384	0.0197

As can be observed from Table 1 above, almost all the variables possess insignificant probability values at 5%, which led to failure to reject null hypothesis of unit root. However, the few variables that show significant p-values such as GDP for Japan and Norway, Brent crude for Denmark and Norway can still be subject to further transformation for perfection of stationarity. The eviews outputs below show the logarithmic differences applied to the data to achieve perfect stationarity as suggested (Yang, Hwang, & Huang, 2002).

Table-2. ADF test results at first difference.

Country	CPI_P-value	Inflation_P-value	GDP_P-value	Stock Market_P-value	Brent_P-value
Belgium	0.0000	0.0000	0.0000	0.0000	0.0000
Japan	0.0000	0.0000	0.0000	0.0000	0.0000
Denmark	0.0000	0.0000	0.0000	0.0000	0.0000
Norway	0.0000	0.0000	0.0000	0.0000	0.0000

As can be observed on the table, all p-values for the ADF test are significant even at 1% thus, leading to the rejection of null hypothesis of unit root. Therefore, the conclusion is that variables have become stationary. To have a visual inspection of the stationary series, the data has been plotted on figures and charts below for the different countries. From the graphs, which are found below for the various countries, a glance shows that the variables now exhibit a constant mean and variance, which is an evidence for stationary series. Furthermore, as can be observed on the histograms, there have been significant improvements. That is, the shapes have generally moved closer to a bell-shaped pattern compared to the earlier ones when the data had not been transformed. However, despite visual evidence of variables moving closer to normality, empirical evidence from skewness, kurtosis and p-value still show that data are not normally distributed. Nonetheless, at this point, we will rely on the central limit theorem which states data variables can still be used for regression even when they are not normally distributed, as normal distribution sometimes can be a question type of sample one obtains (Gujarati & Porter, 2009)

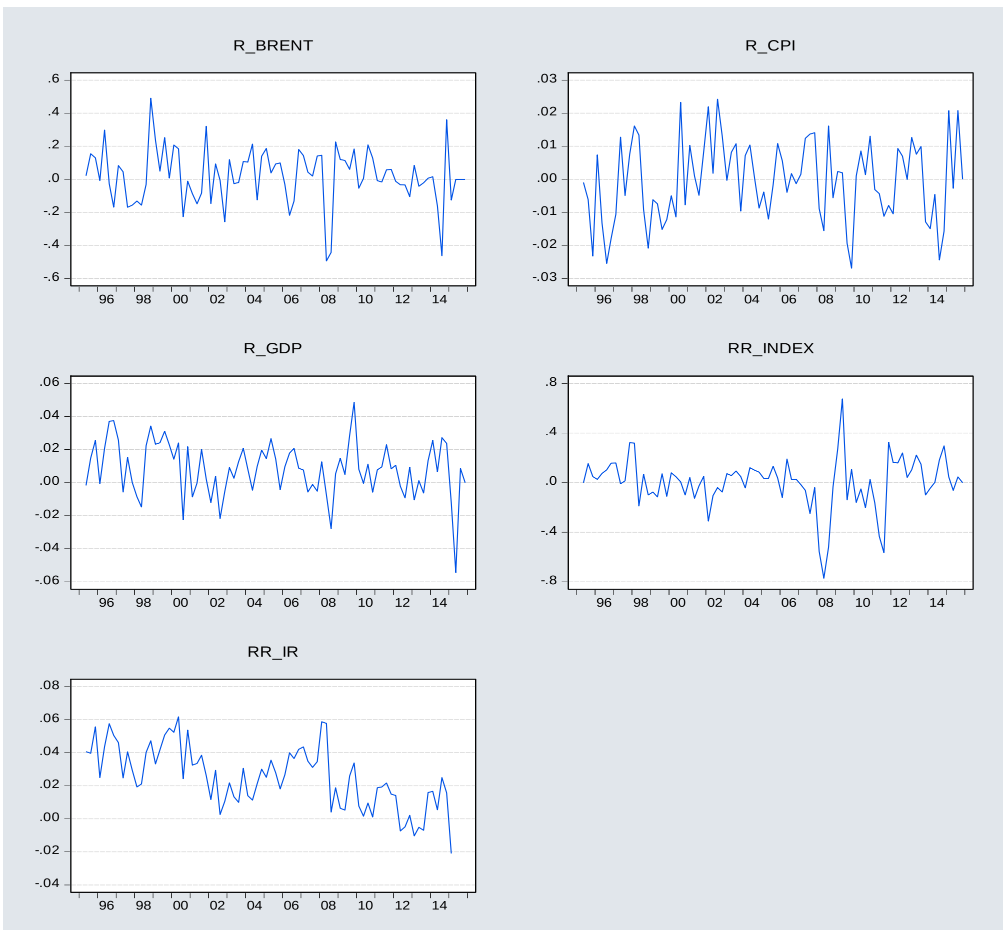
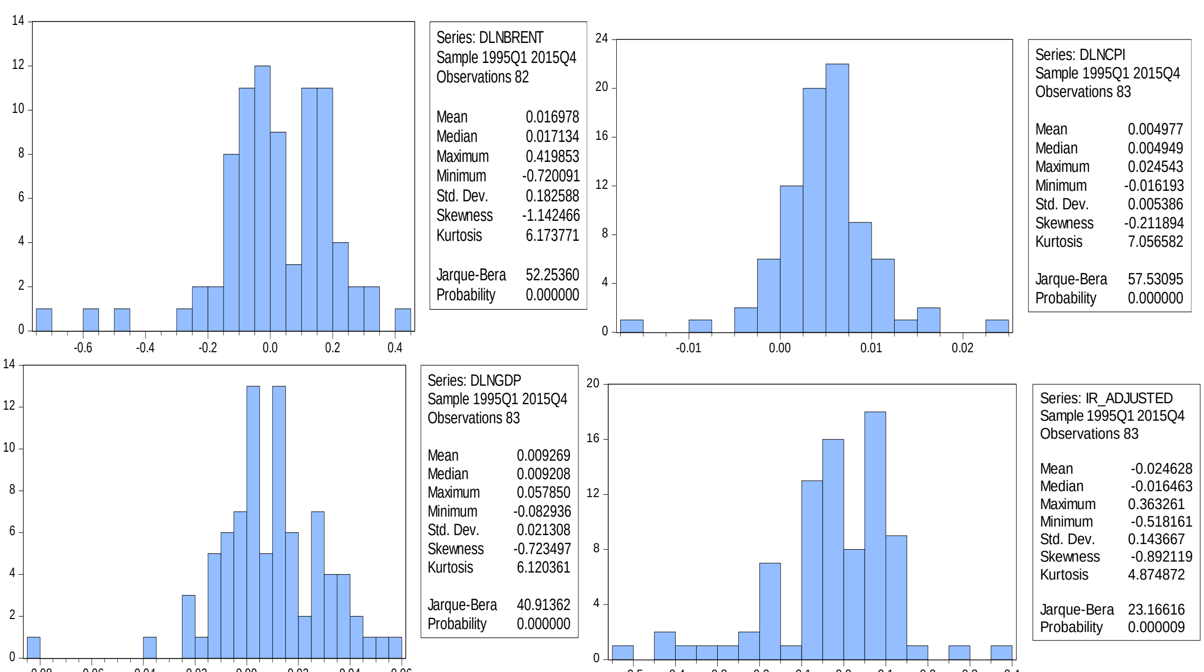


Figure-9. Stationary Series of log-diff Transformed Data for Belgium



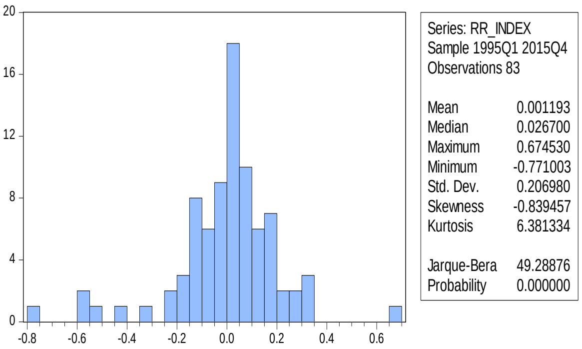


Figure-10. Histogram and Basic Descriptive Statistic of Stationary Series for Belgium

