The Impact of Natural Gas Price Shock on Economy:

Case of Canada and Norway

by

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Abstract

Due to the importance of natural gas price fluctuation, the impact of the natural gas price shock is estimated for two major natural gas exporting countries. Using quarterly data for the period 1993:Q1 - 2008:Q2 for Canada and Norway, the VAR model is employed in order to estimate the effect of natural gas price change on five of several major macroeconomic variables. Using linear specification of natural gas price shock I find that both countries are slightly vulnerable to gas price shocks. Due to the shock in natural gas price, a significant impact is found on Canadian GDP and net export, and the only significant impact on Norwegian GDP. These results are due to the share of natural gas revenue in these countries' GDP and their national regulations.

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"BE IN it to WIN it"

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List of Abbreviations:

AD: Aggregate Demand

ADF: Augmented Dickey Fuller

AIC: Akaike Information Criterion

AS: Aggregate Supply

GDP: Gross Domestic Product

GSP: Gross State Product

HQ: Hannan-Quinn Information Criterion

I(x): Integrated of *x*'s order

IRF: Impulse Response Function

KPSS: Kwiatkowsky, Phillips, Schmidt, Shin

PP: Phillips and Perron

SC: Schwarz Information Criterion

VAR: Vector Autoregressive

VECM: Vector Error Correction Model

1. Introduction

Over the last several decades, natural sources of energy have become an increasingly popular field of research for economists. Sources of energy are important to all industries and their prices affect many sectors of an economy such as their business cycles, stock markets, real exchange rates and export and import revenues. The most popular energy source is crude oil due to its flexible uses. Due to its high demand on the world market, the price of crude oil constantly fluctuates which in turn affects the economies of countries that import and export oil. The importance of the variation in the price of crude oil is reflected in the number of studies exploring the impact of oil on the economies of countries involved in its trade. However, there are there are few studies exploring the impact of natural gas price shock on global economies, especially for exporting countries.

In addition to oil-exporting countries, there are other countries that export natural gas and which are highly dependent on the export of this product. The current leading countries in natural gas export are Russia, Norway, Canada, Algeria and Turkmenistan, which each export more than 50% of their natural gas production except for Russia, which only exports 27.7% of its product. (Leading Natural Gas Exporters 2008). For many natural gas exporters, especially developing countries, natural gas exports are often the main source of government revenue and therefore these countries are vulnerable to natural gas price fluctuation. For developed countries these effects are less obvious due to other successful economic activities. This study investigates the impact of natural gas price shock by looking at the economies of Canada and Norway, since these countries are leaders in exporting natural gas and have the most available recent data for the last 20 years.

The purpose of this study is to find whether natural gas price shocks have a similar effect on macroeconomic variables as seen with crude oil price shocks. I have chosen to use natural gas because it is the fastest growing source of energy and it is expected that by 2025, its consumption will increase by approximately 50%, accompanied by an increase in price. (About Natural Gas, 2009)

Theoretically, a variation in the price of natural gas price will change the cash flow between exporting and importing countries. The difference in impact clearly depends on the share of natural gas in the economy of each of the importing or exporting countries. In the case of an oil price increase, the effect on exporting countries is an increase in government revenue in the short term. However, in the long term, this effect will fade and demand for oil will decrease due to its high price. (Majidi 2006).

Higher natural gas prices affect the economy of an exporting country through a variety of channels. Ceteris paribus, in the long run, high prices will force consumers to use less natural gas and to find alternative and cheaper energy sources, which will subsequently decrease the demand for natural gas as well as net exports. (Chang 2001) An increase in natural gas export price also increase government revenue, which will lead to money appreciation of exporting countries, which, in turn affects the exchange rate of local currency. Accordingly, this makes natural gas more expensive to export, which will result in a decrease in natural gas demand. To keep the exchange rate at the same level, the government and central bank must intervene in the foreign exchange market by creating more local currency and selling it on the foreign exchange market (Friedman 1992) . When the amount of money on the market increases and the money supply curve shifts to the right, exchange rates will decrease. This process will lead to higher inflation in the local economy as the amount of money in the country increases.

The objective of this study is to analyze the impact of natural gas price shock on the same macroeconomic variables of both Canada and Norway and to determine the level of impact. The Vector Autoregressive (VAR) model has been employed for this study by using the quarterly series from 1993-2008. The VAR technique is now frequently used and considered the appropriate tool to employ when estimating the Granger Causality test, Impulse Response, and Variance Decomposition of natural gas price shock on the macroeconomic variables. E-Views 7.0 econometric software has been used to carry out the tests in this study.

The results of this study show that natural gas price shocks do not Granger cause any of the variables studied at the five percent significance level; in the same way, the variable studied do not significantly Granger cause natural gas price shock, with the exception of GDP for Norway. Impulse Response Functions show that natural gas price shocks significantly affect Canadian GDP and net exports and Norwegian GDP. This study also demonstrates that variables other than GDP and net exports are affected by natural gas price shocks; however, these effects are insignificant. Variance Decomposition results show that there is a share of natural gas price shock in the GDP of both Canada and Norway and in the net exports of Canada.

The remainder of the paper is organized as follows: Section two provides brief background information on the economies of Canada and Norway. Section 3 reviews recent theoretical and empirical literature about the methods of studying shocks and effects of natural gas price shocks to other countries. Section 4 describes the data employed in this study. Section 5 discusses the methodology of the study. Section 6 illustrates the empirical results of the study and provides comparative analysis. Section 7 concludes the study by explaining the results and provides suggestions for the future research.

2. Country Information

2.1 Canada

Canada, a member of both the Organisation for Economic Co-operation and Development (OECD) and the Group of Eight (G8), is one of the largest and wealthiest countries in the world with a Gross Domestic Product (GDP) of $1.57 trillion (estimated in 2010)[1]. The Canadian GDP mainly comprises income from services (78%), industry (20%) and agriculture (2%). Canada is one of the largest exporters of agricultural product and primary energy. The main export commodities of Canada are agricultural products, timber, motor vehicles and parts, industrial machinery, aircraft, oil and gas, aluminium and other mining products. Its main exporting partners are the U.S., the United Kingdom, China and Japan. Canada provides approximately 85 percent of its total gas export to U.S. The unemployment rate is 8 % (estimated in 2010).

Between 1990 and 2009, Canadian GDP of Canada grew by 60 percent, which was mainly due to a 28 percent increase in the service sector. The oil and gas industries have become less popular in Canada in recent years because the prices and demand for energy sources declined, leading employment from this sector to move to other sectors, specifically the service, electronic and machinery sectors.[2]

[1] IMF- International Monetary Fund - Canada
[2] CIA World Factbook - Canada

2.2 Norway

Norway is one of the major non-Organization of Petroleum Exporting Countries **(**OPEC) oil-exporting countries, and is also the second largest country in natural gas exports. Its economy is a combination of free market activity and government intervention. The GDP of Norway is $ 414.5 billion, with principle revenues in agriculture (2.1%), industry (40.1%) and service (57.8%). The unemployment rate for 2010 was estimated at 3.6 %. The net export of the country is in a positive scale, where revenues from export exceed costs from imports. The main export commodities are oil and gas, machinery equipment, metals, ships and fish. Its major trading partners are the United Kingdom, Germany, the Netherlands and Sweden. Norway is very rich in natural resources (oil and gas, minerals, forest, hydropower), which are the main sources of income of the country. Oil and gas industries comprise approximately half of the export revenues.[3]

[3] CIA World Factbook - Norway

3. Literature Review

Over the last thirty years, many scholars have investigated the relationship between energy source price shocks and the economic activities of a particular country or set of countries. These works were analyzed with different methods, which produced different results for different time periods and countries. These results also differed depending on the level of development of a country: developed, developing or in transition. Besides these categories, countries can be divided into two subgroups: energy importing and energy exporting countries.

Among the existing literature on energy sources (crude oil, natural gas, coal), There are numerous papers which investigate the effect of oil price shock on macroeconomic variables of the countries studied. One of the first studies about oil price shock was written by Hamilton (1983), who using Sim's (1980) six-variable system, estimated the effect of oil price increase between 1948-1972. In his study Hamilton (1983) found that seven out of eight recessions during this period were caused by the oil price shock and these shocks reduced US output growth. He also found that among all six variables, the only significant variable to predict future oil price change was import prices. Later, Mork (1989) further developed the model by extending the time until 1988. He estimated asymmetric oil price shocks, where asymmetric stands for not only oil price increase but also for oil price decrease. The findings of this research showed a largely negative effect of oil price increase on US total output and a less significant effect of oil price decrease.

Sadorsky (1999) examined the relationship between oil prices and stock market return as well as how oil prices and oil price volatility affect real stock returns based on U.S. monthly data from January 1947 to April 1996. Including short-term interest rate and industrial production to his analysis, he used an unrestricted VAR model to estimate oil price effect, and noted the importance of oil price in explaining the behaviour of other economic variables. He also highlighted that oil price volatility shocks have asymmetric effects on the economy.

Al-Rjoub (2005) also estimated the reaction of U.S. stock markets to the change in oil prices using data from 1985 to 2004. In his study he employed three approaches: VAR model, Mixed Dynamic and Granger Causality approaches. All three approaches gave the same result: the stock market immediately and negatively reacts to the change in oil price. Moreover, in his study with Granger causality he tested for the direction of effect of stock markets and oil prices. His findings were that both stock market returns and oil price shocks Granger cause each other.

Similarly, Gounder and Bartleet (2007) investigated the oil price shock and economic growth for an importing country, New Zealand, using VAR methodology based on quarterly data from 1989 – 2006. They employed the multivariate framework to measure the short-run impact of oil price shocks on economic growth, inflation, real wage and exchange rate. For their model they applied one linear and two non-linear oil price transformations to study the short run impact with direct and indirect effect of oil price shocks. Using the Wald and Likelihood Ration test of Granger Causality they found that in linear and asymmetric oil price increase, the impact of oil price change is significant. Following the Granger Causality test, using Impulse Response Function and Variance Decomposition they found that oil price shocks have a direct effect on economic growth and an indirect effect through inflation and exchange rate.

Other studies done by Eltony (2001) and Al-Mulali and Che Sab (2010) on Middle East oil exporting countries with small open economies which showed slightly different results on the macroeconomic variables by the impact of oil price fluctuation. Eltony, (2001), looking for the effect of oil price fluctuation on Kuwait's economy, found that oil price shocks affected the demand for money, although the role of monetary policy in influencing economic activity of Kuwait was scanty. Al-Mulali and Che Sab (2010) investigated the impact of oil price shocks on Qatar, employing data from 1970-2007 covering all main oil price shocks, starting with the OPEC embargo. In their study, the authors employed four variables and the results revealed that oil price shocks positively impact on Qatar's GDP in both the short-run and the long-run but negatively impact inflation. As Qatar's currency strengthens, the government tries to keep the exchange rate of the Riyal at the same rate, the cost of which is a high inflation rate in Qatar. As for the current study, a similar method and variables that Al-Mulali and Che Sab (2010) used in their study on Qatar will be employed.

