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Summary

The aim of this paper is to investigate how major net oil exporter economies react to oil price shocks. We contribute to the literature by considering, at the same time, the possible nonlinearity and asymmetry of this relationship with respect to sign, size and causes of the oil price shocks, as well as the state of the economy in which the shocks occur. We apply a Threshold Structural VAR approach, characterized by a separation of the observations into different regimes based on a threshold variable, to model time series non-linearities. We use the economic activity as the threshold variable, as it divides economic development in two regimes under which we expect the effects of oil price shocks to differ. First, We find that the effects of oil price shocks on oil exporting economies greatly depend on the underlying cause of the shocks as well as the state of the economy. Second, we find little evidence of asymmetric response of output to the sign of oil price shocks. Our main findings warn decision makers in the area of macroeconomic planning that, when making decisions based on the oil price, the underlying causes of its variations as well as the state of the economy in which the oil price shocks occur have to be considered.

Keywords: Oil Market, Output Growth, Macroeconomic Policy, Threshold SVAR

JEL Classification: C3, G11, Q41, Q43

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Oil Price Shocks and Economic Growth

in Oil-Exporting Countries

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Abstract

The aim of this paper is to investigate how major net oil exporter economies react to oil price shocks. We contribute to the literature by considering, at the same time, the possible nonlinearity and asymmetry of this relationship with respect to sign, size and causes of the oil price shocks, as well as the state of the economy in which the shocks occur. We apply a Threshold Structural VAR approach, characterised by a separation of the observations into different regimes based on a threshold variable, to model time series non-linearities. We use the economic activity as the threshold variable, as it divides economic development in two regimes under which we expect the effects of oil price shocks to differ. First, We find that the effects of oil price shocks on oil exporting economies greatly depend on the underlying cause of the shocks as well as the state of the economy. Second, we find little evidence of asymmetric response of output to the sign of oil price shocks. Our main findings warn decision makers in the area of macroeconomic planning that, when making decisions based on the oil price, the underlying causes of its variations as well as the state of the economy in which the oil price shocks occur have to be considered.

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1 Introduction

Following the large and persistent oil price shock of 1973, and then second shock of 1979, the energy price fluctuations and its impact on the macroeconomy have become an important area of research. Hamilton (1983) is one of the first scholars, who shows the importance of the energy price changes to the U.S. economy. The interest in oil price fluctuations and their role in the macro-economy was renewed again due to a sharp increase in oil price in early 2000 and immediate drop in 2008 (Hamilton [2009]; Yoshino and Taghizadeh-Hesary [2014]). Peersman and Robays [2012] and Taghizadeh-Hesary et al. [2016] identify economies that benefited and lost after the recent oil price shock and find that oil price fluctuations significantly affect oil importers' production costs while in energy exporting countries oil price movements mainly affect energy export revenues and government budget revenues.

It is widely accepted in the literature that energy price shocks do not only affect directly macro-economic fluctuations, but also affect the monetary policy of different economies and therefore, the macro-economy of the energy exporting country is affected by oil prices through the monetary policy channel.[1] Blanchard and Gali [2010] study the macroeconomic performance of a set of industrialized economies and find that monetary policy is likely to have played an important role in explaining the different effects of oil price shocks during the 1970s and during the last decade. Barsky and Kilian [2002] argue that those effects may have been partly caused by exogenous changes in monetary policy, which coincided in time with the rise in oil prices. Bernanke et al. [1997] also argue that much of the decline in output and employment of 1970s was due to the rise in interest rates, resulting from the Fed's endogenous response to the higher inflation induced by

[1] See Kilian and Lewis [2011], Bodenstein et al. [2012], Alekhina and Yoshino [2018] and Ferrero and Seneca [2019].

the oil shocks. However, as Kilian [2009a] argues, they all postulate the same response to all oil price shocks regardless of which underlying shock in the oil market is driving the oil price changes. There is no compelling economic reason for the Federal Reserve to respond to oil price innovations in general, once the price of oil is treated as endogenous. Rather, the Fed must focus on the underlying determinants of the price of oil. This is also illustrated in the context of a specific example by Nakov and Pescatori [2007].