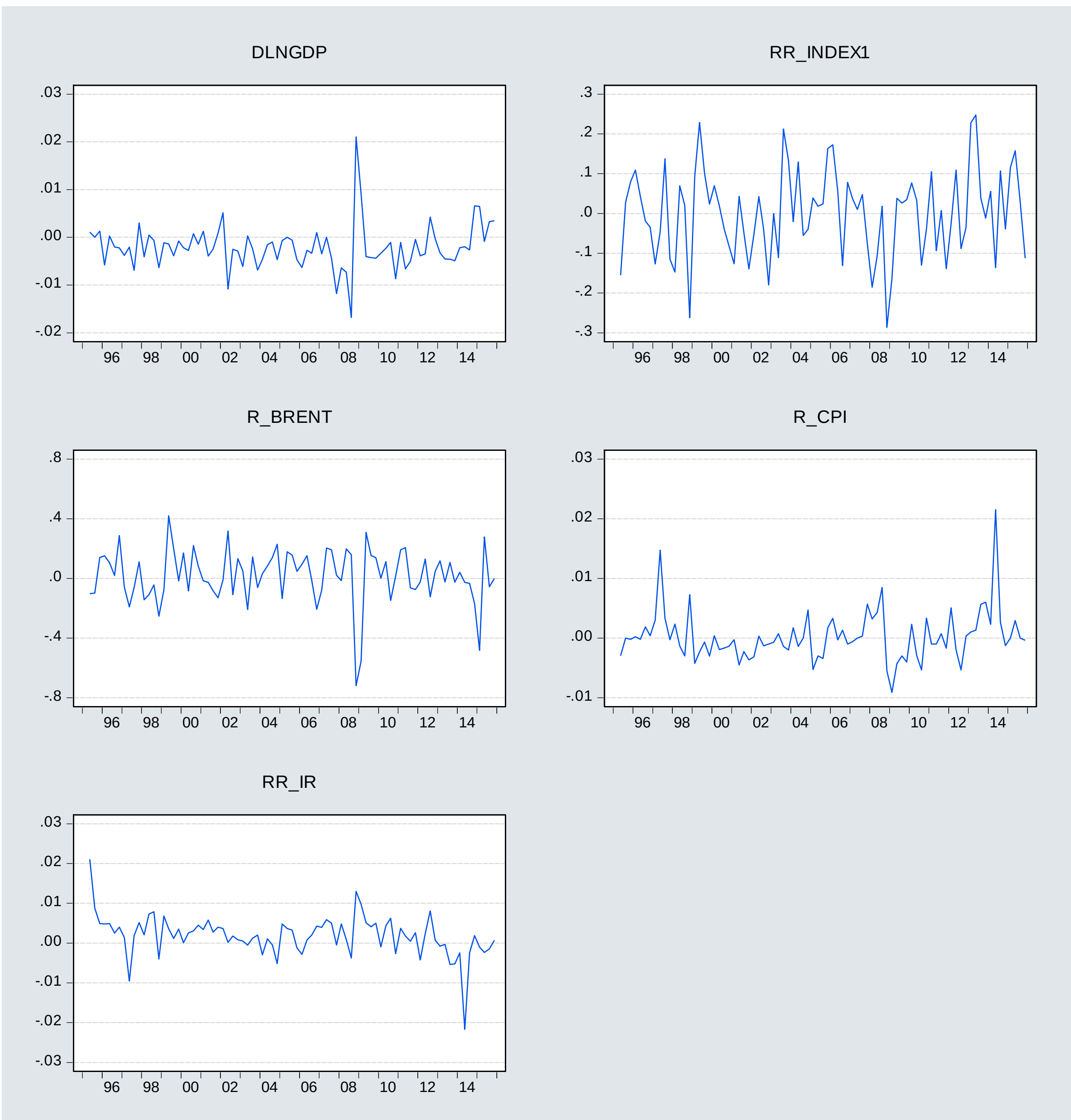
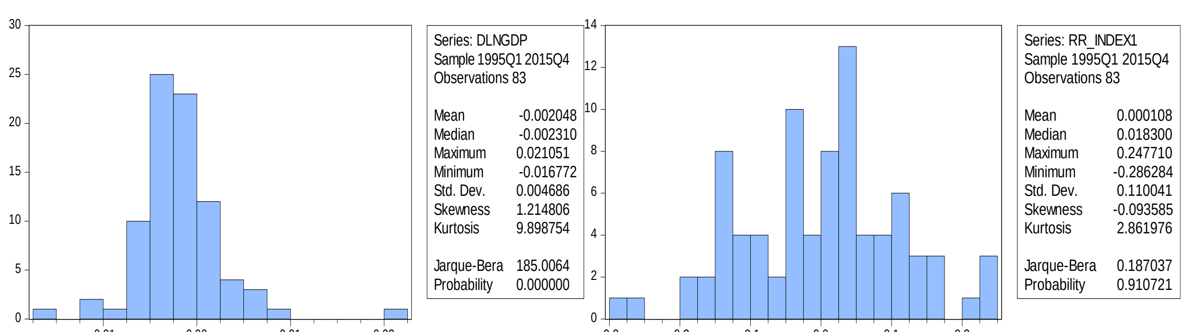


Figure-11. Stationary Series of log-diff Transformed Data for Japan



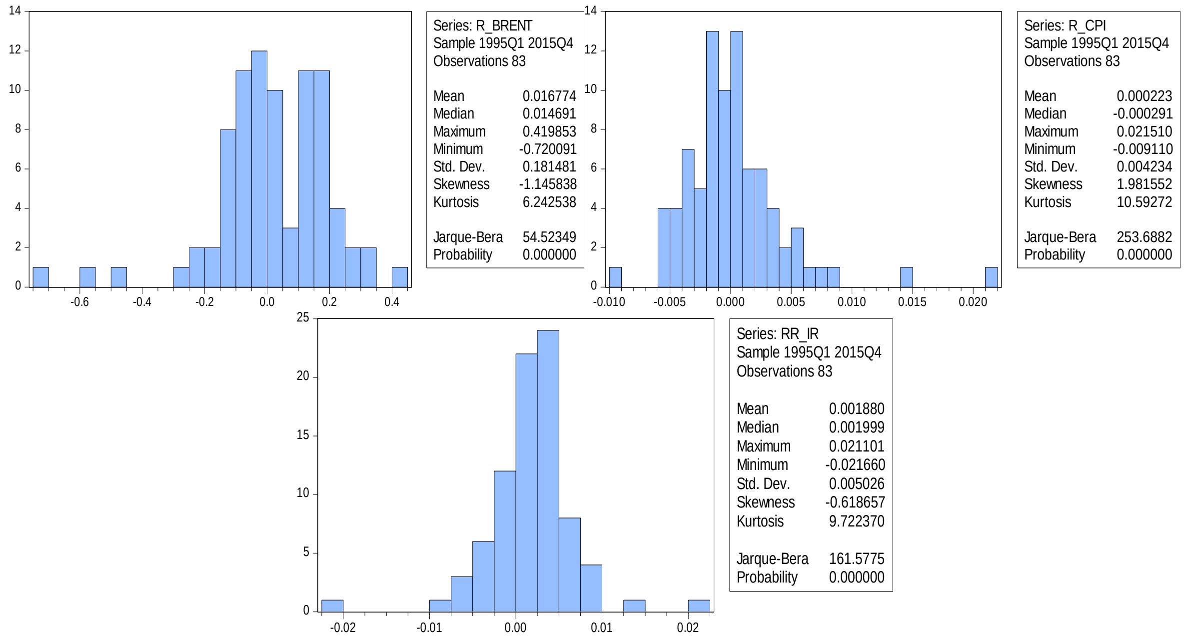


Figure-12. Histogram and Basic Descriptive Statistic of Stationary Series for Japan

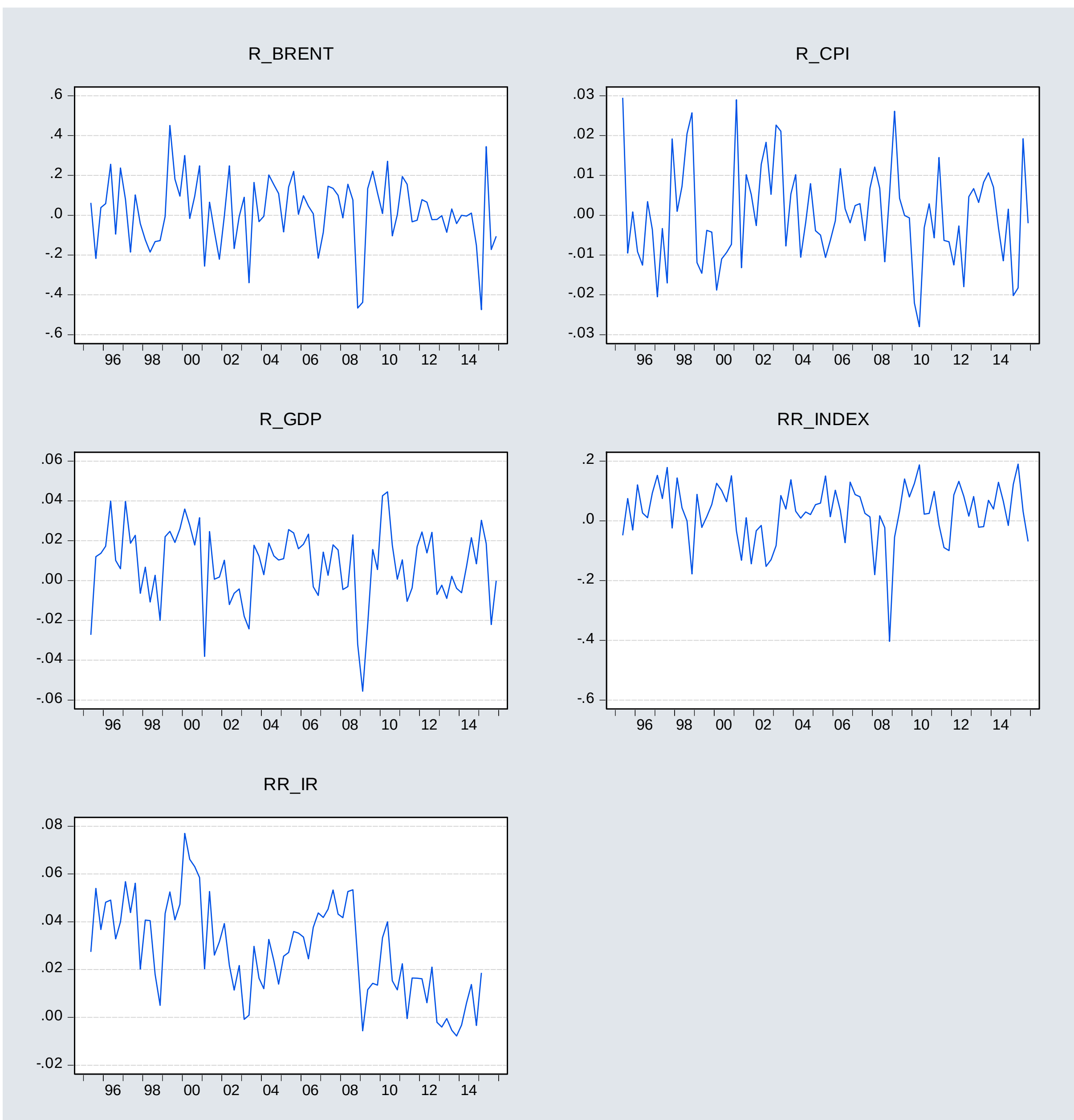
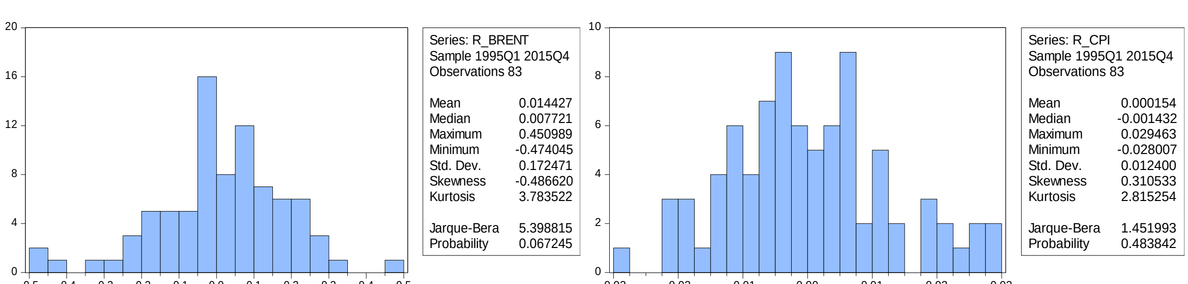