Energy price change in the Canadian economy was studied by Dissous (2007) in the multi-sector model, especially with oil price change. He found that an oil price increase is beneficial for the Canadian economy as it increases real GDP of the country, consumption profile and household welfare. He found that a 20 percent increase in oil price would contribute to a 0.4 percent increase in GDP. An influence of oil price increase was seen in employment as well, as capital and labor tended to move to export booming sector, i.e. petroleum. Dissous (2007) found that for Canada, an oil price shock has a twofold effect. The negative effect of shock appears in other industries, while an increase in GDP will lead to an appreciation of the real exchange rate, which in turn would harm other manufacturing exports. By opposing other studies with a one-sector model, Dissous' (2007) multi-sector model analysis results suggest that not all industries are affected in a similar way. A permanent increase in the price of energy would be beneficial for energy industries but would be harmful for manufacturing industries. As Dissous (2007) studied the effect of energy prices in general, and especially oil price, this study will estimate the effect of natural gas price change and aims to verify whether there is a significant effect on the Canadian economy, as has been previously seen with oil price change.

Jimenez-Rodriguez and Sanchez (2005) studied oil price shock in OECD countries, including Canada and Norway. They found that an oil price shock increases inflation and long-term interest rate. For other macro economic variables they found different effects for Canada and Norway. An increase in oil price would decrease the real wage in Norway, whereas it would increase the real wage in Canada. An oil price decrease had a positive impact on GDP of Norway but a negative impact on Canadian GDP. The authors' explanation of the negative impact on Canadian GDP was due to real exchange rate appreciation. Again, it should be noted that this study will investigate if natural gas price shock has the same impact on both the Canadian and Norwegian economies as the findings of Jimenez-Rodriguez and Sanchez (2005). Both of these countries are leaders in exporting both natural gas and crude oil (top 3 in exporting natural gas and top 15 in exporting crude oil).

Among sources of energy, there are several papers written on natural gas price shocks and its impact on the economic activity of a country. One of the first studies that looked at natural gas price effect is Leone's (1982) who examined the influence of natural gas price on regional economic activity, mainly in the Northeast region of the U.S.A. Stockfisch (1982) studied the income effect of natural gas price on suppliers and households, but he did not find any clear effect overall. Ott and Tatom (1982) studied the natural gas price effect on inflation, which showed that there is an effect on natural gas price shock on inflation but that the effect is temporary. They also found that if the government decontrols natural gas price, there will be competition in the natural gas industry, the price of natural gas will decrease and will not increase. In sum, through the results of previous studies, it can be shown that expected effects of natural gas price change were not very significant.

Several studies were conducted to estimate natural gas price and the export effect on a country. Andersen and Faris (2002) investigated the Bolivian case with natural gas export during the natural gas boom. As a result, it was found that natural gas export would increase government savings and GDP of Bolivia. Other than that, wages and income with employment rate increase. Weinstein and Clower (2000) obtained the dual effect of natural gas price increase on the Texas economy. Higher natural gas price create extra jobs, income and tax revenues. Each 1$ increase in the price of natural gas brings around $3 billion to the state economy, creates an extra 8,800 jobs and pays about $400 million. On the other hand, the increase in gas price will increase the cost of industries that use natural gas as an input for their production. Due to increase in gas price, total state output lowers by $4.29 billion, 21,000 jobs are lost with $758 million compensation. From this paper, it can be concluded that keeping the domestic price of gas at the same level and increasing the export price will lead to the increase in state revenue, employment and income of residents. Analogous results on California were obtained by Global Insight Inc. (2006). Economic activity of the state and natural gas price had an inverse relationship. With the price increase, employment, income and GSP (Gross State Product) would decline, whereas with price decrease they would go up.

Kubo's (2010) findings of the natural gas export effect on the Myanmar economy were not that different from other findings in general. Myanmar's economy was also vulnerable to natural gas price shock as its share in GDP was 12.4 percent and the share of natural gas export was 40 percent of total exports. This high share of natural gas revenue in GDP was a cause for high inflation in the country, which was 22.9 percent per annum in 2009.

From the preceding papers, most of the studies that were carried out are focusing on oil price shocks and few studies were carried out on natural gas price shocks. This study will be one of few studies about natural gas price shock and its impact on the economy using VAR model, which will perform Granger Causality test, Impulse Response Function and Variance Decomposition. This study will provide more evidence on how economies or economic variables are vulnerable to the natural gas price fluctuation and to what extent.

4. Data

This study adopts quarterly data observations from the first quarter of 1993 to the second quarter of 2008, and examines six macroeconomic variables, which are: natural gas price, GDP, inflation, net export, interest rate and employment. Quarterly data for Canada were obtained from Statistics Canada[4] and National Energy Board[5] via personal contact, and for Norway data were obtained from Statistics Norway[6] and from Statistical Portal of OECD web-page[7]. In this study, quarterly data were chosen to obtain the greater number of samples and provide greater degrees of freedom. Here, natural gas prices were used in real terms and were obtained for Canada from the National Energy Board Research Officer of Energy Trade Team, and for Norway from the Statistical Yearbook of Norway.

Other variables are defined as follows;

- Real gross domestic product (*gdp*) by income measures country's GDP at market price, where the data were obtained from Statistic Canada and Statistics Norway.
- Inflation (*inf*) is defined as the quarterly changes in CPI of Canada and Norway.
- Employment (*emp*) is monthly data of employed percentage of people in Canada, who are 15 years old and over and total number of employed people in Norway who are older that 15 years old and who are considered to be employed by Norwegian regulations.
- Net export (*nx*) is monthly data of total of all merchandise of Canada and Norway.
- Interest rate (*int*) is monthly data of interest rate of Bank of Canada and Bank of Norway.
- Natural Gas Price (*ngp*) is the real natural gas trade export price of Canada and Norway.

[4] http://www.statcan.gc.ca/start-debut-eng.html
[5] http://www.neb-one.gc.ca/clf-nsi/rcmmn/hm-eng.html
[6] http://www.ssb.no/uhvp_en/
[7] http://stats.oecd.org/mei/default.asp?rev=4&lang=e

All the data except GDP and inflation were monthly. All monthly data except net export were transformed to quarterly by taking the average of numbers, where net export data were transformed to quarterly by summing the numbers. All variables were seasonally adjusted by Census X12 procedure with multiplicative adjustment except inflation, whereas for inflation additive adjustment was used. All variables except inflation are expressed in logarithmic differentials and employment variable of Norway is in second difference.

In this paper symmetric price shock will be used in order to estimate price shock effect. This shock occurs when there is a change in current price compared to price of a previous period. In this study, if there is a change in current price compared to price of last quarter. The resulting formula is:

$$natural\_gas\_price\_shock_t = natural\_gas\_price_t - natural\_gas\_price_{t-1}$$

5. Methodology

5.1 Unit root and Stationarity

Before selecting the methodology and analyzing time series data this study requires a specific approach to the analysis and investigation of time series properties variables. It is generally known that time series data should be stationary as non-stationary data generally cause wrong interpretation of results. There exist many tests for unit root investigation but the Augmented Dickey Fuller (ADF) tests (Dickey and Fuller, 1979) without trend is used in this study to check for the unit root. Among the three most popular tests for the unit root, the ADF is a better test than the PP test (Phillips and Perron 1988)[8] and the KPSS (Kwiatkowski, Phillips, Schmidt, and Shin 1992)[9] unit root test, as the PP unit root test is valid under general serial correlation and heteroskedasticity and the KPSS unit root test is less existent test for the null hypothesis of trend stationary I(0) than other tests and it tests the null hypothesis that an observable series is stationary around a deterministic trend[10]. Therefore, the ADF unit root test is implemented and all results are based on this test.

As a result of these tests for Canada, natural gas price, GDP, employment, interest rate and exchange rate were non-stationary, integrated of first order *I(1)*, with a 1% significance level. Inflation occurred to be stationary (*I(0)*) with a 1% significance level but net export – stationary with a 5% significance level. For Norway, all variables except inflation and

[8] This PP test is an extension of the Dickey-Fuller test, which makes a non-parametric correction to the t-test statistics and is more robust in the case of unspecified autocorrelated and heteroskedastic regression residuals.
[9] The KPSS test suggests that the observable series can be expressed as the sum of a deterministic trend, random walk, and stationary I(0) disturbance and is based on a Lagrange Multiplier test. By testing both unit rood and stationarity, one can distinguish if a series is stationary, has unit root or data is not sufficiently informative to check whether serias are stationary or integrated.
[10] http://support.sas.com/documentation/cdl/en/etsug/63348/HTML/default/viewer.htm#etsug_autoreg_sect026.htm

employment occurred to be integrated of first order (I (1)), while inflation followed I (0) and employment followed I (2). After getting results of some variables as non-stationary, another step was implemented to convert non-stationary variables into stationary. Log differences were taken, and the result showed that their log differences are stationary. (see Appendix I) Thus, inflation is used in levels while the other variables are in log differences, and employment for Norway is in difference of second order.

5.2 Lag order selection

Another criteria that should be investigated and tested before estimating the VAR is the choice of lag length criteria. This test is very important and should be done before estimating our model. In a model the more variables there are the better the fit of the data. So, if we increase the number of variables our VAR model will fit the data better than if we do not increase. On the other hand, if we increase the number of variables our model will have additional parameters, depending on the number of added lags and regressors. Therefore, it is important to estimate information criteria as these criteria provide an adjustment between goodness of fit and the number of parameters. There are many criteria that can be used in order to determine the right lag order selection. Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) and Hannan-Quinn Information Criterion (HQ) are the most famous and most used criteria in the lag order selection procedure.

It has been known that smaller values of the measure improve models, so the smallest number of lag lengths in information criteria indicate the most appropriate lag length. It has been argued that in selecting proper lags, four lags can be chosen if it is quarterly data or twelve lags if it is monthly data. When testing lag length criteria, the abovementioned information criteria's preferences do not always coincide with each other. It happens that some information criteria give different lag selection than others. This means that VAR does not properly represent the data generating process. This study was not an exception in lag selection as not all the information criteria coincide. While doing the lag selection test for Canada, SC suggested that 0 lag should be included while all other information criteria suggested that 1st lag should be included. As for Norway, SC indicated 0 lag as well, while all other information criteria indicated 2nd lag. Thus, the most widely used and from the results that were obtained for current study, AIC approach is used. The results of these tests are presented in Appendix II.

In order to recheck the results from Appendix I, lag exclusion tests were conducted for both countries. This test is conducted to check whether lags of variables are jointly significant or not. If lags are jointly insignificant, it means that insignificant lags can be excluded from the regressions. The results of lag exclusion tests confirmed that for Canada all lags are jointly insignificant except lag 1, and for Norway lags are insignificant after lag 2. (see Appendix III)

5.3 Unrestricted VAR

To study the response of macroeconomic variable to the price change of natural gas, an Unrestricted Vector Autoregressive model (VAR) is employed. The VAR is a model that includes many variables where changes in one particular variable are caused by change in its own lags and by changes in other variables and the lag of those variables. The VAR treats all variables as endogenous and does not impose *a priori* restrictions on structural relationship.