This paper investigates the effects of oil price shocks on macroeconomic performance of major developed net oil exporting countries, taking into account the role of monetary variables for each country as well as the underlying structural shocks that drive the oil price ups and downs. The contributions of the study are the followings. First, this paper is the first to examine the effects of disentangled oil price shocks on oil exporting economies. The key motivation is based on the argument that demand and supply shocks may have a distinct impact on the economy compared to the impact of a composite of demand and supply shocks.[2] Cologni and Manera [2014] show that changes in the world oil demand affect significantly output while responses of oil exporting countries to oil price shocks are much weaker. Expansions of world demand are important for the oil producers, since they can be leading indicators of more favorable economic conditions and, consequently, of larger capital inflows by foreign investors. They explain the latter result by the possibility that, in many small oil producing countries, the oil sector is characterized by low levels of spare capacity. It could be also related to the different sources of oil price shocks. Examining the relationship between disentangled oil price shocks and stock market, Kilian and Park [2009] and Ahmadi et al. [2016] find that demand (supply) shocks have a positive (negative) impact on stock returns. Intuitively, increase

[2]See, e.g. Hamilton [2009] and Kilian [2009a]

in oil price due to increase in demand results in an increase in revenue and stock returns of oil producing firms. However, if price rise is accompanied by a supply constraint, then benefit to oil producing firms is less clear. Second, since our sample period corresponds to a number of major economic, financial and political events that can lead to a regime dependent relationship between oil price and economic growth, we study the effects of oil price shocks during contractionary and expansionary times. Jiménez-Rodríguez [2009], in a study of the US economy, argues that the effects of an oil price shock should be considered along with the economic environment at the time of the shock. She finds that the relation between the US economy and oil price changes is non-linear and oil price shocks during stable economic periods would generate a higher impact on the economy. Third, we extend the analysis in previous studies by evaluating potential correlations between sign and business cycles asymmetries. For example, we consider the possibility that positive oil price innovations may generate a large response in output during recessions, but not during expansions. Donayre and Wilmot [2016], in a study of Canada's economy, finds the nonlinearity and asymmetry of response of Canada's economy to oil price shocks. However they do not identify different structural supply and demand effects of oil price shocks from exogenous monetary shocks. Fourth, while much of the empirical literature focuses on U.S. data, this paper focuses on developed net oil exporting countries, Canada, Norway and Russia, and provides a comprehensive evidence of the association between oil and exporting economies. Crude oil production requires a high level of investment, generally stretching over several years. Such expensive capital projects have the potential to drive asymmetric responses between oil prices and output.[3] To the extent that crude oil production affects a large fraction of GDP, potential asymmetric effects of oil price

[3]For example, Donayre and Wilmot [2016] find that a negative oil price shock during the contraction phase may not delay spending, particularly if the shock is expected to be transitory.

shocks could have important implications for living standards.

We apply a Threshold Structural VAR (TSVAR) model that allows us to study, the effects of oil price shocks on the economy of each country taking into account the possible nonlinearities and asymmetries in the relationship. The advantages of applying this model are the followings. This model allows us to identify the effects of oil demand and supply shocks from the effects of exogenous shocks to the real exchange rate and to the real interest rate on the economy. By identifying the structural shocks to the oil price, we can assess the asymmetric effects of shocks within a multivariate environment. The model also allows the regime switching (due to different business cycle phases) to be endogenously estimated. This makes it possible that regime switches occur after the shock to each variable. Using this model, we can explicitly take into account the possibility that positive and negative oil price shocks have different effects during periods of low and high growth. It enables us to capture the dynamic propagation of oil price innovations by means of nonlinear Impulse Response Functions (IRF).[4]

The TSVAR model is estimated for each country separately in order to account for the heterogeneity across countries in response to the oil price shocks that is well evidenced in the literature.[5] In order to check the heterogeneity as well as the cross section dependence across countries, we estimate a one regime SVAR model for each country and compare the impulse response of output of each country to the different shocks and the pairwise cross country correlation coefficients of the residuals.

The rest of the paper is structured as follows: in the next section, we review the relevant literature. In the third section, we provide the methodology and data description. The

[4]This is important because the effects of the shocks are allowed to depend on the size and the sign of the shock, and also on the initial conditions, the impulse response functions are no longer linear, and it is possible to distinguish, for instance, between the effects of oil price shocks under expansionary or recessionary initial conditions.

[5]See e.g. Jimenez-Rodriguez and Sanchez [2005] and Moshiri [2015].

model estimation and discussing the results are provided in the fourth section. The last section summarizes the results and concludes the paper.