Figure-13. Stationary Series of log-diff Transformed Data for Denmark



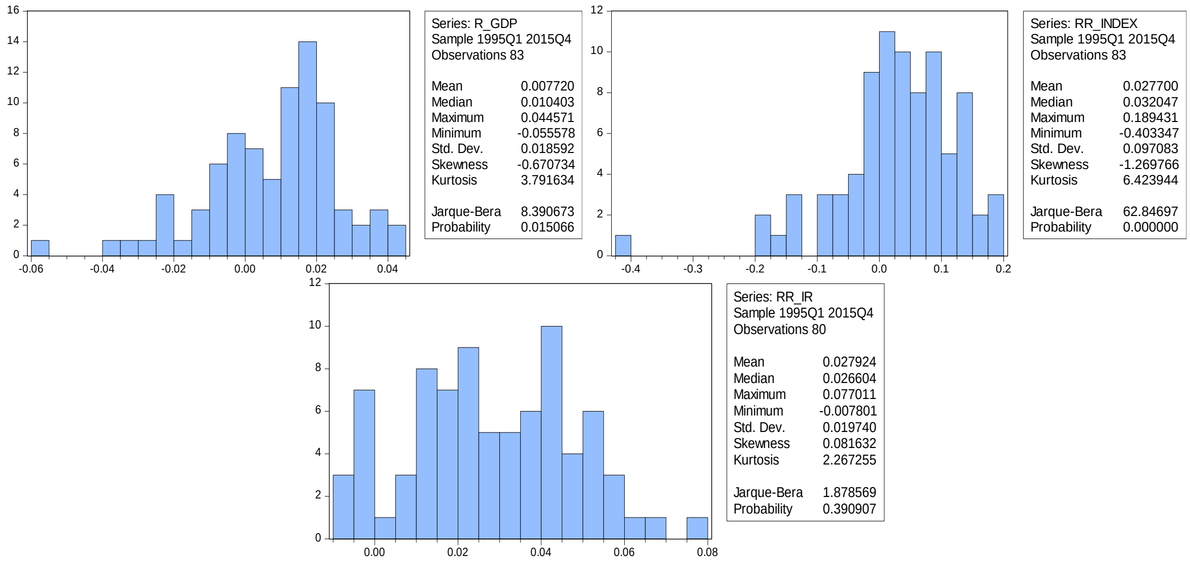


Figure-14. Histogram and Basic Descriptive Statistics of Stationary Series for Denmark.

Figure-15. Stationary Series of log-diff Transformed Data for Norway

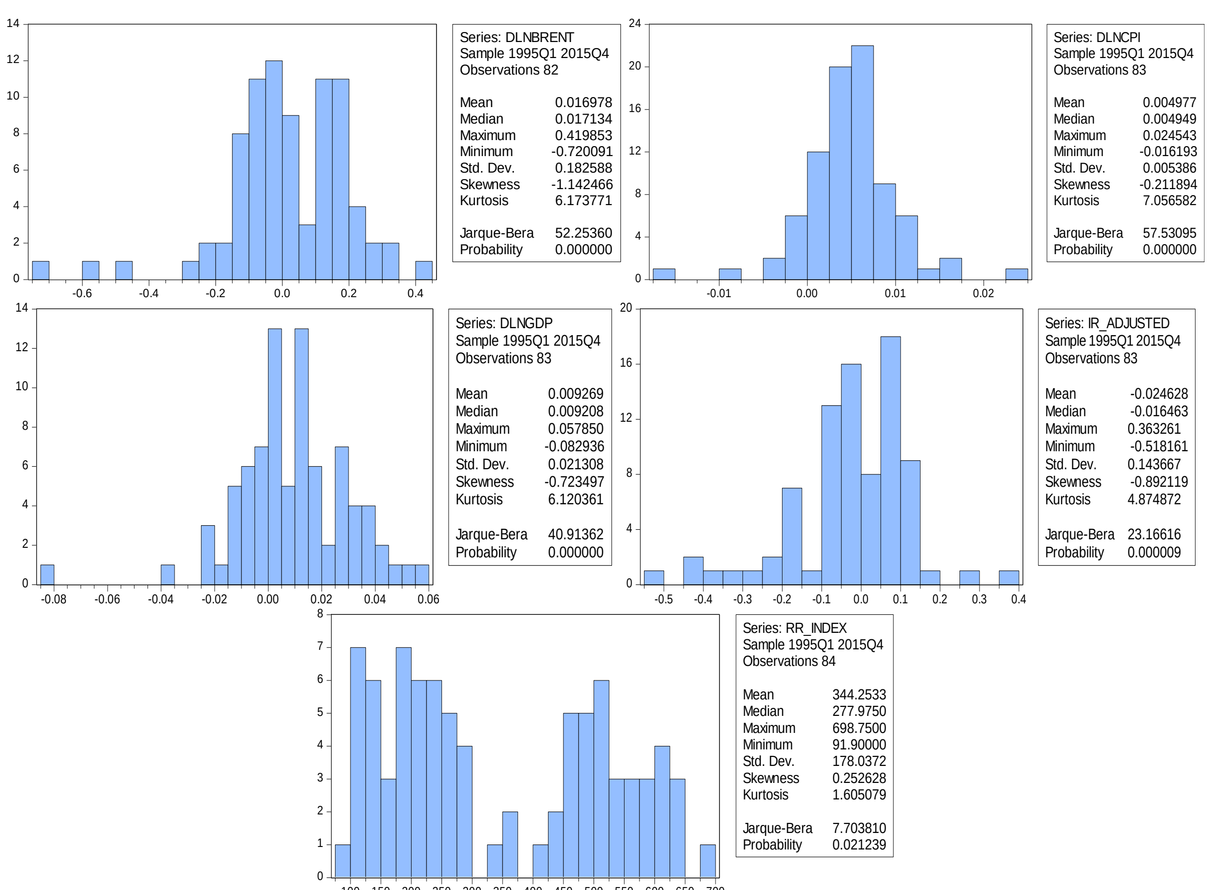


Figure-16. Histogram and Basic Descriptive Statistics of Stationary Series for Denmark

3.4. Econometric Model Specification for VAR

The VAR model provides results where a change in one variable is interdependent with the changes in its own lags and lags in other variables (Maghyereh, 2004). Numerous authors such as Gausden (2010); Gokmenoglu, Azin, and Taspinar (2015); Chen (2009); Bernanke et al. (1997) and Lardic and Mignon (2008) among others adopt this approach in their empirical studies. According Maddala (1992) the VAR model is an essential starting point in the analysis of interrelationships between different time series. The VAR results are interpreted using the forecast error variance decomposition (FEVD) analysis and the impulse-response functions (IRFs). According to Enders (2010) The VAR model is better than the multiple regressive model because VAR is useful in examining the relationship between a group of economic variables and the results for estimation can be used for the purposes of forecasting. The five variables incorporated in the model for the purposes of this paper are treated as endogenous or dependent variables. Ayadi (2005); Obioma and Eke (2015) state that VAR model enables researchers to understand better the interrelationships between economic variables. The Cholesky decomposition is used to identify a VAR and implies a particular ordering of the variables in the VAR model (Elbourne & de Haan, 2009). The variables in this paper follows this sequence: (a) the log of oil prices; (b) the log gdp; (c) the log of the CPI index (d) the log of the interbank interest rate; (e) the log of stock market returns. The initial variable in the sequential system is oil price (BRENT), as it is not simultaneously affected by shocks to the other variables. However, oil shocks affect the rest of the variables. Then GDP is the second in the order, as it simultaneously affects the other variables, except for oil price (BRENT), but not contemporaneously affected by them. The rest of the order is described by the same logic. The specific model used in this study is the model proposed by Jiménez-Rodríguez and Sánchez (2005) which is,

$$yt = \mathrm{C} + \sum_{i=1}^{p} \Phi i\, yt - i + \varepsilon t \qquad (1)$$

The above model can be broken down for each variable in the equation as:

$$\Delta LBRENTt = \beta o + \sum_{i=1}^{P} \beta 1i\, \Delta LBRENTt\_i + \sum_{i=1}^{P} \beta 2i\, \Delta LGDPt\_i + \sum_{i=1}^{P} \beta 3i\, \Delta LIRt\_i + \sum_{i=1}^{P} \beta 4i\, \Delta LCPIt\_i + \sum_{i=1}^{P} \beta 4i\, \Delta LINDEXt\_i + \varepsilon t \qquad (2)$$

$$\Delta LGDPt = \alpha o + \sum_{i=1}^{P} \alpha 1i\, \Delta LGDPt\_i + \sum_{i=1}^{P} \alpha 2i\, \Delta LBRENTt\_i + \sum_{i=1}^{P} \alpha 3i\, \Delta LIRt\_i + \sum_{i=1}^{P} \alpha 4i\, \Delta LINDEXt\_i + \sum_{i=1}^{P} \alpha 5i\, \Delta LCPIt\_i + \varepsilon t \qquad (3)$$

$$\Delta LCPIt = Uo + \sum_{i=1}^{P} U1i\, \Delta LCPIt\_i + \sum_{i=1}^{P} U2i\, \Delta LBRENTt\_i + \sum_{i=1}^{P} U3i\, \Delta LGDPt\_i + \sum_{i=1}^{P} U4i\, \Delta LIRt\_i + \sum_{i=1}^{P} \alpha 5i\, \Delta LINDEXt\_i + \varepsilon t \qquad (4)$$

$$\Delta LIRt = \Phi o + \sum_{i=1}^{P} \Phi 1i\, \Delta LIRt\_i + \sum_{i=1}^{P} \Phi 2i\, \Delta LBRENTt\_i + \sum_{i=1}^{P} \Phi 3i\, \Delta LGDPt\_i + \sum_{i=1}^{P} \Phi 4i\, \Delta LCPIt\_i + \sum_{i=1}^{P} \Phi 5i\, \Delta LINDEXt\_i + \varepsilon t \qquad (5)$$

$$\Delta LINDEXt = Zo + \sum_{i=1}^{P} Z1i\, \Delta LINDEXt\_i + \sum_{i=1}^{P} Z2i\, \Delta LBRENTt\_i + \sum_{i=1}^{P} Z3i\, \Delta LGDPt\_i + \sum_{i=1}^{P} Z4i\, \Delta LIRt\_i + \sum_{i=1}^{P} Z5i\, \Delta LCPIt\_i + \varepsilon t \qquad (6)$$

Where BRENT represents the Crude oil prices, GDP is the Gross Domestic Product, IR is the Interbank Rate, and INDEX is the stock market price, CPI is the consumer price index (CPI). β, α, Φ, Z and U represent the matrix coefficient of the parameters to be estimated, P is the number of lag value and t is the time, εt is the noise error term.