In this study most variables follow I(1) process and there may exist cointegration between variables. When there is cointegration it is suggested to use Vector Error Correction Model (VECM) or cointegrating VAR. Although five of six variables are I(1) process, in this study unrestricted VAR will be used. The reason of why VECM is not used is that the sample is short, which covers 1993Q1-2008Q2 periods. The study of Hoffman and Rasche (1996) showed that in the short term, when a sample is short, unrestricted VAR would perform better than VECM. The same result was shown in previous studies by Engle and Yoo (1987) and Clements and Hendry (1995). These studies also revealed that in the short run, when the true restriction is imposed, an unrestricted VAR gives more accurate forecast variance than restricted VECM. Naka and Tufte (1997) also showed that in the short term VECM perform poorly relative to unrestricted VAR. Using Monte Carlo experiment, Naka and Tufte examined the effect to impulse response function and found out that in the short run both models give similar results but different in the long run. This suggests that if in the short term, the loss efficiency is not crucial when VAR is used.

Based on abovementioned studies of Naka and Tufte (1997), Hoffman and Rasche (1996), Clements and Hendry (1995) and Engle and Yoo (1987) in time horizon, the employment of unstructured VAR in this study seems to be reasonable.

Our unrestricted Vector Autoregressive model in reduced form of order p is established to express dynamic response of system interaction in the following way:

$$y_t = c + \sum_{i=1}^{p} A_i Y_{t-1} + \varepsilon_i$$

where y_t=(ngp, gdp, inf, emp, int, nx), c ={c_1,....c_6} is the (6x1) intercept vector of VAR, Ai is the (6x6) coefficient matrix for i=1,2,...p, and ε_i = {$\varepsilon_{1,t}$,.....$\varepsilon_{6,t}$} is an unobservable i.i.d. zero mean error term.

In this study of unrestricted VAR model vectors of endogenous variables are natural gas price (ngp), real GDP (gdp), inflation (inf), employment (emp), interest rate (int) and country net export (nx) and are according to first Cholesky ordering. Within the impulse response analysis, the innovation of the unrestricted VAR is orthogonalized using the Cholesky decomposition of the covariance matrix and so that the covariance matrix is diagonal. The purpose of Cholesky decomposition is explained as a shock in first variable simultaneously affects all other variables while not being affected by others. A shock in a second variable affects all other variables except the first one and itself is affected only by the first variable and so on. Thus, the ordering of the variables plays the crucial role in estimating shocks effects and different ordering may give different results. The variables' order of current study is the following:

$$\begin{pmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{pmatrix} \begin{pmatrix} e^{ngp} \\ e^{gdp} \\ e^{\inf} \\ e^{emp} \\ e^{\text{int}} \\ e^{nx} \end{pmatrix} = \begin{pmatrix} \varepsilon^{ngp} \\ \varepsilon^{gdp} \\ \varepsilon^{\inf} \\ \varepsilon^{emp} \\ \varepsilon^{\text{int}} \\ \varepsilon^{nx} \end{pmatrix}$$

In the matrix, applied ordering implies that natural gas price changes are exogenous variables. Even though Canada and Norway are the largest natural gas exporters after Russia their exports are vulnerable, especially for Canada. Demand and price of natural gas depends on many factors like: domestic consumption, global economic growth, energy intensity, expectations of natural gas producers regarding future natural gas demands, speculative trading in natural gas market and the price of crude oil. Accordingly, natural gas prices are considered as exogenous, and it is expected that there is an immediate and considerable impact on other key macroeconomic variables if there are significant shocks in natural gas price.

The second variable in the ordering is GDP. For natural gas exporting countries increase/decrease in a price of natural gas will automatically increase/decrease governmental revenue in a short run. Thus, the order of GDP in the matrix being second means that GDP is affected only by natural gas price shocks and not affected by any other macro economic variables. An increase of money in the government budget will increase the money supply in a country, which will lead to inflation.

Referring to the Phillips curve an increase in inflation is followed by an increase in employment. An increase in the government budget will lead to inflation and this will give more revenue to industries, as prices will increase. This will give industries extra money to spend, which will open more positions in the labor market. Hence, a boost in inflation results in an increase in the bank interest rate[11]. Since the value of money decreases due to inflation, banks, in order not to lose money, tend to increase an interest rate, so that they can compensate the loss because of inflation. As for inflation, the value of local currency will weaken which results in a stronger valuation of foreign currency, i.e. the exchange rate for foreign currency will increase. For importers, for the amount of money that they used to get goods and service now they get

[11] http://www.keralabanking.com/html/inflation_vs_interest_rates.html

more, which increases net export of the exporting countries. The orders of variables are thoroughly revised and put in that way that the previous variables affect the following variables but are not affected by them.

To study the effect of unexpected natural gas price shock on macro economic variables in a more expedient way, it is suggested using impulse response functions (IRF). The use of IRF for evaluating the effect is favorable because the IRFs sketch the response of all the variables in the VAR system to innovations in one of the variables and thus can be used to evaluate the impact of structural innovations. In his critique of Sim's (1980) work, Runkle (1987) suggests that impulse response functions be with standard error band. In this study, standard error bands for all impulse response functions are stated at 95% significance level and they were obtained by Monte Carlo simulations with 1000 replications.

Besides IRF, to complete the analysis of the effect of natural gas price shock, Variance Decomposition should be analyzed as well. Variance decomposition shows a share of shocks in a variable, i.e. what is the percentage of a shock due to its own shock and what is the percentage of a shock due to shock of other variables at each forecast horizon. If one variable has no share in other variables in any periods, which means that the latter variable is exogenous: the movements of the two variables are totally independent from each other. Analysis of variance decomposition needs some identification, which is obtained by the same method as in the case of impulse response. Standard errors are also determined by Monte Carlo simulations with 1000 replications.

To determine if there is a statistically significant relationship between natural gas price shock and other important macroeconomic variables, the pairwise Granger Causality test was carried out using the standard Wald test.[12] This test exemplifies which variable has an ability to cause the change in other variable(s).

[12] It is essential to highlight that this test is performed in the VAR model with differenced data. For levels data modified Wald is used

6. Empirical results

In this section I will discuss the empirical results and analysis of the VAR model that was applied to this study. In this study three analytical tools were mainly used to analyze the impact of natural gas shock: granger causality test, impulse response functions and variance decomposition. In addition, comparison of this study with other studies was implemented to see if there are same effects or not. In comparison I have used studies about both crude oil and natural gas. The reason for comparison of crude oil is that it is also a source of energy which is in high demand and it may have the same impact as natural gas The following results are statistically significant at a five percent level.

As was mentioned in the previous section, changing the orders of variables in the Cholesky decomposition may give different results for impulse response and variance decomposition. For the robustness test an alternative ordering was used based on VAR Impulse Response and Variance Decomposition: natural gas price shock, GDP, inflation, employment, net export and interest rate.[13]

6.1 Granger Causality test

The results of the Granger Causality test for six variables are presented in Appendix VI. For Canada, a natural gas price shock does not Granger cause any macroeconomic variables at five percent significance level. For the case of Norway natural gas price shock does not Granger cause any Norwegian macroeconomic variables as well at five percent significance level but it is

[13] Jimenez-Rodriguez (2007) replaced real effective exchange rate at the end reasoning that exchange rate should be affected by all macroeconomic variables. In this study, replacement of net export and interest rate is explained in that due to inflation, net export can have an immediate impact.

Granger caused by GDP shock. Inflation is Granger caused for Norway at ten percent significance level.

Based on the results from Granger causality tests it can be concluded that, with 90 percent of confidence interval, a natural gas price change can forecast the inflation rate of Norway but cannot forecast movement of any macroeconomic variables of Canada.

6.2 Impulse Response Functions

In this section I will discuss how other variables such as GDP, inflation, employment, interest rate and net export respond to an impulse of natural gas price shock. Impulse Response Functions are based on one standard deviation shock with ninety five percent confidence intervals and results are presented in Appendix V and Va. Appendix V stands for graphical results of Impulse Response Function and Appendix Va shows Impulse Response Functions results in table with standard deviation in parenthesis.

6.2.1 Canada

In the case of Canada, the natural gas price shock affects all macroeconomic variables but not all variables have a significant effect. The only statistically significant variables at the five percent significance level are GDP and net export. For other variables we cannot reject the null hypothesis that there is an effect of natural gas price change on macroeconomic variables. The response of GDP to the natural gas price shock is positive and is significant only during the first quarter. In the first quarter the effect is positive and is 0.0042 percent. In the fourth quarter we can see that GDP's response is negative and -0.0010 percent effect, but it is statistically insignificant. Then the effect dies away.

As for net export, the natural gas price shock's positive impact is seen only in the first quarter as well, by increasing up to 0.113 percent in the first lag and totally disappearing from the second lag.

Although the response of an inflation variable is statistically insignificant, the effect has a longer duration. In the fist lag inflation is increasing to 0.12 percent and in the next lag it goes up to 0.22 percent and gradually fades away after seventh lag. In employment we can observe a negative effect of shock starting from the second lag. The peak of the impact of the shock to employment can be seen in the third lag and vanishes in the eighth lag.

In interest rate we can first observe both positive and negative effects. We can see the negative effect in the first lag, with -0.020 percent change and then in the second lag positive effect by 0.019. Starting from the fourth lag until the tenth lag we can again observe negative effect.

6.2.2 Norway

The case of Norway gave us almost the same results as Canada. A natural gas price shock affects all macroeconomic variables but not all variables have a significant effect. The only statistically significant variable at the five percent significance level is GDP. The impact of the shock on other variables is statistically insignificant; nevertheless the impact is present. The response of GDP to natural gas price shock is positive and is significant only during the first quarter. In the first quarter GDP increases up to 0.008 percent and starting from the second period this effect disappears.

As mentioned above, the other macroeconomic variables also respond to the shock in natural gas price but they are insignificant. For instance, employment and an interest rate increase in the first quarter but from the second quarter the effect of shock disappears. The effect in inflation is revealed after the second quarter and lasts until the sixth quarter and then vanishes. The net export variable has an interesting effect. The shock in natural gas is followed by negative response from net export in the second period and immediate positive response in the third period, after which the effect again vanishes

In both cases this positive response of inflation and both positive and negative response of net export to the change in natural gas price can be justified with the Aggregate Demand (AD) and Aggregate Supply (AS) model. Since both Canada and Norway are natural gas exporting countries, a natural gas price increase may lead to an increase in wages of workers who are employed in natural gas industries, thus affecting income distribution. Moreover, a natural gas price increase will lead to an increase in net exports, as natural gas is an exporting commodity for both countries. The occurrences of all of these economical phenomena shift the AD curve to the right, thereby resulting in an inflation increase.