2 Literature review

Following the 1970s oil price shocks and stagnation, a large number of empirical studies investigated the effect of fluctuations in oil prices on economic activity and found a significant relationship between higher oil prices and lower economic activity. Since then, this body of literature has expanded especially in two areas that have captured the interest of academics and policy makers: the functional form of the relationship between oil price changes and aggregate production and the interaction between monetary policy and oil price shocks (Herrera et al. [2019]).

The asymmetry of the response of different economies to oil price shocks is investigated in a number of studies. Hamilton [1988] proposes a model where the asymmetry arises because workers choose not to relocate to other sectors, given a positive probability that their sectors will improve after a positive oil price shock. Hence, in this model, the negative effect of an oil price increase is amplified for oil importers. Edelstein and Kilian [2009] and Edelstein and Kilian [2007] propose a model that explains this type of asymmetry by means of precautionary savings motives. For an oil importing country, a positive oil shock may cause concern about future income and employment, leading to an increase in precautionary savings. To the extent that declines in oil prices are not associated with higher uncertainty, output may respond asymmetrically to positive and negative oil price innovations. Kilian and Vigfusson [2011a] show some evidence of asymmetry in the response of real GDP to very large shocks, but none in response to shocks of typical magnitude. At a more disaggregated level, Herrera et al. [2011] test different asymmetric specifications between the real price of oil to U.S. industrial production and its sectoral components. They find that there is strong evidence of an asymmetric effect at the disaggregated level, especially for energy-intensive sectors, although the evidence is weaker at the aggregate level. Cologni and Manera [2009], in a study of G7 countries, show that for most of the countries, an unexpected oil price shock is followed by a decline in output growth. Moreover, the results of simulation exercises directed to estimate the total impact of the 1990 oil price shock indicate that a significant part of the effects of the oil price shock resulted indirectly from the response of monetary policy. For nearly all the countries they find a negative impact of the oil price shock on output. Important exceptions are represented by U.K. and Canada, two oil exporters, for which the total impact of the oil price shock is positive. In Canada, France and Germany, the oil price increase is followed by a reduction of interest rates.

From the perspective of an oil exporter economy, the effect of a positive oil price shock is less clear. In this case, the negative demand effects are offset by the positive supply effects. In general, positive oil price changes are good news for oil-exporting countries because they bring in foreign reserves and investment opportunities, and negative oil price changes are bad news because they restrain the revenues and halt investment projects. However, as Moshiri [2015] discusses, oil price changes might cause non-standard effects as positive oil price changes may lead to stagnation due to higher inflation and a dampening in the tradable sector, and negative changes may induce diversification in economic activities and an increase in non-oil exports leading to economic growth. This bi-directional effect is reflected in the empirical literature. Some studies on single or multi oil-exporting countries show that oil has been a curse (Eltony and Al-Awadi, 2001; Sachs and Warner, 2001; Ayadi, 2005 and Berument et al. [2010]), but other studies such as Esfahani et al.

(2012) suggest that oil has contributed positively to long-run economic performance of oil-exporting countries. Jimenez-Rodriguez and Sanchez [2005] study the effects of oil price on Norwegian economy in comparison with the other oil exporter economies. They evidence that the effects of oil shocks on output growth differ among oil exporting countries. Their results show that the United Kingdom is negatively effected while Norway benefits from an oil price increase.

Some studies have investigated the transmission mechanism of oil price shocks, searching for causes of non-linearity. In an analysis of oil production levels, Cologni and Manera [2014] find that small oil exporting countries respond significantly to changes in the world oil demand but their response to oil price shocks are much weaker. They justify this results by the possibility that, in many small oil producing countries, the oil sector is characterized by low levels of spare capacity and production adjustments are constrained. Alekhina and Yoshino [2018] estimate the impact of an oil price shock on two main macroeconomic indicators, which are real GDP growth rate and CPI inflation rate. They include the short-term interest rate and exchange rate in order to capture the indirect effect of oil price on the macro economy. According to their results, the economy was not affected by oil prices before 2000, while with the increase in oil prices from late 1999, the variables have showed significant responses to the oil price shock. Real GDP growth is positively affected by oil prices immediately after the shock while interest rate, and exchange rate negatively respond to positive oil price shock. Farzanegan and Markwardt [2009] analyse the dynamic relationship between oil price shocks and major macroeconomic variables in the Iranian economy and find a positive relationship between oil price increases and industrial output growth. They also detected an inflationary effect and an appreciation of the domestic currency. Moshiri [2015] in a study of the effect of oil shocks on the economic performance of selected oil-exporting countries, argue that a change in oil price has direct and indirect effects on GDP in oil-exporting countries through a shift in both aggregate demand and aggregate supply, and through inflation, investment and real exchange rates.