A parsimonious model can be described as the simplest theory with few variables that accomplishes a great level of explanation (Meys, 2011). The VAR model can be referred to as parsimonious as it concentrates on a small number of variables, usually up to seven to arrive at an answer. The VAR model is however faced with certain drawbacks argued by many researchers. Swanson and Granger (1997);

Stock and Watson (2012) and Brooks (2008) point out that, the IRFs and FEVDs can only be interpreted easily after the orthogonalisation of the results in the VAR model. This question the strength of the VAR model, as the orthogonalisation involves "the subjective specification of a structural model in the errors" (Swanson & Granger, 1997). Also, it is argued by Elbourne and de Haan (2009) that the Cholesky decomposition approach is constrained, as it allows "only one direction of contemporaneous causation" Furthermore, Stock and Watson (2012) argue that the VAR models which include two or three variables are not sturdy and fail to predict the outcome in future. Also, Kormilitsina (2011) argues that the VAR model is not suitable for policy experiments because it violates the Lucas critique. The author overcomes this problem by employing counterfactual experiments within an oil price shock model that "replicates the predictions of the empirical VAR model. Lastly, (Koop et al., 1996) maintains that linear models such as VAR are excessively restrictive as it cannot appropriately grasp assymetries that may be present in fluctuations of a business cycle.

4. Results and Discussion

4.1. VAR Lag Order Selection

The Tables 3-6 below show the VAR autoregressive lag selection criteria for each country. For easy selection, only the suggestion from AIC is followed for all the countries

Table-3. Lag selection for Belgium.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	760.7997	NA	1.58e-15	-19.88947	-19.73613	-19.82818
1	925.2060	302.8537*	4.05e-17*	**-23.55805***	-22.63803*	-23.19036*
2	942.8037	30.10142	4.96e-17	-23.36326	-21.67654	-22.68916
3	965.9025	36.47182	5.33e-17	-23.31322	-20.85982	-22.33273
4	982.0841	23.42064	7.01e-17	-23.08116	-19.86107	-21.79426

Note: * indicates lag order selected by the criterion.

Table-4. Lag Selection for Japan

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1123.349	NA	3.48e-19	-28.31264	-28.16267	-28.25256
1	1197.315	136.6954	1.01e-19*	-29.55227	-28.65248*	-29.19178*
2	1222.370	43.13291*	1.02e-19	**-29.55366***	-27.90405	-28.89278
3	1243.187	33.20254	1.15e-19	-29.44778	-27.04833	-28.48649
4	1265.292	32.45799	1.28e-19	-29.37448	-26.22522	-28.11279

Note: * indicates lag order selected by the criterion.

Table-5. Lag Selections for Denmark.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	798.0404	NA	5.94e-16	-20.86948	-20.71615	-20.80820
1	925.5323	234.8534	4.01e-17	-23.56664	-22.64661*	-23.19895*
2	951.9901	45.25686*	3.90e-17*	**-23.60500***	-21.91829	-22.93091
3	963.3779	17.98069	5.70e-17	-23.24679	-20.79338	-22.26629
4	983.7690	29.51342	6.70e-17	-23.12550	-19.90541	-21.83860

Note: * indicates lag order selected by the criterion.

Table-6. Lag Selection for Norway.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	58.49609	NA	1.75e-07	-1.371695	-1.220623	-1.311218
1	188.0726	239.2182	1.20e-08*	**-4.053144***	-3.146717*	-3.690285*
2	211.6227	40.45784	1.25e-08	-4.015967	-2.354185	-3.350725
3	228.9906	27.61048	1.55e-08	-3.820271	-1.403134	-2.852647
4	257.1423	41.14488*	1.49e-08	-3.901086	-0.728593	-2.631079

Note: * indicates lag order selected by the criterion.

From the tables above, AIC has suggested lag 1 for Norway and Belgium and lag 2 for Japan and Denmark, which this research follows.

From our estimate output, probability values are calculated to assess significant relationships. On the tables, significance is represented by asterisk. One asterisk for 10%, two asterisks for 5% and three asterisks for 1% level. Significant relationships in econometric model is very essential as it indicates that results from the model can be relied upon

4.2. VAR Estimates for Belgium

According to the AIC lag selection criteria, lag 1 better fits the data and as such lag 1 is estimated for analysis.

Table-7. Belgium VAR estimate output.

Vector Autoregression Estimates
Sample (adjusted): 1995Q3 2015Q1
Included observations: 79 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	R_BRENT	R_GDP	R_CPI	RR_IR	RR_INDEX
R_BRENT(-1)	-0.071389	-0.006529	0.006845	-0.003430	-0.295566**
	(0.12286)	(0.01076)	(0.00880)	(0.00929)	(0.13533)
	[-0.58108]	[-0.60665]	[0.77800]	[-0.36911]	[-2.18412]
R_GDP(-1)	8.608771***	0.311166	-0.025110	0.344975	6.282836*
	(3.07096)	(0.26903)	(0.21993)	(0.23229)	(3.38263)
	[2.80329]	[1.15664]	[-0.11417]	[1.48508]	[1.85738]
R_CPI(-1)	7.567167**	-0.041106	0.308923	1.014325***	1.430945*
	(3.63826)	(0.31872)	(0.26056)	(0.27521)	(4.00751)
	[2.07988]	[-0.12897]	[1.18560]	[3.68568]	[0.35707]
RR_IR(-1)	-1.102634	-0.070945	0.069354	0.907285***	-3.370977**
	(1.35278)	(0.11851)	(0.09688)	(0.10233)	(1.49007)
	[-0.81509]	[-0.59865]	[0.71586]	[8.86651]	[-2.26229]
RR_INDEX(-1)	-0.009266	0.005631	0.000718	0.002841	0.342894***
	(0.09959)	(0.00872)	(0.00713)	(0.00753)	(0.10970)
	[-0.09304]	[0.64539]	[0.10069]	[0.37706]	[3.12572]
C	-0.021639	0.008157	-0.002150	-0.000447	0.038516
	(0.04247)	(0.00372)	(0.00304)	(0.00321)	(0.04678)
	[-0.50947]	[2.19227]	[-0.70673]	[-0.13908]	[0.82329]

From Table 7 above, each column represents a single equation for each dependent variable presented in section 3. The table reveals that oil price has a significant negative relationship with stock market at lag 1, significant at 5%. This means that shock in oil price explains fluctuations in the lagged value of stock market prices in Belgium. Specifically, a 1% rise in oil price will decrease stock market prices by about 0.30%.

4.3. VAR Estimates for Japan

According to the AIC lag selection criteria, lag 2 better fits the data and as such lag 2 is estimated for analysis.

Table-8. Japan VAR Estimate outputs.

Vector Autoregression Estimates
Sample (adjusted): 1995Q4 2015Q4
Included observations: 81 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	R_BRENT	DLNGDP	R_CPI	RR_IR	DLNINDEX
R_BRENT(-1)	-0.008523	-0.006956*	0.002243	-0.002276	-0.043506
	(0.14699)	(0.00387)	(0.00358)	(0.00366)	(0.07945)
	[-0.05799]	[-1.79956]	[0.62667]	[-0.62255]	[-0.54760]
R_BRENT(-2)	-0.194597	0.001425	0.000941	-3.69E-05	-0.014682
	(0.14528)	(0.00382)	(0.00354)	(0.00361)	(0.07852)
	[-1.33946]	[0.37299]	[0.26615]	[-0.01020]	[-0.18698]
DLNGDP(-1)	0.574539	-0.116588	-0.022044	-0.115656	7.654803**
	(6.07127)	(0.15965)	(0.14782)	(0.15102)	(3.28145)
	[0.09463]	[-0.73026]	[-0.14913]	[-0.76581]	[2.33275]
DLNGDP(-2)	-2.541295	0.110556	0.047173	0.041816	0.524956
	(6.32758)	(0.16639)	(0.15406)	(0.15740)	(3.41998)
	[-0.40162]	[0.66443]	[0.30620]	[0.26567]	[0.15350]
R_CPI(-1)	-17.51722	0.100292	-0.023554	0.819290*	-1.630707
	(17.5416)	(0.46128)	(0.42709)	(0.43635)	(9.48103)
	[-0.99861]	[0.21742]	[-0.05515]	[1.87760]	[-0.17200]
R_CPI(-2)	-0.798357	0.063175	0.449324	-0.408401	-6.217570
	(14.7290)	(0.38732)	(0.35861)	(0.36639)	(7.96086)
	[-0.05420]	[0.16311]	[1.25296]	[-1.11468]	[-0.78102]
RR_IR(-1)	-14.44891	0.171873	-0.209000	0.994591**	-11.96015
	(17.0342)	(0.44794)	(0.41474)	(0.42373)	(9.20677)
	[-0.84823]	[0.38370]	[-0.50393]	[2.34724]	[-1.29906]
RR_IR(-2)	9.506774	-0.279460	0.339806	-0.333638	2.963338
	(13.2317)	(0.34795)	(0.32216)	(0.32914)	(7.15159)
	[0.71848]	[-0.80317]	[1.05479]	[-1.01366]	[0.41436]
DLNINDEX(-1)	0.370772*	0.000415	-0.000625	-0.000115	0.346972***
	(0.22271)	(0.00586)	(0.00542)	(0.00554)	(0.12037)
	[1.66479]	[0.07079]	[-0.11527]	[-0.02075]	[2.88244]
DLNINDEX(-2)	-0.089213	0.002456	0.006938	-0.006674	-0.224057*
	(0.21898)	(0.00576)	(0.00533)	(0.00545)	(0.11836)
	[-0.40740]	[0.42644]	[1.30137]	[-1.22513]	[-1.89307]
C	0.028225	-0.001810	-0.000154	0.000323	0.035665
	(0.03049)	(0.00080)	(0.00074)	(0.00076)	(0.01648)
	[0.92581]	[-2.25773]	[-0.20801]	[0.42647]	[2.16445]

From Table 8, the only equation with statistically significant result for Oil price is GDP, which shows 1% significance for oil price at lag one. Although few other variables are significant but not directly related to oil price which is where our interest mostly resides. Thus, one can comfortably say that oil price explains changes in GDP.