6.3 Variance Decomposition

The results of variance decomposition of estimated VAR are shown in Appendix VI and VIa. Appendix V shows graphical results of variance decomposition and Appendix Va shows variance decomposition results in table with standard deviation in parenthesis.

6.3.1 Canada

In the case of Canada a high share of natural gas price shock exists in GDP and net export and a small share in inflation. For other variables the null hypothesis that there is not a contribution of natural gas price shock to other variables cannot be rejected. Since in estimating variance decomposition only ten periods were included, we can see that in GDP the contribution of natural gas price shock remains for the whole ten periods at the same level: 33-29 percent. For the net export variable the level of share of natural gas price shock is almost the same as in GDP, (28-26 percent) and remains during the ten periods as well. The subsistence of natural gas price shock in inflation starts only from the third period until the tenth period with gradual increase in first two periods. The gas shock in inflation remains at the 17 percent level after the third period and on.

6.3.2 Norway

In contrast to Canada, the GDP of Norway is the only variable which includes natural gas price shock and statistically significant with five percent level. The other variables do not include any other shocks. As we can see in the first period, a natural gas price shock has 23 percent of share in GDP shock and then, after the third quarter it goes down to 16 percent and remains at this level up to the tenth period.

From the observation of all obtained results for both countries, I can confirm that the contribution of natural gas price shock is crucial for Canada in variation of GDP and net exports, where its average shares are 31 and 27 percent respectively. In the long run the natural gas price shock plays an important role in inflation as well which starts from the third period, as we can see from the graph. Macroeconomic variables of Norway are less sensitive to natural gas price shock that Canada, as the share of gas shock can be seen only in GDP and not in any other variables.

6.4 Robustness Check

For robustness check I have tested impulse responses and variance decompositions for both countries with the alternative order: replacing net exports and the interest rate. The results of the alternative ordering are almost similar to my main ordering with only slight changes in the standard errors. (see Appendix VII, VIIa, VIII) This confirms that the robustness of the results was checked in this paper.

6.5 Comparative Analysis

The studies of Al-Mulali and Che Sab (2010), Dissous (2007) and Jimenez-Rodriguez and Sanchez (2005) with oil price shock and Kubo's (2010), Andersen and Faris' (2002) and Weinstein and Clower (2000) with natural gas price shock found that with an increase in price of natural gas (crude oil) the GDPs of all countries go up; one exception is Global Insight Inc (2006), who found that natural gas price increase negatively affects the GSP of the California. The findings of Jimenez-Rodriguez and Sanchez also gave an inverse result for Canada. My findings about GDP in this study show that the natural gas price shocks positively affect the GDPs of both Canada and Norway. The impact persists only one period but it is significant.

Al-Mulali and Che Sab's (2010), Jimenez-Rodriguez and Sanchez' (2005) and Kubo's (2010) results of the impact of natural gas (crude oil) price shock on inflation rate coincide with each other. They all observed a negative response of inflation on natural gas (crude oil) price change, i.e. they observed an increase in the inflation rate. This study revealed that natural gas price shocks increase the inflation rate in both countries and the impact lasts longer than in GDP. My results with inflation are in line with these other results.

Dissous (2007) and Andersen and Faris (2002) found that crude oil and natural gas price increase positively affects the employment of the countries but Weinstein and Clower (2000) and Global Insight Inc. (2006) found a negative impact of the price shock. The reason of the negative impacts, which were found in Weinstein and Clower and Global Insight Inc. papers, are that gas price shocks had a dual effect on employment. They found that employment in gas industries increases but decreases in other industries, where the latter's effect is higher that the previous'. In my study I found different results for Canada and Norway although the results, as I have mentioned above, are insignificant. Norway has a positive effect in employment due to the natural gas price shock but Canada has a negative effect. In the case of Canada I can say that the increase in export prices will increase domestic prices as well, since Canada exports only 57.2 percent of its natural gas production and the other 42.8 percent of production are used in Canadian market by residents and industries. Norway exports 93.6 percent of its natural gas production and the rest 6.4 percent is used domestically, which has a diminutive impact on employment.

Jimenez-Rodriguez and Sanchez (2005) found that interest rates of studied OECD countries increase with the oil price shock. This result coincides with my findings with natural gas price shock for Norway. Canadian interest rate behaves differently with the gas price shock comparing to the oil price shock. The interest rate has a negative impact at the beginning, and then attains a positive effect, and later, a negative effect of the past shock can be observed.

Dissous (2007) found that with oil price increase there is a decline in net exports of Canada. For Canada I found that with a natural gas price shock there is a positive and significant effect in net exports for Canada. With the increase in the natural gas price net exports also increase in the first period. In Norway, with the rise in export natural gas price, the net exports first decline and then goes up by having a negative impact first and then a positive impact later. The negative impact in Norwegian net export can be explained by the "Dutch Disease"[14] effect. Stijns (2003) also found that for energy exporting countries the increase in the exporting price of energy commodities for 1 percent will decrease countries' real manufacturing exports by 8 percent.

[14] Dutch Disease is a decrease in net export of a country due to increase in value of that country's currency. This phenomenon first occurred in the Netherland during 1960's with a discovery of natural resources, which raised the value of nation's currency, thereby making other manufactured goods less competitive with other countries, which led to the increase in imports and decrease in exports

7. Conclusions and policy implications

The initial objective of this study was to estimate the effect of natural gas price shock on the macroeconomic variables of Canada and Norway. There are many studies about the impact of energy price shocks on the economies of countries which are dependent on sources of energy (E.g. Kuwait, Iran, Nigeria, U.S.). I chose to study Canada and Norway because (1) they are world leaders in natural gas export and (2) sources of energy are not the only export commodity of these countries and do not constitute their chief government revenue. A combination of models and variables of different studies were used to estimate the effect of natural gas price shocks. Using unrestricted VAR model I have used the Granger causality test, Impulse Response function and Variance Decomposition. The results showed that natural gas price shock does not Granger cause any studied macroeconomic variables and the impulse response function showed that the GDP of both countries is affected as well as the net exports of Canada. Variance Decomposition showed the same result as Impulse Response; a portion of natural gas price shock is present in the GDPs of both countries and in the net exports of Canada.

Overall, the results of the current study showed that economic performances of both countries are strong and only slightly affected by natural gas price shock. A change in the price of natural gas will also affect the GDP, which is clear because an increase in the price of an export commodity will also increase the revenue of the exporting country. The slightly negative effect of the shock can be seen in the net exports of Norway. In order to prevent the "Dutch Disease" effect, the Norwegian government should be wary of their currency value in the international market. The reason why GDP and net exports were the only affected variables in Canada is because the oil and natural gas share in Canada constitutes only 4.2 percent of its total

GDP.[15] GDP and net exports are directly affected since these variables are directly related to money flow into the country, whereas other variables (inflation, employment and interest rate) are indirectly affected. Even though oil and gas industries represent approximately 30 percent of Norway's GDP the impact on natural gas price shock is observed only on the GDP. This is because a large share of the oil and gas industries' revenues goes to the Petroleum Fund. This fund serves as a financial safety net to reduce inflationary impact of oil revenue.

For future researchers, it may be useful to undertake studies on the impact of natural gas price shock on domestic economies by employing other important macroeconomic variables such as exchange rate and monetary policy. Exchange rate is important because with a price increase in natural gas, government revenue will increase, which will lead to national currency appreciation. Accordingly, the exchange rate of a nation's currency will also change. Using the same variables, asymmetric shocks can be studied and compared to the current study and any differences in results through the estimation of both symmetric and asymmetric shocks can be observed.

[15] http://www.neb-one.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgdmnd/ndstrlnrgscnd2010/ndstrlnrgscnd-eng.html

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Appendix I : ADF-tests

Table 1: ADF test - level

Canada		
ADF-test		
H_0: a variable has a unit root		
Variables	Without trend-level	
	t-stat	prob*
ngp_sa	-1.71144	0.4204
gdp_sa	2.181079	0.9999
inf_sa	-3.21817	0.0236**
emp_sa	-0.76258	0.8222
int_sa	-1.84124	0.3573
nx_sa	-2.52713	0.1142

Norway		
ADF-test		
H_0: a variable has a unit root		
Variables	Without trend-level	
	t-stat	prob*
ngp_sa	0.870221	0.9944
gdp_sa	1.484696	0.9991
inf_sa	-3.71941	0.0061***
emp_sa	-0.15146	0.9383
int_sa	-2.27047	0.1847
nx_sa	-1.72452	0.414

*MacKinnon (1996) one-sided p-values.

Table 2: ADF tests – 1st difference

Canada		
ADF-test		
H_0: a variable has a unit root		
Variables	Without trend-level	
	t-stat	prob*
dngp_sa	-5.99498	0.0000***
dgdp_sa	-4.80732	0.0002***
demp_sa	-5.13472	0.0001***
dint_sa	-5.19224	0.0001***
dnx_sa	-7.0091	0.0000***

Norway		
ADF-test		
H_0: a variable has a unit root		
Variables	Without trend-level	
	t-stat	prob*
dngp_sa	-4.09493	0.0021***
dgdp_sa	-3.23225	0.023**
demp_sa	-2.4135	0.1425
dint_sa	-5.72801	0.0000***
dnx_sa	-9.12722	0.0000***

*MacKinnon (1996) one-sided p-values.

Note: ” ** ” and ” *** ” are signifant at 5 % and 1 % significance level, respectively.