These studies include single state models that take the price of oil as a given exogenous variable. This approach does not incorporate the underlying factors driving oil price shocks and the possible nonlinearity of the oil price-economy relationship. Jiménez-Rodríguez [2009] argues that the effects of oil price shocks should be considered along with the economic environment at the time of the shock. Oil price shocks during stable economic periods would generate a higher impact on the economy compared to similar shocks during turbulent periods. Donayre and Wilmot [2016] support a nonlinear relationship between oil price and industrial production in Canada. They find that output responds asymmetrically to the direction of oil price innovations and this asymmetry is correlated with the business cycle phase.

This paper contributes to this literature by using a framework to study not only the possible nonlinearity and asymmetry of the responses of the oil exporting economies to oil price shocks, but also identify different supply and demand components of the oil price from exogenous monetary shocks of different oil exporting countries. We study the nonlinearity of the oil price transmission to the oil exporting economies with respect to the state of the world economy. We also study the asymmetric response of the economies to the positive and negative oil price shocks. More interestingly we can see if the nonlinearity and the asymmetry of the responses depends on the underlying reason behind the oil price shock.

3 Data description

We need three variables to decompose oil price changes into supply and demand driven shocks. Global oil market variables include global crude oil production, an updated measure of cyclical fluctuations in global real economic activity[6] and the real price of oil, which are all available in monthly frequency. Data on global oil production are from the Monthly Energy Review of the Energy Information Administration (EIA). The real price of oil, proxied by the U.S. refiners' acquisition cost for imported crude oil, is also available from the EIA. The price of oil is deflated by the U.S. consumer price index. Countries included in this study are Canada, Norway and Russia. For our empirical analysis, we use a monthly data set, from January 1991 to August 2019 for Canada and from 1994 to 2019 for Norway and Russia. We estimate the model once for each country.[7] In the model for each country, the interest rate (Central Bank key rate) of each country is used and data is obtained from its Central Bank, the exchange rate, the currency of the country per USD exchange rate is selected,[8] and finally the growth rate of industrial production is used as a widely watched economic indicator of business cycles. We deflate the nominal variables using CPI inflation of each country with the base year of 2010. Data are seasonally adjusted using the technique Census X-13.

[6]This measure of global real economic activity, introduced by Kilian [2009a] and updated by Kilian [2019], captures the global business cycle, and is used to measure consumption demand for oil and all industrial commodities.

[7]This is to account for the heterogeneity across countries in response to the oil price shocks that is well evidenced in the literature. We check for cross section dependence across countries, by looking at the pairwise cross-country correlation coefficients of the residuals from the estimation of a SVAR model for each country.

[8]This is because oil trading operates are mostly in U.S. dollars.

4 Methodology

In order to see the heterogeneity and the cross section dependence across countries in response to the different oil price shocks, first, we estimate a one-regime SVAR model for each country. This enables us, first, to compare the responses of the countries to oil price shocks by means of impulse response functions and second, to check for cross section dependence across countries by means of pairwise cross-country correlation coefficients of the residuals. The SVAR model is:

$$A_0 y_t = \alpha + \sum_{i=1}^{p} A_i y_{t-i} + \epsilon_t \tag{1}$$

where y_t is the vector of endogenous variables including two sets of variables, oil market and the country specific variables. Oil market variables are, percent changes in the global production of oil, the measure of fluctuations in global real activity[9] and the real price of oil[10], as reported by the EIA and deflated by consumer price index. The country specific monetary and macro variables are, the percent change of the 3-month Treasury bill rate, the percent change of exchange rate and the industrial production growth (IP). The reduced-form representation of equation 1 is given by:

$$y_t = A_0^{-1}\alpha + \sum_{i=1}^{p} A_0^{-1} A_i y_{t-i} + e_t$$

and the vector of residuals, e_t, has the following relation with the vector of structural shocks, ε_t: $e_t = A_0^{-1}\varepsilon_t$. In order to identify structural innovations from the reduced-