4.4. VAR Estimates for Denmark

According to the AIC lag selection criteria, lag 2 better fits the data and as such lag 2 is estimated for analysis.

Table-9. Denmark VAR Estimate Outputs.

Vector Autoregression Estimates
Sample (adjusted): 1995Q4 2015Q1
Included observations: 78 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	R_BRENT	R_GDP	R_CPI	RR_IR	RR_INDEX
R_BRENT(-1)	-0.049204	-0.001871	0.007284	-0.011155	-0.085563
	(0.14543)	(0.01518)	(0.01052)	(0.01132)	(0.08001)
	[-0.33834]	[-0.12328]	[0.69242]	[-0.98579]	[-1.06942]
R_BRENT(-2)	-0.051037	0.011935	-0.011166	0.011933	-0.151931**
	(0.14289)	(0.01491)	(0.01034)	(0.01112)	(0.07861)
	[-0.35717]	[0.80027]	[-1.08021]	[1.07332]	[-1.93264]
R_GDP(-1)	1.029139	0.010717	0.002625	0.156649	-0.127550
	(2.26061)	(0.23594)	(0.16353)	(0.17589)	(1.24369)
	[0.45525]	[0.04542]	[0.01605]	[0.89059]	[-0.10256]
R_GDP(-2)	-0.607888	0.115946	-0.181295	0.207789	-0.034636
	(2.25688)	(0.23555)	(0.16326)	(0.17560)	(1.24163)
	[-0.26935]	[0.49223]	[-1.11046]	[1.18329]	[-0.02790]
R_CPI(-1)	14.91316***	0.770772**	-0.121075	1.530397***	5.396746**
	(5.44804)	(0.56862)	(0.39411)	(0.42390)	(2.99726)
	[2.73735]	[1.35552]	[-0.30721]	[3.61029]	[1.80056]
R_CPI(-2)	-13.60502**	-0.739551**	0.103548	-0.390099	-9.122889***
	(6.15553)	(0.64246)	(0.44529)	(0.47895)	(3.38650)
	[-2.21021]	[-1.15112]	[0.23254]	[-0.81449]	[-2.69390]
RR_IR(-1)	15.11534***	1.012457	-0.263962	1.534470***	6.868336***
	(4.87397)	(0.50870)	(0.35258)	(0.37923)	(2.68144)
	[3.10124]	[1.99027]	[-0.74866]	[4.04626]	[2.56144]
RR_IR(-2)	-14.97186***	-1.084951	0.395944	-0.725644**	-8.178348***
	(4.83680)	(0.50482)	(0.34989)	(0.37634)	(2.66099)
	[-3.09541]	[-2.14917]	[1.13162]	[-1.92816]	[-3.07343]
RR_INDEX(-1)	0.162783	0.040136	-0.018560	0.019209	0.061650
	(0.24238)	(0.02530)	(0.01753)	(0.01886)	(0.13334)
	[0.67162]	[1.58659]	[-1.05857]	[1.01860]	[0.46234]
RR_INDEX(-2)	-0.303477	0.012245	-0.000331	-0.003764	0.076918
	(0.23708)	(0.02474)	(0.01715)	(0.01845)	(0.13043)
	[-1.28007]	[0.49488]	[-0.01929]	[-0.20407]	[0.58972]
C	0.025169	0.008575	-0.001977	0.001906	0.073437
	(0.04162)	(0.00434)	(0.00301)	(0.00324)	(0.02290)
	[0.60478]	[1.97418]	[-0.65681]	[0.58874]	[3.20744]

From Table 9, it can be noticed that the different models have produced statistically significant coefficients at some point. For instance, in Brent equation, the following variables are statistically significant R_CP1 (-1), R_CPI (-2), RR_IR (-1) and RR_IR (-2). For GDP equation, we also have R_CP1 (-1) and R_CPI (-2) being statistically significant and it goes on and on, which show how other variables affect each other and themselves irrespective of oil price. Rather interestingly, only stock market equation shows a statistically significant negative coefficient of 0.15 for Brent (Oil price) in 2 lags period. This means that if a shock should increase oil price by 1%, stock market prices will go down by about 0.15% after 2 quarters (6 months).

4.5. VAR Estimate for Norway

According to the AIC lag selection criteria, lag 1 better fits the data and as such lag 1 is estimated for analysis.

From the Table 10 above output on table 10, it can be noticed a few significant estimates. DLNCPI (-1) is significant for GDP and stock market, and DLNBRENT (-1) is significant for GDP, CPI and stock market. Which means that oil price explains changes in GDP, CPI and stock market for Norway.

Table-10. Norway VAR Estimate Outputs.

Vector Autoregression Estimates
Sample (adjusted): 1995Q3 2015Q3
Included observations: 81 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DLNBRENT	DLNGDP	DLNCPI	DLNIR	RR_INDEX
DLNBRENT(-1)	0.064487	0.027092*	0.004833**	0.036249	-55.70531***
	(0.13774)	(0.01538)	(0.00421)	(0.10202)	(39.6122)
	[0.46819]	[1.76176]	[1.14919]	[0.35532]	[-1.40627]
DLNGDP(-1)	1.352294	0.202351	-0.003047	1.120401	533.4648
	(1.18617)	(0.13243)	(0.03621)	(0.87857)	(341.137)
	[1.14005]	[1.52795]	[-0.08413]	[1.27525]	[1.56378]
DLNCPI(-1)	-8.762074	-0.849941**	-0.142717	3.094357	-2262.560**
	(3.77418)	(0.42138)	(0.11523)	(2.79545)	(1085.43)
	[-2.32159]	[-2.01706]	[-1.23856]	[1.10693]	[-2.08448]
DLNIR(-1)	-0.148760	-0.009052	0.005863	0.301576***	-61.61156
	(0.14604)	(0.01630)	(0.00446)	(0.10817)	(42.0003)
	[-1.01863]	[-0.55517]	[1.31499]	[2.78802]	[-1.46693]
RR_INDEX(-1)	-7.74E-05	-1.45E-05	1.26E-06	0.000130	0.973702
	(0.00012)	(1.3E-05)	(3.6E-06)	(8.7E-05)	(0.03378)
	[-0.65893]	[-1.10750]	[0.35136]	[1.49556]	[28.8246]
C	0.071107	0.016249	0.005255	-0.084461	21.04342
	(0.05092)	(0.00569)	(0.00155)	(0.03772)	(14.6451)
	[1.39637]	[2.85807]	[3.37994]	[-2.23931]	[1.43689]

4.6. Analysis of Impulse Response Functions (IRF) and Forecast Error Variance Decompositions

An impulse response function (IRF) according to Koop et al. (1996) measures within a particular period of time, the impact a shock has on a series of behavior. This is estimated from the coefficient of the VAR. IRF points out how the dependent variables respond to one positive standard deviation shock in oil price on the current and future values of each of the macroeconomic variables. On the other hand forecast error variance decomposition measure the contribution of each type of shock to the forecast error variance. Both computations are useful in assessing how shocks to economic variables reverberate through a system. The resultant graphs have been placed.

4.6.1 IRF and Variance Decomposition for Oil Price

Graphs in Figures 17-20 above show how variables for each country respond to a 1% standard deviation shock on oil price and their respective variance decomposition graphs. At this point, we concentrate on own shock for BRENT variable. Looking at the IRF graph for Belgium, Japan, Denmark and Norway, there are two different patterns observed. While Denmark, Belgium and Norway show a continuous positive response to own shock, Japan although still is positive, shows a tendency for a decrease in the future. These responses appear to loose statistical significance after the first quarter.

Variance decompositions show that for all the first quarters, own shock contributed to 100% in its fluctuations. From the second quarter, this percentage fell to around 90% for Norway, Belgium and Japan, with main contributor variable for the remaining 10% being Inflation (CPI). For Denmark, the value fell from 100% in the first quarter to around 84% starting from second quarter. Unlike other countries, the main contributor variable here seems to be interest rate (IR), contributing to about 13.8% of the fluctuations in oil price.

4.6.2. IRF and Variance Decomposition for GDP

When it comes to the impulse response function for GDP to positive oil price shock, Japan becomes negative but significance is very weak. For Belgium, it is slightly difficult to decide whether the response is negative or even no effect at all as the lower confidence bound slightly crosses to negative but insignificance. However, it would not be totally wrong to decide no effect as most of the lower bound line is on zero. Denmark and Norway saw positive response of GDP to shock in oil price. This could be because they belong to oil exporting category and any increase in price means more inflow of foreign currency although significance is weak at point of shock and erodes after that.

The VD for GDP show a different picture compared to that from oil price. It is observed that effect of immediate own shock is not as strong, with oil price shock contributing up to 30% of fluctuations in GDP for Norway, 22% for Denmark and Japan, and around 10% for Belgium. Here, it can be observed that oil price shock has important role to play in explaining trends and fluctuations in GDP. More importantly, the result for Norway and Denmark is expected. This is because since they are exporting countries, their GDP will rely mostly on revenue from oil exports and thus, a positive shock becomes beneficial to the exporting countries.