Appendix II: Lag Length Criteria Results

Table 3:

Canada						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	469.9777	NA	2.56E-15	-16.5706	**-16.35363***	-16.4865
1	533.9234	**111.9049***	**9.52e-16***	**-17.56869***	-16.0497	**-16.97977***
2	561.6861	42.63569	1.33E-15	-17.2745	-14.4535	-16.1808
3	584.0275	29.52247	2.44E-15	-16.7867	-12.6637	-15.1882
4	624.5793	44.89669	2.63E-15	-16.9493	-11.5242	-14.846
5	676.699	46.53541	2.28E-15	-17.525	-10.7979	-14.9169

Norway						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	542.8197	NA	2.66E-16	-18.8358	**-18.62072***	-18.7522
1	591.3146	85.07882	1.73E-16	-19.2742	-17.7688	-18.6892
2	645.6085	**83.82215***	**9.48e-17***	**-19.91609***	-17.1203	**-18.82956***
3	671.0152	33.87553	1.54E-16	-19.5444	-15.4583	-17.9564

Note: * indicates lag order selected by the criterion

Appendix III : Lag exclusion tests results

Table 4:

Canada							
H_0: lags are jointly significant							
	DNGP_SA	DGDP_SA	INF_SA	DEMP_SA	DINT_SA	DNX_SA	Joint
Lag 1	10.37452	7.207872	49.19499	12.57437	11.25689	5.074392	113.0634
	[0.109741]	[0.302051]	[6.82e-09]	[0.050316]	[0.080754]	[0.534308]	[6.88e-10]
Lag 2	16.67183	3.926705	9.389914	2.395136	2.948163	3.829769	40.25638
	[0.010568]	[0.686595]	[0.152808]	[0.880014]	[0.815324]	[0.699700]	[0.287386]
Lag 3	18.34757	6.225066	6.049559	4.369738	2.950513	7.915793	41.49222
	[0.005420]	[0.398456]	[0.417661]	[0.626774]	[0.815032]	[0.244338]	[0.243615]
Lag 4	15.22806	5.612346	11.1768	7.83196	5.981689	11.35136	47.02689
	[0.018555]	[0.467983]	[0.083063]	[0.250675]	[0.425244]	[0.078106]	[0.103242]

Norway							
H_0: lags are jointly significant							
	DNGP_SA	DGDP_SA	INF_SA	DDEMP_SA	DINT_SA	DNX_SA	Joint
Lag 1	8.265494	8.511213	15.98397	32.1073	7.576572	9.445324	93.08149
	[0.219291]	[0.202990]	[0.013840]	[1.56e-05]	[0.270794]	[0.150039]	[6.02e-07]
Lag 2	49.88163	11.61104	8.981795	15.85436	7.621574	2.890752	92.33262
	[4.97e-09]	[0.071230]	[0.174604]	[0.014557]	[0.267159]	[0.822428]	[7.66e-07]
Lag 3	5.588015	1.192755	7.761865	7.963898	5.979909	3.99051	38.1603
	[0.470883]	[0.977241]	[0.256074]	[0.240760]	[0.425444]	[0.677961]	[0.371471]

Note: Number in [] are p-values

Appendix IV : Pairwise Granger Causality Test Results

Table 5:

Canada			
Null Hypothesis:	Obs	F-Statistic	Prob.
DGDP_SA does not Granger Cause DNGP_SA	59	1.07881	0.3472
DNGP_SA does not Granger Cause DGDP_SA		0.65146	0.5253
INF_SA does not Granger Cause DNGP_SA	59	0.88899	0.417
DNGP_SA does not Granger Cause INF_SA		1.92998	0.155
DEMP_SA does not Granger Cause DNGP_SA	59	0.4732	0.6256
DNGP_SA does not Granger Cause DEMP_SA		0.47022	0.6274
DINT_SA does not Granger Cause DNGP_SA	59	0.11753	0.8893
DNGP_SA does not Granger Cause DINT_SA		1.41137	0.2527
DNX_SA does not Granger Cause DNGP_SA	59	0.02589	0.9745
DNGP_SA does not Granger Cause DNX_SA		0.65514	0.5234

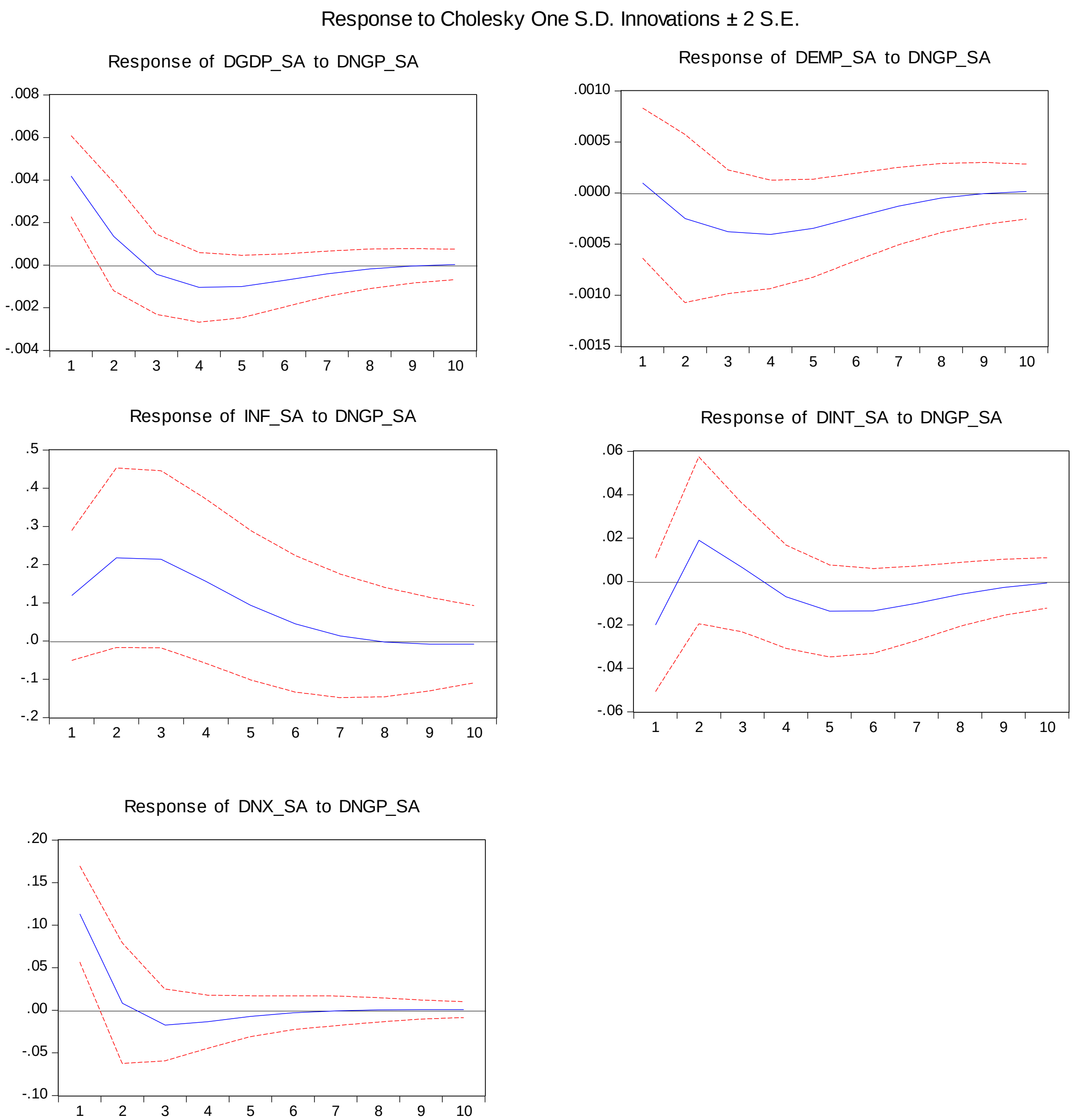
Norway			
Null Hypothesis:	Obs	F-Statistic	Prob.
DGDP_SA does not Granger Cause DNGP_SA	59	26.1084	1.00E-08
DNGP_SA does not Granger Cause DGDP_SA		0.82831	0.4423
INF_SA does not Granger Cause DNGP_SA	59	2.51693	0.0901
DNGP_SA does not Granger Cause INF_SA		2.68451	0.0774
DDEMP_SA does not Granger Cause DNGP_SA	58	0.13894	0.8706
DNGP_SA does not Granger Cause DDEMP_SA		0.90679	0.41
DINT_SA does not Granger Cause DNGP_SA	59	1.36811	0.2633
DNGP_SA does not Granger Cause DINT_SA		0.06744	0.9349
DNX_SA does not Granger Cause DNGP_SA	59	0.08489	0.9187

DNGP_SA does not Granger Cause DNX_SA		1.01975	0.3675

Appendix V : Impulse Response Functions Results: Graph

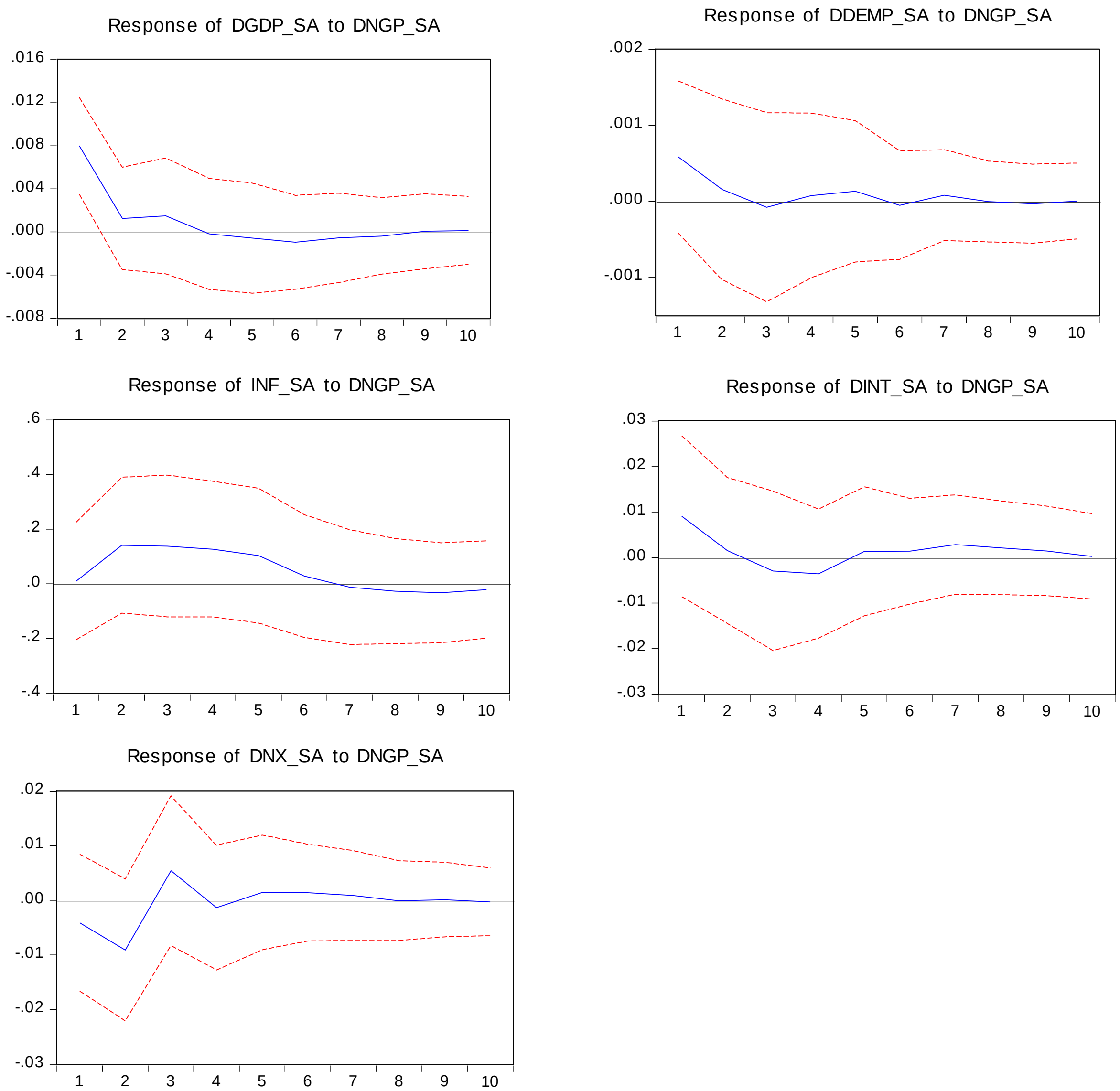
Figure 1:

Canada



Norway (continued)

Response to Cholesky One S.D. Innovations ± 2 S.E.