[9]the dry cargo shipping rate index developed in Kilian [2009a] and updated by Kilian [2019]

[10]defined as the US refiners' acquisition cost for imported crude oil. We use the refiners' acquisition cost for imported crude oil because it is likely to be a better proxy for the price of oil in global markets (Kilian and Murphy [2014]).

form residuals, we impose short-term exclusive identifying restrictions on the matrix A_0^{-1} based on four assumptions. First, within a month, changes in global oil production do not respond to oil demand shocks. This assumption is made because adjustment in oil production plans is very costly. Second, when the increase in the oil price is caused by precautionary demand shocks, it affects global real economic activity with at least one month of delay. Third, within a month, the real price of oil responds to oil supply and demand shocks. Finally, oil market variables are predetermined with respect to IP and monetary variables of each country, while those variables are affected by different oil price shocks.[11] This ordering also implies that, within a month, short-term rates affect exchange rate and IP.[12]

Then we estimate a TSVAR model for each country. The TSVAR is a piecewise linear model with different autoregressive matrices in each regime. The regimes are determined by a transition variable, which is either one of the endogenous variables or an exogenous variable (Balke [2000] and Baum and Koester [2011]). The TSVAR of the joint determination of the oil market and country specific variables, is a generalization of the TVAR model proposed by Balke [2000] and global oil market model in Kilian [2009a]. The specification of the TSVAR is given by:

$$Y_t = A^1 Y_t + B^1(L)Y_{t-1} + (A^2 Y_t + B^2(L)Y_{t-1})I(c_{t-d} > \gamma) + U_t \tag{2}$$

where Y_t is the vector of endogenous variables. $B^1(L)$ and $B^2(L)$ are lag polynomial matrices and U_t is the vector of structural disturbances. c_{t-d} is the threshold variable that determines the regimes of the system and $I(c_{t-d}))$ is an indicator function that

[11] This assumption is in line with the findings of recent literature that shows that exogenous oil demand and oil supply shocks in turn cause fluctuations not only in the real price of oil, but also in the real interest rate. See e.g. Kilian and Lewis [2011]; Bodenstein et al. 2012 and Kilian and Xiaoqing [2019].

[12] See e.g. (in on ex); ManeraG7; Kilian and Xiaoqing [2019]

takes the value of 1 when $c_{t-d} > \gamma$ and 0 otherwise. A^1 and A^2 reflect the structural contemporaneous relationships in the two regimes. We suppose that A^1 and A^2 have a recursive structure. The endogenous variables and the recursive identification scheme for the VAR are the same as in the one-regime SVAR model.

The size of the economic activity index that makes the effects of oil price shocks different is unknown. It is also a priori unclear, whether there is a significant difference between the two regimes. Therefore the threshold value γ in model 2 needs to be estimated. Following Balke [2000], we estimate the threshold model by OLS for all possible threshold values. For each possible threshold value, we calculate the Wald statistic with the null hypothesis of no difference between regimes. Next, we compute three test statistics for threshold behavior, namely, sup-Wald, avg-Wald and exp-Wald. Sup-Wald is the maximum value of the Wald statistics over all possible γs, avg-Wald is the average Wald statistic over all possible threshold values, and exp-Wald is a function of exponential Wald statistics sum. In order to conduct inference, we use the Hansen (1996) simulation method and simulate the empirical distribution of sup-Wald, avg-Wald and exp-Wald statistics with p values obtained from 500 replications of the simulation procedure. The estimated thresholds are those that maximize the log determinant of the structural residuals U_t . If the null hypothesis of no difference between regimes is rejected, the system is nonlinear. To prevent overfitting, in each regime, we restrict the possible threshold values to at least 15% of the observations plus the number of coefficients included in each regime.

In a linear model, the impulse responses can be derived directly from the estimated coefficients and the estimated responses are symmetric in terms of the sign and the size of the structural shocks. Furthermore, these impulse responses are constant over time as the covariance structure does not change. However, Koop et al. [1996] and Potter [2000] show that these properties do not hold in a nonlinear model and the moving average representation of the TVAR is nonlinear in the structural disturbances Ut, because some shocks may lead to switches between regimes, and thus their Wold decomposition does not exist. Koop et al. [1996], address this issue by developing the Generalized Impulse Response Functions (GIRF). The GIRF allows the regimes to shift after a shock, which is responsible for different responses to small and big size as well as negative and positive shocks. In this study, we calculate the GIRF that allows us to capture the asymmetry of responses to the direction of shocks, and nonlinearity of responses to the size of shocks and to the state of the economy in which the shocks occur.