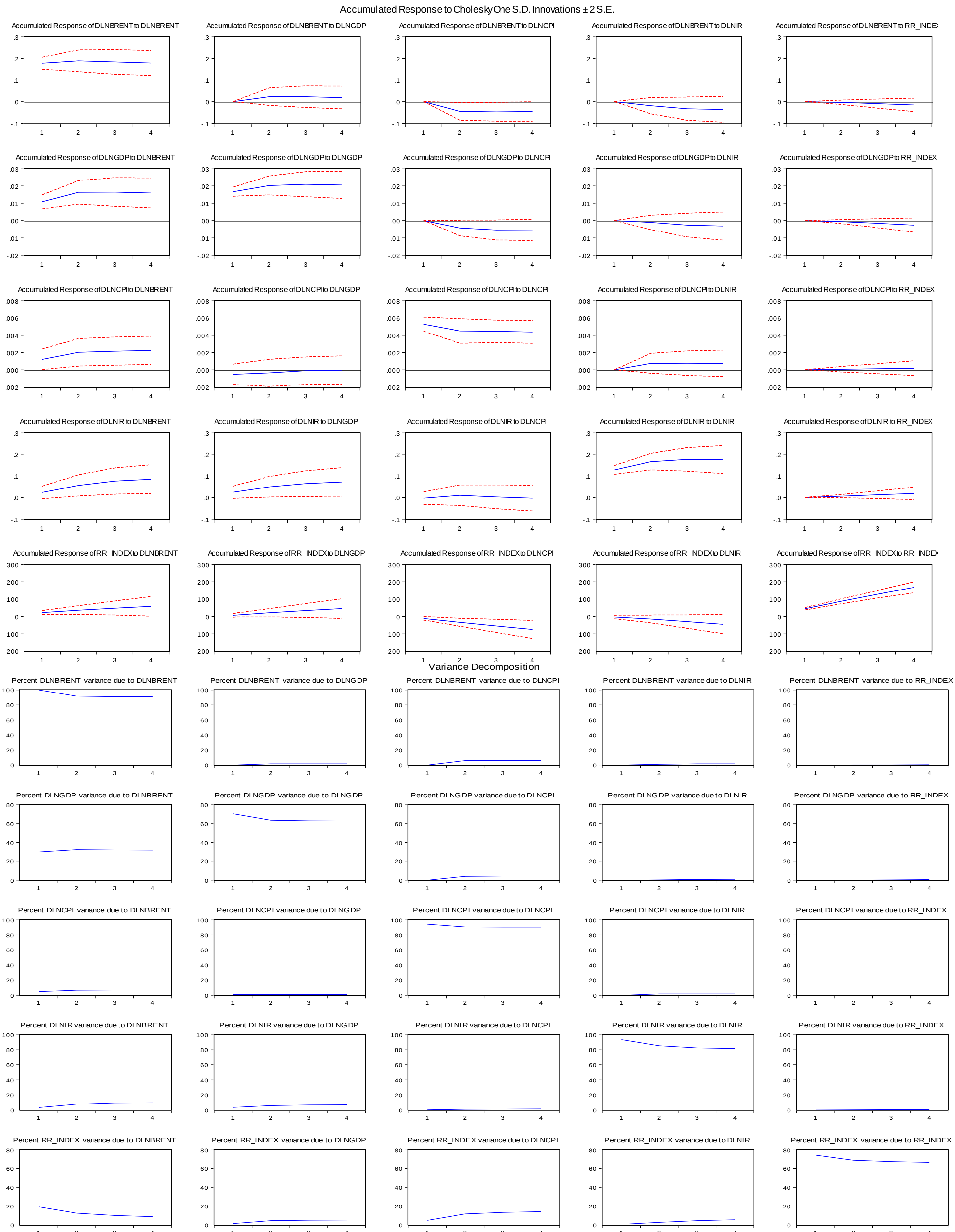


Figure-17. IRF and Variance Decomposition for Norway.

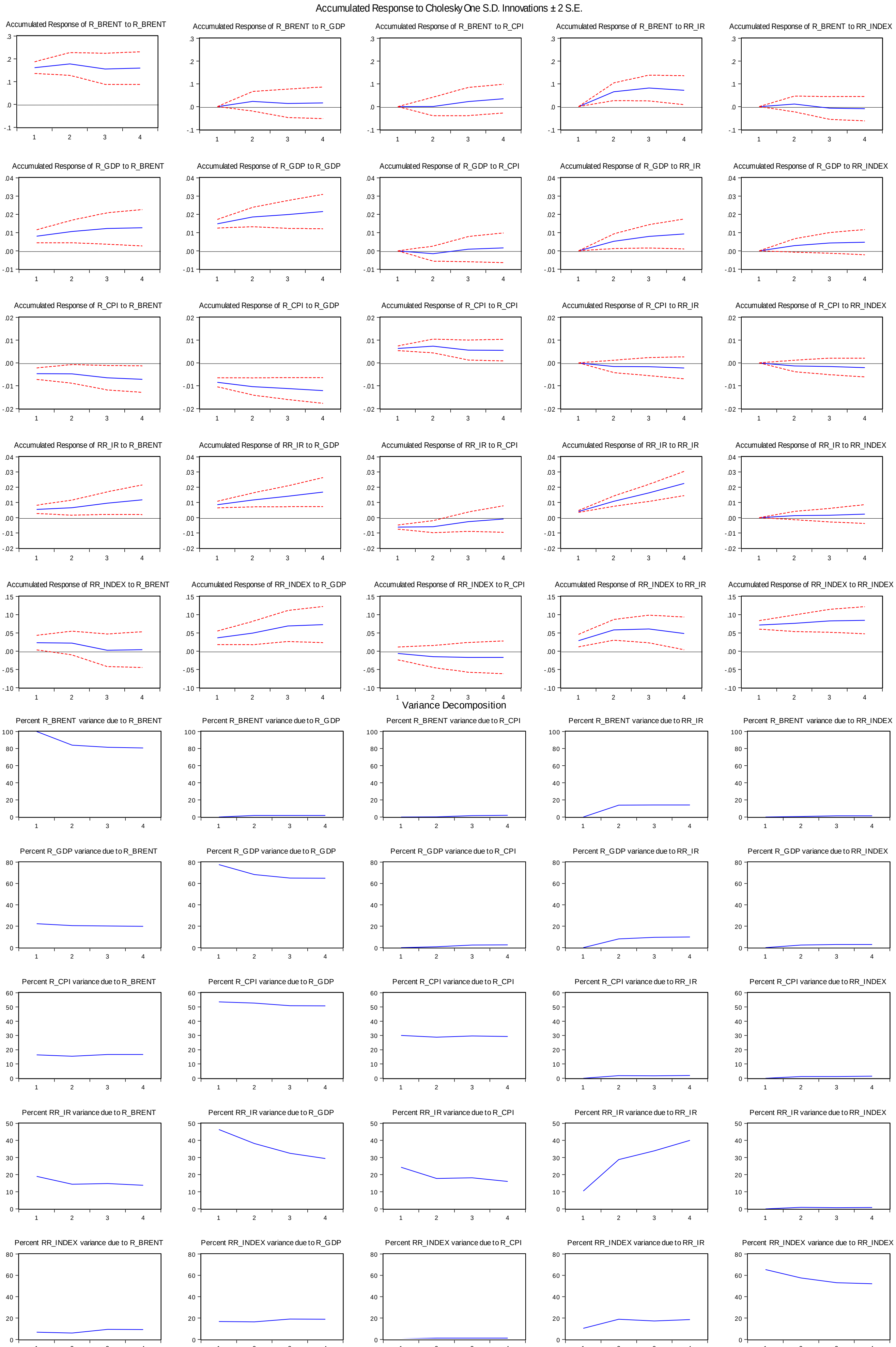


Figure-18. IRF and variance decomposition for Denmark.