Appendix Va : Impulse Response Functions Results: Table

Table 6:

Canada						
Period	DNGP_SA	DGDP_SA	INF_SA	DEMP_SA	DINT_SA	DNX_SA
1	0.176182	0.004182	0.119284	0.000097	(0.019936)	0.113184
	(0.017790)	(0.000950)	(0.084050)	(0.000350)	(0.015510)	(0.028930)
2	0.038139	0.001353	0.217820	(0.000251)	0.018973	0.008300
	(0.028550)	(0.001230)	(0.112710)	(0.000420)	(0.019630)	(0.034310)
3	0.005597	(0.000430)	0.213757	(0.000379)	0.006293	(0.017324)
	(0.019180)	(0.000900)	(0.114140)	(0.000300)	(0.014630)	(0.020810)
4	(0.003656)	(0.001046)	0.156577	(0.000405)	(0.007032)	(0.013413)
	(0.014420)	(0.000750)	(0.106860)	(0.000250)	(0.011960)	(0.015170)
5	(0.005649)	(0.001005)	0.093964	(0.000345)	(0.013622)	(0.007089)
	(0.011990)	(0.000660)	(0.098320)	(0.000230)	(0.010590)	(0.011920)
6	(0.004765)	(0.000716)	0.044829	(0.000235)	(0.013567)	(0.002938)
	(0.010590)	(0.000590)	(0.091000)	(0.000210)	(0.009910)	(0.010110)
7	(0.003052)	(0.000408)	0.013441	(0.000127)	(0.010053)	(0.000611)
	(0.009610)	(0.000500)	(0.084910)	(0.000180)	(0.009200)	(0.008620)
8	(0.001513)	(0.000175)	(0.002654)	(0.000049)	(0.005937)	0.000481
	(0.008900)	(0.000430)	(0.079690)	(0.000160)	(0.008400)	(0.007450)
9	(0.000481)	(0.000035)	(0.008332)	(0.000005)	(0.002685)	0.000795
	(0.008520)	(0.000370)	(0.075610)	(0.000140)	(0.007750)	(0.006640)
10	0.000062	0.000031	(0.008322)	0.000014	(0.000662)	0.000707
	(0.008460)	(0.000310)	(0.073530)	(0.000120)	(0.007320)	(0.006170)

(Continued)

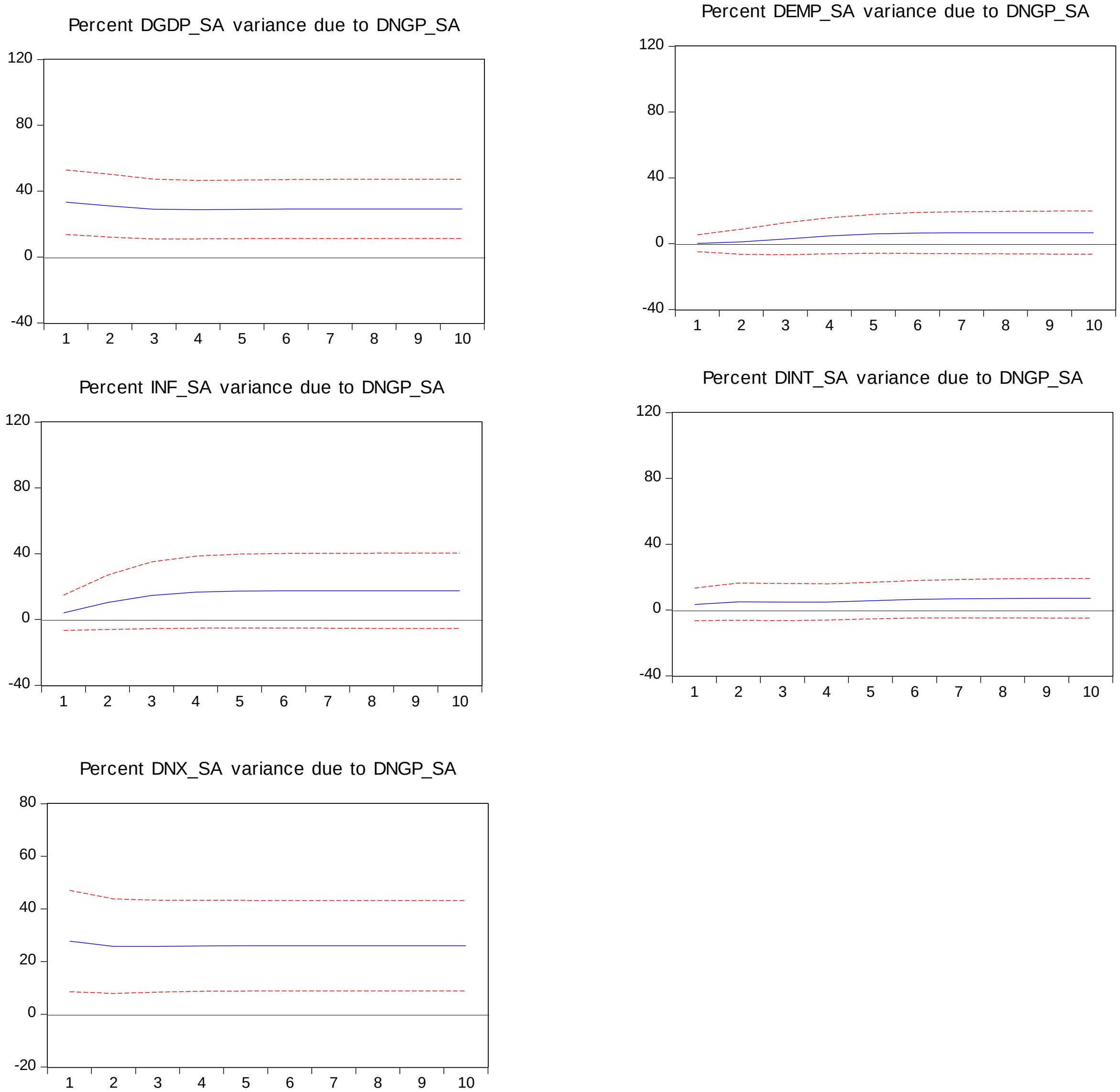
Norway						
Period	DNGP_SA	DGDP_SA	INF_SA	DDEMP_SA	DINT_SA	DNX_SA
1	0.066320	0.007997	0.009916	0.000586	0.009086	(0.004099)
	(0.007190)	(0.002310)	(0.112510)	(0.000460)	(0.008770)	(0.006650)
2	(0.005508)	0.001245	0.141110	0.000156	0.001538	(0.009111)
	(0.009510)	(0.002350)	(0.124230)	(0.000550)	(0.008240)	(0.006140)
3	0.031549	0.001486	0.137879	(0.000080)	(0.002942)	0.005406
	(0.012190)	(0.002710)	(0.127960)	(0.000600)	(0.008800)	(0.006920)
4	(0.002246)	(0.000188)	0.126179	0.000076	(0.003551)	(0.001332)
	(0.012680)	(0.002450)	(0.121520)	(0.000570)	(0.006920)	(0.005760)
5	0.006315	(0.000577)	0.102877	0.000132	0.001373	0.001445
	(0.013360)	(0.002630)	(0.116590)	(0.000460)	(0.006970)	(0.005420)
6	(0.003964)	(0.000957)	0.028183	(0.000051)	0.001376	0.001399
	(0.012200)	(0.002160)	(0.105140)	(0.000340)	(0.005650)	(0.004430)
7	(0.002859)	(0.000557)	(0.012620)	0.000080	0.002855	0.000864
	(0.012060)	(0.001990)	(0.099400)	(0.000280)	(0.005410)	(0.004140)
8	(0.003738)	(0.000375)	(0.027228)	(0.000003)	0.002134	(0.000091)
	(0.010490)	(0.001740)	(0.096250)	(0.000250)	(0.004600)	(0.003600)
9	(0.001738)	0.000056	(0.032900)	(0.000032)	0.001435	0.000128
	(0.009510)	(0.001680)	(0.088780)	(0.000240)	(0.004380)	(0.003410)
10	(0.000902)	0.000135	(0.021092)	0.000003	0.000233	(0.000290)
	(0.008750)	(0.001650)	(0.078880)	(0.000220)	(0.004040)	(0.003160)

Note : Cholesky Ordering: Natural Gas Price, GDP, Inflation, Employment, Interest Rate, Net export (DNGP_SA DGDP_SA INF_SA DEMP_SA DINT_SA DNX_SA)
Standard Errors: Monte Carlo (1000 repetitions)

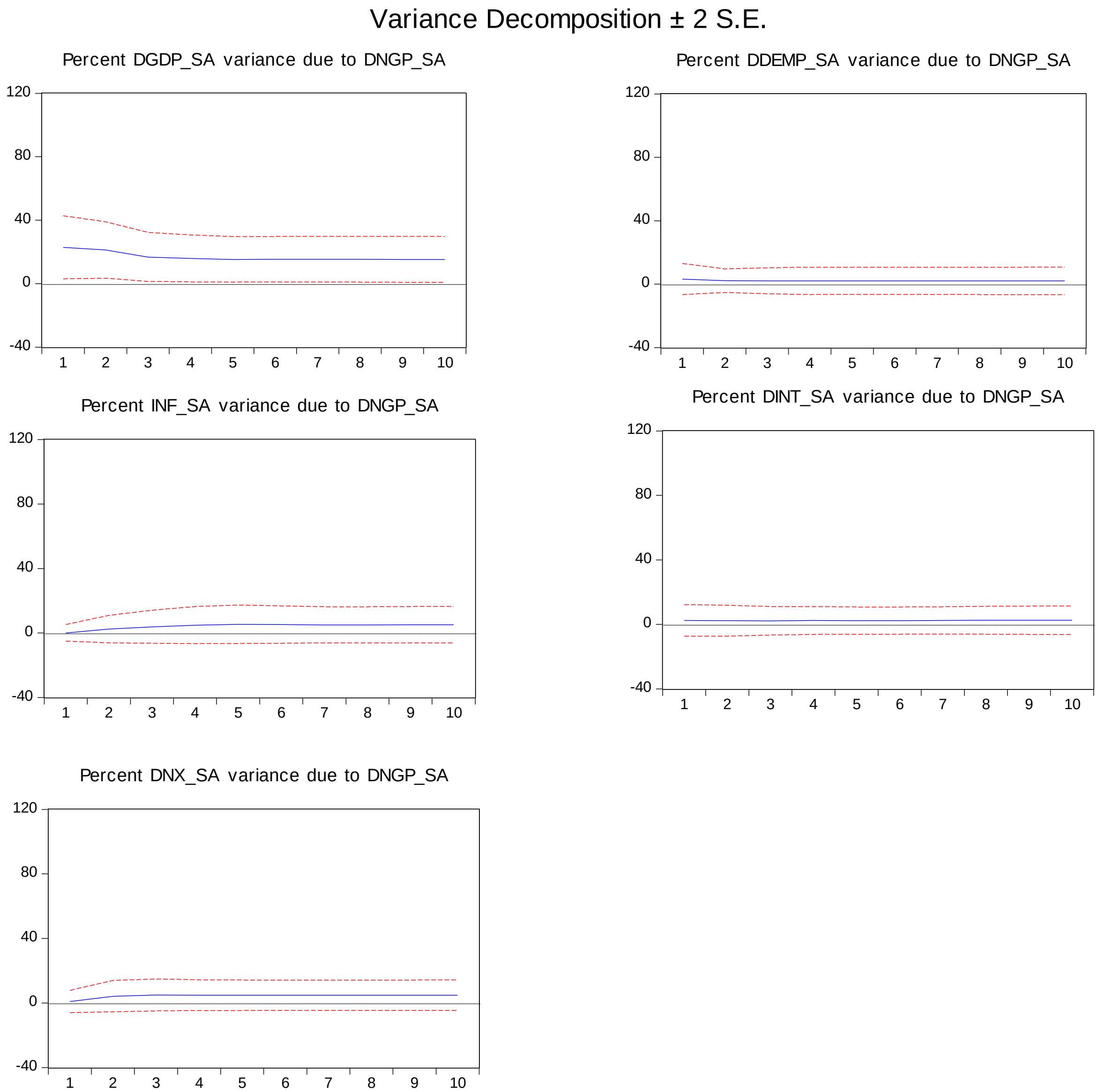
Appendix VI : Variance Decomposition Results: Graph

Canada

Variance Decomposition ± 2 S.E.



Norway (continued)



Appendix VIa : Variance Decomposition Results: Table

Table 7 :

Canada					
Variance Decomposition:					
Periods	DGDP_SA	INF_SA	DEMP_SA	DINT_SA	DNX_SA
1	33.276400	4.004272	0.164246	3.302958	27.791770
	(10.383400)	(5.336740)	(2.777530)	(5.048200)	(10.381500)
2	31.080410	10.373900	1.051418	4.984969	25.812290
	(10.145600)	(8.622980)	(4.195870)	(5.392850)	(9.601070)
3	29.056750	14.651410	2.859230	4.792945	25.805400
	(9.537850)	(10.399600)	(5.296660)	(5.389740)	(9.327110)
4	28.707340	16.586770	4.678072	4.832418	25.973520
	(9.268850)	(11.100600)	(5.945760)	(5.193920)	(9.225510)
5	28.920250	17.243350	5.892446	5.625218	26.019760
	(9.270520)	(11.320700)	(6.308740)	(5.210160)	(9.186560)
6	29.100920	17.386110	6.438833	6.429971	26.025460
	(9.320990)	(11.376900)	(6.501490)	(5.374340)	(9.165850)
7	29.168460	17.391170	6.597782	6.869037	26.024100
	(9.347910)	(11.400200)	(6.599540)	(5.540630)	(9.154180)
8	29.178120	17.385170	6.620659	7.022098	26.023210
	(9.359630)	(11.420500)	(6.656260)	(5.655700)	(9.148520)
9	29.174240	17.387060	6.619747	7.052951	26.023230
	(9.366110)	(11.439000)	(6.689420)	(5.719640)	(9.145120)
10	29.171740	17.391090	6.621033	7.054119	26.023490
	(9.367400)	(11.455400)	(6.709800)	(5.750730)	(9.142270)

(Continued)

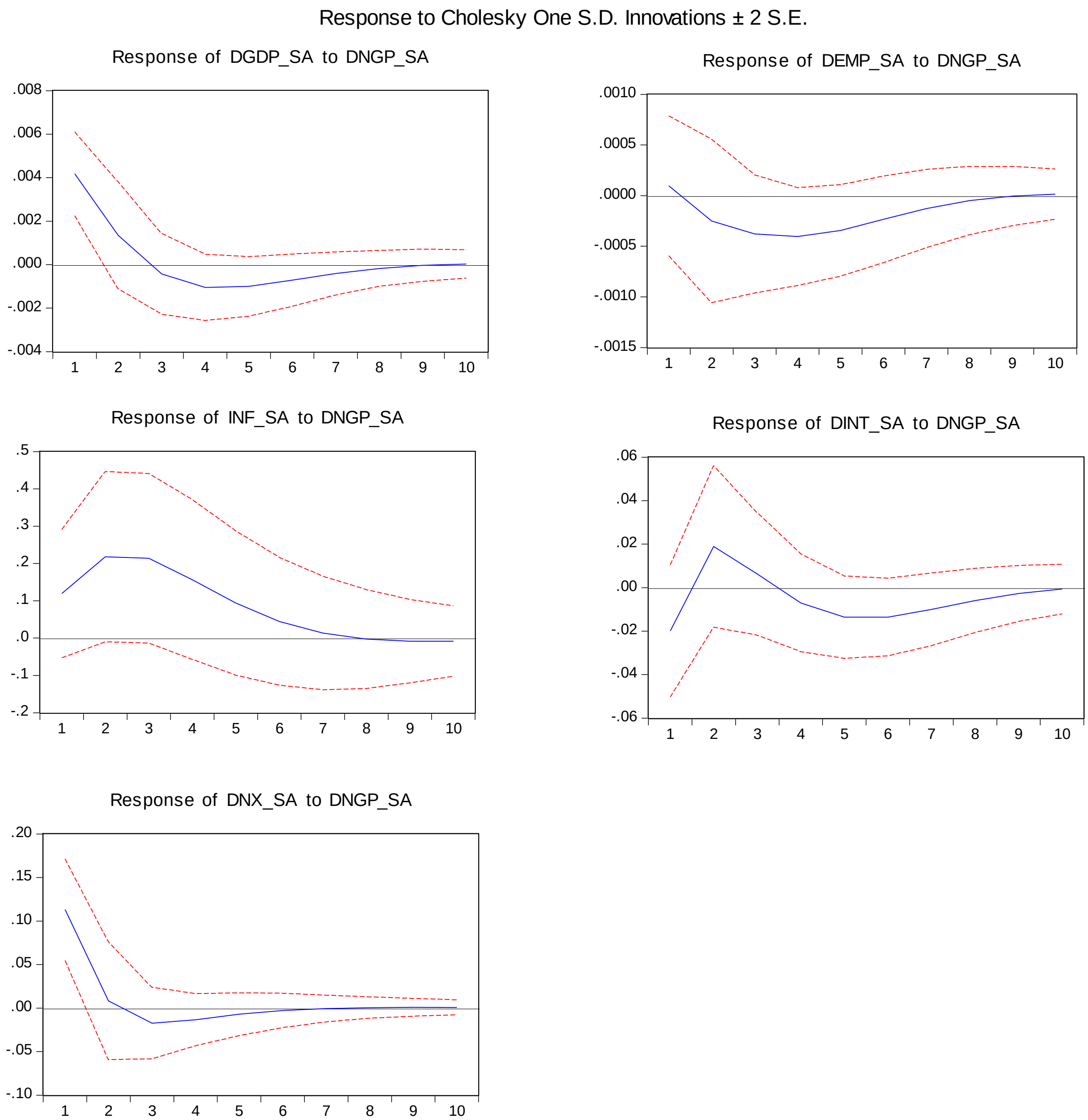
Norway					
Variance Decomposition:					
Periods	DGDP_SA	INF_SA	DDEMP_SA	DINT_SA	DNX_SA
1	22.804530	0.017728	3.148763	2.396353	0.849275
	(9.757530)	(2.769760)	(4.825540)	(4.647260)	(3.788140)
2	21.181520	2.382794	2.126112	2.237396	4.165184
	(8.628210)	(5.053140)	(3.591460)	(4.392120)	(4.946660)
3	16.777600	3.769856	2.023878	2.144787	4.956866
	(7.624740)	(6.003090)	(3.791320)	(4.214440)	(5.223140)
4	15.873630	4.849540	1.996311	2.355855	4.782134
	(7.225440)	(6.822880)	(4.164870)	(4.158920)	(5.035180)
5	15.244760	5.406007	1.998188	2.284590	4.736172
	(7.062870)	(6.903540)	(4.288220)	(4.056030)	(5.026190)
6	15.344130	5.181796	1.990897	2.280513	4.795952
	(7.050640)	(6.552860)	(4.264100)	(4.026030)	(4.989790)
7	15.374240	5.015228	2.017442	2.417692	4.802330
	(7.024090)	(6.297620)	(4.276790)	(4.085470)	(4.990790)
8	15.322020	5.022001	2.009296	2.498757	4.793367
	(7.005260)	(6.282080)	(4.309100)	(4.125680)	(4.991700)
9	15.269040	5.093221	2.008711	2.525886	4.786599
	(6.992360)	(6.338400)	(4.348030)	(4.183040)	(4.999870)
10	15.245550	5.115240	2.008469	2.517255	4.787859
	(7.004620)	(6.351450)	(4.385190)	(4.203120)	(5.043750)

Note : Cholesky Ordering: Natural Gas Price, GDP, Inflation, Employment, Interest Rate, Net export (DNGP_SA DGDP_SA INF_SA DEMP_SA DINT_SA DNX_SA)
Standard Errors: Monte Carlo (1000 repetitions)