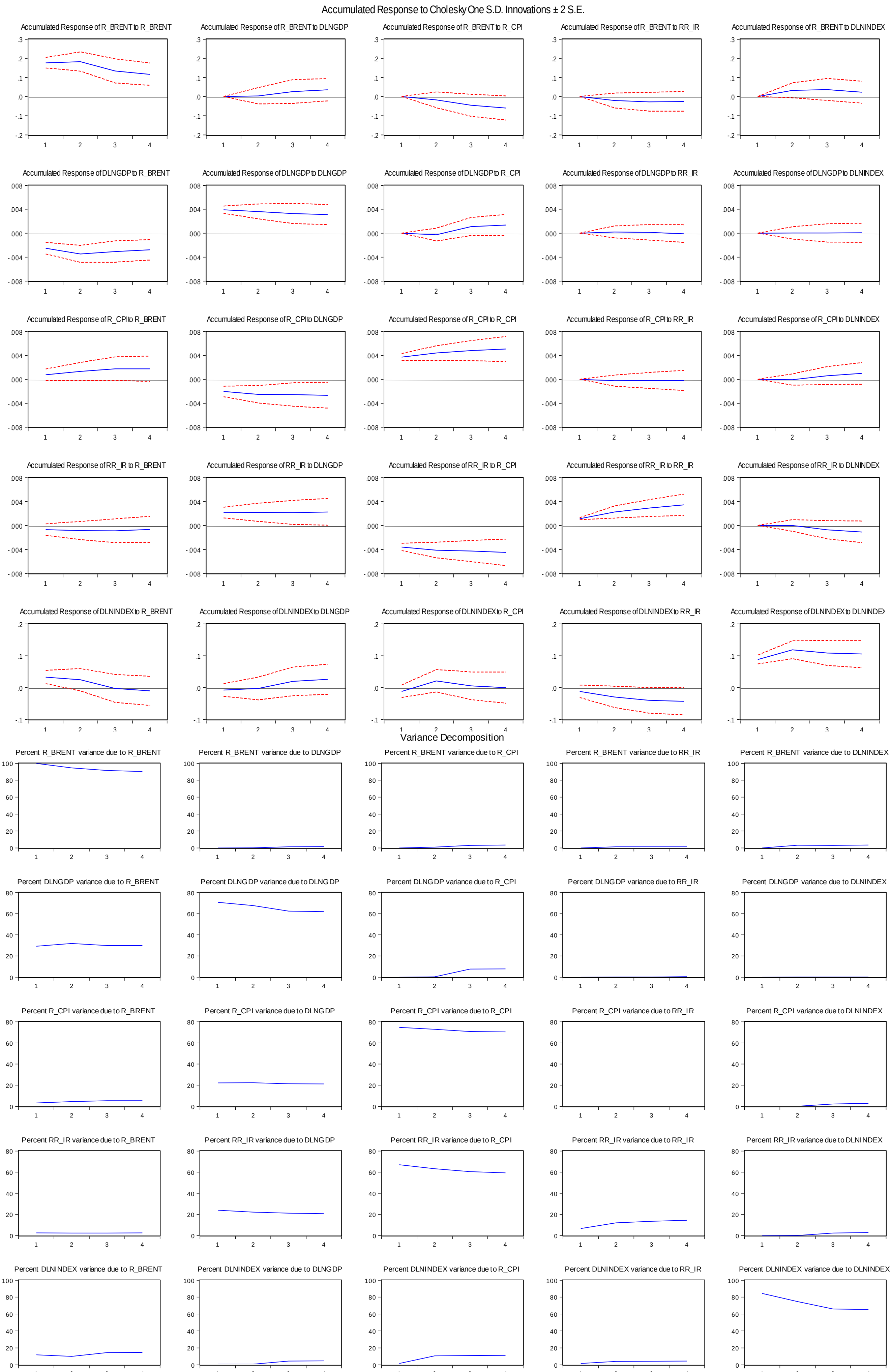


Figure-19. IRF and variance decomposition for Japan.

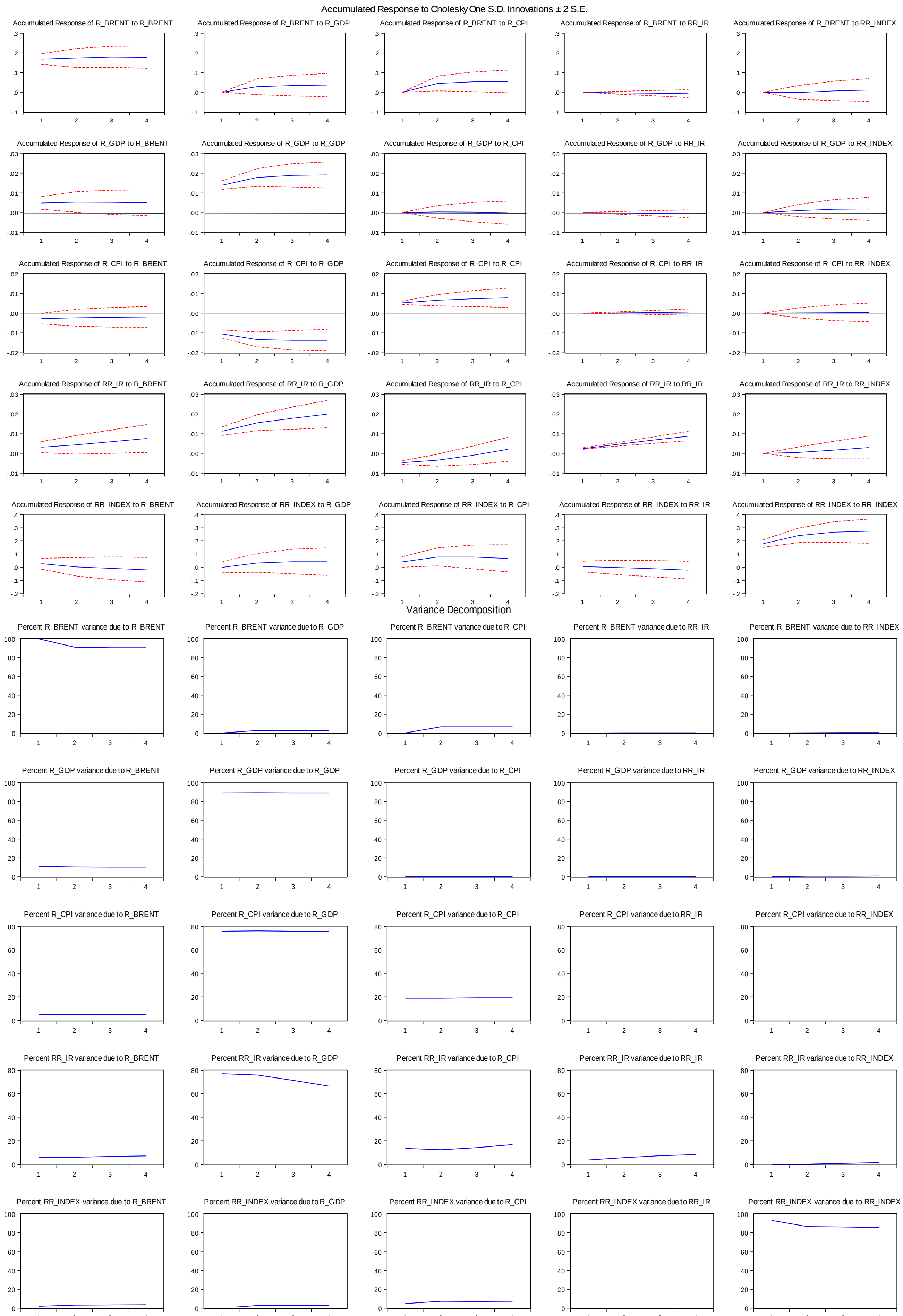


Figure-20. IRF and Variance Decomposition for Belgium.

4.6.3. IRF and Variance Decomposition for CPI

The impulse response functions from the countries are somewhat different, With Japan showing almost no effect as the lower confidence bound is on zero. Norway shows slightly positive response while Belgium and Denmark are showing full negative response. However, only the response for Japan shows significant in the first quarter although weak. Again, the pattern here does not meet prior expectations of importing and exporting countries having similar traits.

Variance decompositions show that fluctuations in CPI for Norway is mainly due to its own shock, contributing up to 94%, while shock in oil price contributes to the rest fluctuation. This implies that oil price shock has very mild effect on inflation. For other countries, this is also the same picture shown. Except for Denmark where oil price contributes up to 16% of fluctuations in CPI and Norway up to 6%, other countries have maintained a figure below 5% throughout the observation period. This again is consistent with economics reasoning as more money through export of oil has the tendency to increase the inflationary pressure

4.6.4. IRF and Variance Decomposition for Stock Market

From the IRF graph, there is an indication that a shock in oil price has little or no effect on Norway, as the lower bound of the confidence interval lies on the zero line throughout the period and significant up to the second quarter. Instead own shock has more effect, as the graph shows a strong significance and positive to own shock up to the fourth quarter. Denmark and Japan have shown a similar pattern in response to oil price shock. During the first quarters, it was fairly positive but fell to zero after the second quarter, while stretching further to negative into the future. Just like in Norway, own shock for Japan and Denmark contributes more to fluctuations in their stock market prices. For Belgium, the response to oil price shock has also been zero and stretching to negative into the future. Just like other countries, own shock contributes more to its fluctuations.

Variance decomposition for all the countries confirms that, own shock contributes more to its fluctuations than that from oil price shock. Surprisingly for Norway, shock in oil price actually explain up to 19% of fluctuations in stock market prices while own shock contributes about 74% in the first quarter and slowly decreases and CPI around 5% in the first quarter but increases after that. Similar behavior is shown for Japan where oil prices explains up to 11-14% of variations in stock market prices, with own shock contributing around 84% but dies down to around 65% in the long run as interest rate picks up. For Denmark, own shock is not as strong, lying around 65-50% throughout the period, leaving the rest fluctuations to GDP, IR and BRENT although, BRENT has the least contribution to the fluctuations. For Belgium, a shock in oil price has very little effect on stock market prices as own shocks contributes to around 93% of its fluctuations oil price only accounts for about 2% for Belgium.

4.6.5. IRF and Variance Decomposition for Interest Rate

The response of interest rate to a shock in oil price is positive for Denmark and Norway, but at the point of shock, there is no immediate effect on Norway. It only becomes mildly positive after the second quarter. The shock has no effect on Belgium but negative for Japan. The response is slightly significant in the first quarters for Denmark, Japan and Belgium and insignificant for Norway.

Variance decompositions show that shock in oil price has a mild effect on interest rate for all the countries being observed. But Denmark feels the effect more, with oil price contributing up to 19% of its fluctuations in the first quarter although decreasing to around 14% from the second quarter whereas the shock only affects interest rate in other countries up to around 5% in the initial quarters, but this increases to around 9% for Norway in the last quarter. This indicates that perhaps, oil exporting countries feel the effect of oil price hike in interest rates more than those of importing. This is logical, as a positive shock in oil price leads to more inflow of foreign currency to exporting countries which in turn appreciates the local currency and promote investments while reducing unemployment. Thus, a possible way to minimize demand-pull inflation is an increase in interest rates.

5. Discussion of Results

The table below highlights the main research findings from impulse response functions for various countries. For the purpose of clarity, the discussion addresses oil importing and exporting countries in separate paragraphs.

Table-11. Overall IRF for impact of oil price shocks on macro-economic variables.

Countries	BRENT to BRENT	GDP to BRENT	CPI to BRENT	IR to BRENT	Stock market to BRENT
Oil exporting Norway	Positive	Positive	Positive	Mildly positive	Mildly positive
Oil exporting Denmark	Positive	Positive	Negative	Mildly positive	Zero to negative
Oil importing Japan	Positive	Negative	No effect	Negative	Zero to negative
Oil importing Belgium	Positive	No effect	Negative	No effect	Zero to negative

A glance at Table 11 above reveals that GDP and interest rate in Norway and Denmark (that are oil-exporting countries) respond positively to a shock in oil price. Nevertheless, the response from interest rate is very mild. When it comes to CPI and Stock Market, it seems not to matter whether a country belongs to the importing or exporting category, as behaviors are not coherent. The results for Norway and Denmark indicate that increase in oil price benefits their economy, as GDP is positive. Although inflation is also positive but this inflation is likely to be a demand-pull inflation of which if enough resources are made available, would not have much effect on the economy. Moreover, interest rate is also mildly positive which suggests that a move has been made to cut down demand. This can be evident in the IRF for Norway where initially, the shock did not affect interest rate, but after about 5 months later, interest rate becomes positive, which can be seen as a move to reduce inflation. This results lends support to the work of Bjørnland (2009) which argue that the economy of Norway benefits from oil price increase. Consistent with this, Jiménez-Rodríguez and Sánchez (2005) also argue that oil exporting countries benefit from positive shock in oil price while those of importing countries do not benefit the same way. Although it is strange to notice that stock market prices and inflation of Denmark have different response to oil price shock from that of Norway even when they are both exporting countries, different countries are expected to react slightly differently to oil price shocks due to different economic backgrounds. While authors such as Sadorsky (1999); Jones and Kaul (1996); Wei (2003) Lardic and Mignon (2008) and Basher et al. (2012); Cifarelli and Paladino (2010); Huang et al. (1996); Miller and Ratti (2009) and Apergis and Miller (2009) lend support for negative response for stock market prices as found in our literature review, authors such as Park and Ratti (2008) argue for a positive response. This leads to further argument as to what the right response should be. From our results, except for Norway which have a slightly positive response, the rest countries possess a negative response after five months period of no effect. From the law of majority, we can argue that it is possible that the response of stock market prices to a 1 standard deviation positive shock in oil price is negative, irrespective of whether it is an oil importing or exporting country.

Moreover, differences in the results for the two oil exporting countries in our research are consistent with that of Jimenez-Rodriguez (2013) which argue that not all oil exporting countries do not respond the same way to oil price shocks due to other factors such as differences in exchange rates.

Nevertheless, other authors such as Hamilton (1983); Rotemberg and Woodford (1996) and Carruth et al. (1998) report a contrasting result to our earlier assertion of positive impact of oil price shock on GDP, arguing that GDP response negatively to oil price shocks. Nevertheless, because their work did not distinguish between oil importing and exporting countries, it is possible that this negative response might have in fact, come from those of importing countries. This line of reasoning can be justified by the work of Jiménez-Rodríguez and Sánchez (2005) which argues that oil exporting countries benefit from positive shock in oil price while those of importing countries do not benefit the same way.

Nonetheless, one can say to a certain extent, that the two oil-importing countries (Japan and Belgium) show a similar behavior. From the results shown on the table, especially for GDP, there is no indication that oil-importing countries benefit from a positive oil price shock, just as expected from literature review. It is observed that GDP is negative in Japan and no effect for Belgium, which accords with the work of Carruth et al. (1998) and Jimenez-Rodriguez (2013) which lend support for negative impact of positive oil price shock on GDP. For Japan the zero effect found for CPI is also consistent with that reported in Hooker (2002). Nevertheless, the reason why oil importing countries might not benefit from positive oil price shock is obvious, but it is still necessary to reaffirm it. This is because an increase in oil price will cause the importing countries to spend more, using resources which would have been used to invest in other sectors to be used to import oil. To some extent, a very drastic shock in oil price has the tendency to even cause imported inflation to importing countries. However, CPI for Japan has shown no effect for a shock in oil price rather, a positive shock in GDP shows a strong effect on CPI, which renders it negative. Thus, this implies that for Japan, fluctuations in GDP has more impact on CPI than shocks in oil price. In the case of Belgium, CPI shows negative response to shock in oil price. Negative response of CPI to oil price shocks is against previous studies such as Leduc and Sill (2004) and Frankel (2006) which report a positive response and Hooker (2002) who argue for no effect of oil price shock on CPI. However, it might be the case that Belgium reduces oil import and switches to alternative fuel, which increases its industrial outputs and as a result, pressure on cost-push inflation is reduced. This could be the possible reason why CPI is negative for Belgium. For interest rate, it can be observed that a common trait for importing countries is that a shock in oil price does not have the tendency to increase interest rates, it can either reduce it or not affect it at all, which is consistent with the work of Leduc and Sill (2004) and Frankel (2006). For stock market, a common behavior for importing countries has been an initial zero effect but later becomes negative after the second quarter. This is logical as during the first quarter importing countries might still have some stock of oil but after that, will begin to feel the effect of the increase in price.

Moreover, the negative response of CPI to oil price shock for Belgium and Denmark in this paper is contradictory to previous research. But let us consider a few explanations. Looking at the variance decomposition for Denmark and Belgium shown earlier, one can discover that fluctuations in CPI is mainly due to GDP, unlike Japan and Norway where GDP has lesser effect. This means that one should not rule out the possibility that the negative response might have in fact, been as a result of the shock in GDP in response to shock in oil price. Nevertheless, another possible reason is that, it might have been caused by recent fluctuations in the world economy like the 2008 financial crises. Again, because slightly different methodologies are used alongside different set of data for the different papers, there is tendency for results to differ slightly.

6. Conclusion

This paper investigates the impact of oil price shocks on macroeconomic variables of two oil importing countries (Japan and Belgium) and two oil exporting countries (Norway and Denmark), using data from 1995q1 to 2015q4. In order to achieve this purpose, the research employs the VAR model in line with previous work, which is then estimated with the use of the Cholesky decomposition. Specifically, the objectives set are

- To investigate the effect of oil price shock on macroeconomic variables.
- To assess how macroeconomic variables in oil importing and exporting countries respond to oil price shocks.

From our discussions so far, it can be noticed that positive oil price shocks affect each macroeconomic variable differently. At this point we will ignore whether a country belongs to importing or exporting category and focus on variables. Let us reconsider the table shown earlier, while pursuing the answer to the first question for this research.

6.1 Question 1: How Do Macroeconomic Variables Respond to a Positive Shock in Oil Price?

Table-12. Responds to oil price shocks.

Countries	BRENT to BRENT	GDP to BRENT	CPI to BRENT	IR to BRENT	Stock market to BRENT
Norway	Positive	Positive	Positive	Mildly positive	Mildly positive
Denmark	Positive	Positive	Negative	Mildly positive	Zero to negative
Japan	Positive	Negative	No effect	Negative	Zero to negative
Belgium	Positive	No effect	Negative	No effect	Zero to negative

Firstly, from Table 12 above, it can be noticed that own positive shock (BRENT) also leads to a positive response at all times. Again, there is a high chance that GDP responds positively to oil price shocks since majority of the outcomes are positive. From the table, one can say that the response of CPI to oil price shocks, whether positive or negative has 50-50 chance, as results on the table have two positives and two negatives. Turning to interest rate, it can be argued that it slightly responds positively to oil price shocks as shown on the table, but it could also be negative or have no effect at all. Finally, the stock market has shown to have zero response at the time of oil price shock but runs to negative after few months.

6.2 Question 2: Are there Differences and/or Similarities between Oil Importing and Exporting Countries to the Response of Macro-Economic Variables to Oil Price Shocks?

The objective here is to assess whether there are differences or similarities on the effect of positive oil price shocks on variables according to whether a country belongs to importing or exporting category. For simplicity, the table is called up again, indicating whether a country belongs to importing or exporting.

Table-13. Differentiating between IRF for oil importing and exporting countries.

Countries	BRENT to BRENT	GDP to BRENT	CPI to BRENT	IR to BRENT	Stock market to BRENT
Exporting Norway	Positive	Positive	Positive	Mildly positive	mildly positive
Exporting Denmark	Positive	Positive	Negative	Mildly positive	Zero to negative
Importing Japan	Positive	Negative	No effect	Negative	Zero to negative
Importing Belgium	Positive	No effect	Negative	No effect	Zero to negative

From the above Table 13, one can conclude that there is a little pattern in the response of all variables according to whether they belong to oil importing or exporting countries. However, we cannot say for sure whether there are general similarities within oil importing and exporting countries. Two obvious similarities within oil exporting countries is found in GDP and interest rate where both countries show mildly positive responses to positive shock in oil price.

Within oil importing countries, the pattern seen is that CPI, interest rate and stock market do not have the tendency to respond positively to oil price shocks rather, it could be negative or zero. Lastly, a general comment is that because GDP and stock market have tendency to increase for exporting countries unlike importing countries, it can be concluded that oil exporting countries are bound to benefit from oil price shocks while oil importing countries suffer for it. However, the resultant effect for oil exporting countries is a minimal increase in interest rates.

6.3. Policy Implication of Findings

This section will recommend possible response policies for government policy makers in both importing and exporting countries, based on the behavior of variables to shock in the price of oil found through this research. Furthermore, it will also suggest possible strategies to business men in response to the behavior of the economies during the period of oil price shock

6.3.1. Implications to Oil Importing Countries

The implication of these results might be of interest to both government policy makers and business men in oil importing countries. When there is a positive shock in the price of oil which reduces GDP and stock market for importing countries, the most viable response might be to cut spending on imports and use expansionary fiscal policy to boost the economy. Since oil price shock does not have the tendency to increase inflation in importing countries, increasing aggregate demand will not cause much pressure on inflation. For business men in importing countries, the most viable response will be to borrow more from banks to invest since interest rate has the tendency to reduce.

6.3.2. Implications to Oil exporting Countries

In the case of oil exporting countries, government policy makers should adopt measures to avoid the overheating of the economy. They can decide to use monetary policy to cut aggregate demand. Again, because the increasing interest rate and more inflow of foreign currency will lead to the appreciating of local currency, it is advisable for the country to use the managed float regime for its exchange rate. This is because, the currency is allowed to over appreciate, local industries will suffer as their products will become internationally uncompetitive and thus, a cut in demand. Therefore, for business men, this is not a good time for investment as borrowing has become expensive and international demand cut down. Perhaps the best option would be to focus on local demand and focus on home market, while reducing its international exports.

6.4. Limitations of Study and Recommendations for Future Research

There are two limitations which are found in this research. One of them is in the use of the Cholesky decomposition which implies that variables must be ordered in a particular way and secondly, because macroeconomic variables are very quick in response to changes in the economy, the use of quarterly data might not be revealing. lastly, because our research also looks at how macroeconomic variables respond to oil price shock irrespective of whether they are oil importing or exporting, the individual time series analysis would have been augmented by a panel data analysis thus, we might not have shown the best results by not also running a panel data analysis

Based on the limitations noted above, our recommendations for future research are to run a structural VAR with monthly data, both at individual country level, and at panel level.

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