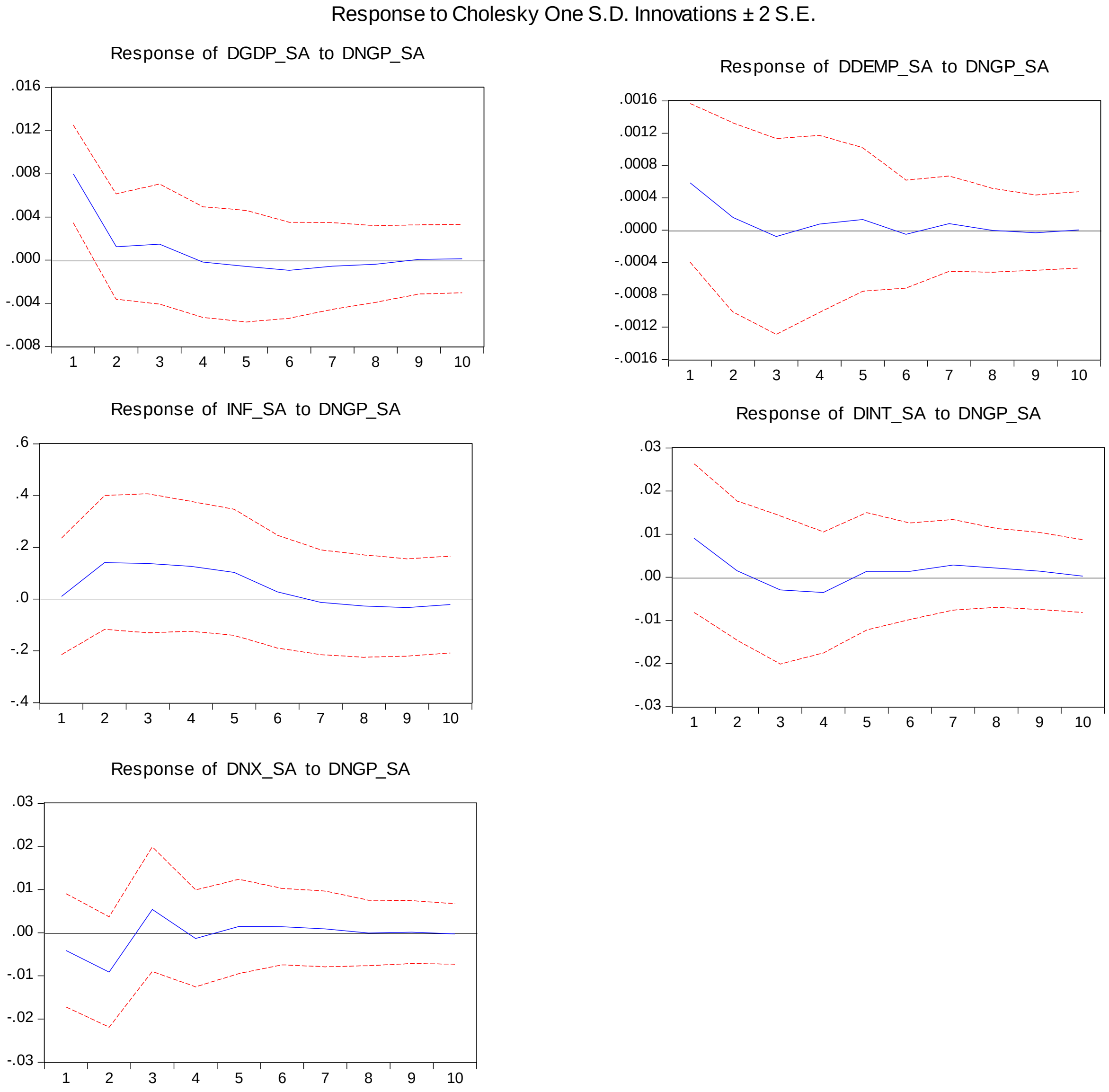
Appendix VII : Robustness Check: Impulse Response Functions: Graphs

Figure 3:

Canada



Norway (Continued)



Appendix VIIa : Robustness Check : Impulse Response Functions : Table

Table 8 :

Canada						
Period	DNGP_SA	DGDP_SA	INF_SA	DEMP_SA	DNX_SA	DINT_SA
1	0.176182	0.004182	0.119284	0.000097	0.113184	(0.019936)
	(0.017640)	(0.000920)	(0.085560)	(0.000350)	(0.028190)	(0.016110)
2	0.038139	0.001353	0.217820	(0.000251)	0.008300	0.018973
	(0.029310)	(0.001180)	(0.115490)	(0.000400)	(0.036840)	(0.018730)
3	0.005597	(0.000430)	0.213757	(0.000379)	(0.017324)	0.006293
	(0.018100)	(0.000920)	(0.112550)	(0.000300)	(0.021250)	(0.014240)
4	(0.003656)	(0.001046)	0.156577	(0.000405)	(0.013413)	(0.007032)
	(0.013790)	(0.000790)	(0.102840)	(0.000270)	(0.014700)	(0.011490)
5	(0.005649)	(0.001005)	0.093964	(0.000345)	(0.007089)	(0.013622)
	(0.010840)	(0.000690)	(0.091290)	(0.000240)	(0.011780)	(0.010290)
6	(0.004765)	(0.000716)	0.044829	(0.000235)	(0.002938)	(0.013567)
	(0.009240)	(0.000610)	(0.079570)	(0.000210)	(0.010240)	(0.009240)
7	(0.003052)	(0.000408)	0.013441	(0.000127)	(0.000611)	(0.010053)
	(0.007930)	(0.000530)	(0.069160)	(0.000180)	(0.008340)	(0.008120)
8	(0.001513)	(0.000175)	(0.002654)	(0.000049)	0.000481	(0.005937)
	(0.006460)	(0.000440)	(0.060430)	(0.000150)	(0.006330)	(0.007010)
9	(0.000481)	(0.000035)	(0.008332)	(0.000005)	0.000795	(0.002685)
	(0.005110)	(0.000370)	(0.052790)	(0.000130)	(0.004680)	(0.006050)
10	0.000062	0.000031	(0.008322)	0.000014	0.000707	(0.000662)
	(0.004050)	(0.000300)	(0.046190)	(0.000110)	(0.003480)	(0.005270)

(Continued)

Norway						
Period	DNGP_SA	DGDP_SA	INF_SA	DDEMP_SA	DNX_SA	DINT_SA
1	0.066320	0.007997	0.009916	0.000586	(0.004099)	0.009086
	(0.006990)	(0.002420)	(0.111970)	(0.000460)	(0.006450)	(0.008930)
2	(0.005508)	0.001245	0.141110	0.000156	(0.009111)	0.001538
	(0.009320)	(0.002260)	(0.125800)	(0.000570)	(0.006420)	(0.007960)
3	0.031549	0.001486	0.137879	(0.000080)	0.005406	(0.002942)
	(0.012900)	(0.002760)	(0.131430)	(0.000600)	(0.007050)	(0.008650)
4	(0.002246)	(0.000188)	0.126179	0.000076	(0.001332)	(0.003551)
	(0.011860)	(0.002450)	(0.127350)	(0.000570)	(0.005660)	(0.007120)
5	0.006315	(0.000577)	0.102877	0.000132	0.001445	0.001373
	(0.013380)	(0.002470)	(0.117850)	(0.000490)	(0.005090)	(0.007040)
6	(0.003964)	(0.000957)	0.028183	(0.000051)	0.001399	0.001376
	(0.011220)	(0.002000)	(0.102690)	(0.000350)	(0.004200)	(0.005440)
7	(0.002859)	(0.000557)	(0.012620)	0.000080	0.000864	0.002855
	(0.011660)	(0.001950)	(0.091710)	(0.000290)	(0.003970)	(0.005280)
8	(0.003738)	(0.000375)	(0.027228)	(0.000003)	(0.000091)	0.002134
	(0.009700)	(0.001590)	(0.086430)	(0.000250)	(0.003130)	(0.004470)
9	(0.001738)	0.000056	(0.032900)	(0.000032)	0.000128	0.001435
	(0.009490)	(0.001460)	(0.078630)	(0.000230)	(0.003020)	(0.004380)
10	(0.000902)	0.000135	(0.021092)	0.000003	(0.000290)	0.000233
	(0.008170)	(0.001300)	(0.072030)	(0.000220)	(0.002530)	(0.003810)

Note : Cholesky Ordering: Natural Gas Price, GDP, Inflation, Employment, Interest Rate, Net export (DNGP_SA DGDP_SA INF_SA DEMP_SA DINT_SA DNX_SA)
Standard Errors: Monte Carlo (1000 repetitions)

Appendix VIII : Robustness Check: Variance Decomposition: Table

Table 9 :

Canada					
Variance Decomposition:					
Periods	DGDP_SA	INF_SA	DEMP_SA	DNX_SA	DINT_SA
1	33.276400	4.004272	0.164246	27.791770	3.302958
	(10.286900)	(5.076290)	(2.676170)	(10.006700)	(5.322000)
2	31.080410	10.373900	1.051418	25.812290	4.984969
	(9.821490)	(8.395060)	(3.862570)	(9.220560)	(5.477400)
3	29.056750	14.651410	2.859230	25.805400	4.792945
	(9.378740)	(10.391500)	(4.951720)	(8.988470)	(5.499620)
4	28.707340	16.586770	4.678072	25.973520	4.832418
	(9.185270)	(11.292200)	(5.659570)	(8.905600)	(5.304500)
5	28.920250	17.243350	5.892446	26.019760	5.625218
	(9.187420)	(11.639100)	(6.135260)	(8.872780)	(5.286920)
6	29.100920	17.386110	6.438833	26.025460	6.429971
	(9.241770)	(11.760800)	(6.435840)	(8.855900)	(5.438930)
7	29.168460	17.391170	6.597782	26.024100	6.869037
	(9.282970)	(11.812200)	(6.598400)	(8.846500)	(5.625780)
8	29.178120	17.385170	6.620659	26.023210	7.022098
	(9.300280)	(11.850400)	(6.688930)	(8.842990)	(5.758700)
9	29.174240	17.387060	6.619747	26.023230	7.052951
	(9.305970)	(11.884300)	(6.754680)	(8.843120)	(5.830250)
10	29.171740	17.391090	6.621033	26.023490	7.054119
	(9.310640)	(11.909000)	(6.809840)	(8.844640)	(5.871500)

(Continued)

Norway					
Variance Decomposition:					
Periods	DGDP_SA	INF_SA	DDEMP_SA	DNX_SA	DINT_SA
1	22.804530	0.017728	3.148763	0.849275	2.396353
	(9.559460)	(2.665750)	(4.992760)	(3.203570)	(4.572760)
2	21.181520	2.382794	2.126112	4.165184	2.237396
	(8.647920)	(4.270320)	(3.737450)	(5.111430)	(4.621540)
3	16.777600	3.769856	2.023878	4.956866	2.144787
	(7.432380)	(5.241390)	(4.034370)	(5.282930)	(4.425230)
4	15.873630	4.849540	1.996311	4.782134	2.355855
	(7.064340)	(5.871600)	(4.356600)	(5.175530)	(4.413820)
5	15.244760	5.406007	1.998188	4.736172	2.284590
	(6.883690)	(5.979370)	(4.467380)	(5.086480)	(4.312670)
6	15.344130	5.181796	1.990897	4.795952	2.280513
	(6.841620)	(5.728030)	(4.505560)	(5.044650)	(4.280310)
7	15.374240	5.015228	2.017442	4.802330	2.417692
	(6.844500)	(5.539860)	(4.508450)	(5.077450)	(4.353170)
8	15.322020	5.022001	2.009296	4.793367	2.498757
	(6.844350)	(5.531640)	(4.546610)	(5.082670)	(4.389410)
9	15.269040	5.093221	2.008711	4.786599	2.525886
	(6.872010)	(5.552410)	(4.577190)	(5.106430)	(4.412550)
10	15.245550	5.115240	2.008469	4.787859	2.517255
	(6.893470)	(5.549020)	(4.609240)	(5.133230)	(4.414440)

Note : Cholesky Ordering: Natural Gas Price, GDP, Inflation, Employment, Interest Rate, Net export (DNGP_SA DGDP_SA INF_SA DEMP_SA DINT_SA DNX_SA)
Standard Errors: Monte Carlo (1000 repetitions)