5 Estimation results

5.1 Results of the one-regime Structural VAR model

In this section we report the results from estimating a one-regime structural VAR model for each country. The results are presented in the forms of impulse responses and cross correlation coefficients of the residuals. The impulse responses of the output growth of the countries to different oil market shocks are reported in figure 1. Each panel of this figure shows the impulse response of the output growth of a country to the different structural oil price shocks. The figure confirms heterogeneity across countries in response to three oil-related shocks, namely oil supply, global demand and speculative demand shocks. Table 1 reports the pairwise correlation coefficients of the residuals of the model equations across countries. The small correlations between the residuals of the country-specific model equations points out to the low cross section dependence across countries. For example from table 1 the correlation between the residuals of the outputgrowth equation from the model estimated for Norway and the same equation from the model estimated for Russia is -0.002277. These results leads us to the estimation of the threshold structural VAR model for each country, separately.

5.2 Results of the Threshold Structural VAR model

5.2.1 The estimated threshold values

In this section, the results from estimation of the TSVAR model for the three countries are reported. Table 2 presents the threshold value and the Wald tests for each country. Each row of table 2 corresponds to a country. For all the three countries, the three Wald tests reject the null hypothesis of no difference between the regimes at the 1% significance level and confirm the nonlinearity of responses. The threshold value of the economic activity index for Canada is 0.61 which means that the economic activity index that is equal to or higher than 0.61 will be considered as a high economic activity regime. The threshold values of the economic activity of Norway and Russia are -0.68, -0.84, respectively.

5.2.2 Nonlinear impulse responses

We report the nonlinear impulse responses from estimation of the TSVAR model in figure 2. The left panel shows the impulse responses of industrial production growth to different oil price shocks in the high economic activity regime and the right panel shows the responses of industrial production growth to different oil price shocks in the low economic activity regime. In each panel, the rows correspond to the countries and the columns correspond to the shocks including, oil supply, global consumption demand and other oil specific demand shocks. The figure reports the cumulative generalized responses of output growth to oil price shocks. The one- and two-standard deviation structural shocks, represent small and big shocks, respectively. Figure 2 shows that the dynamic and the size of the response of the output growth of each country to an oil price shock differ depending on the state of the economy and on the reason behind the shock.

Our results mirror some of the previous studies that emphasize the nonlinear impact of oil price on oil exporting and importing countries. Filis et al. [2011] focus on correlation between oil and stock market prices and finds that the correlation increases positively (negatively) in respond to demand-side (precautionary demand) oil price shocks while supply-side oil price shocks do not influence the relationship of the two markets. In a study of the impact of different oil price shocks on selected oil exporting countries, Berument et al. [2010] find that oil supply shocks are associated with lower output growth while the effect of demand shocks is persistently positive. In addition, to investigate nonlinearities in the relation between oil price and economic activity of selected countries, Holm-Hadulla and Hubrich [2018] apply a regime-switching vector autoregressive model and finds that in the normal economic activity regime, oil price shocks trigger only limited adjustments in economic activity while in the adverse regime, oil price shocks are followed by sizeable and sustained macroeconomic fluctuations.

In line with the findings of Kilian and Vigfusson [2011a], Kilian and Vigfusson [2011b], we find little evidence of asymmetric response of output to the sign of oil price shock. More interestingly the asymmetry shows up in the response to the large shocks. Our results are also consistent with Herrera et al. [2015] who find stronger evidence of asymmetric responses at the sectoral level, than in the aggregate data. Next, we discuss the results in details.

6 Discussing the results

6.1 Canada

An oil price increase, when it is due to different demand shocks, raises output growth in both high and low economic activity periods, although the dynamic and the size of the response differ greatly across the states of the economy as well as the different demand shocks. When a supply shock increases the price of oil, output growth decreases in both regimes. When a global consumption demand shock raises the price of oil, the increase in output growth is very short lived in the high activity period. The increase in oil price coming from other oil specific demand shocks, raises output growth as well in both high and low states of the economy.

While many Americans think OPEC supplies most of the country's oil, Canada is the biggest oil supplier to the U.S. This country is also the 3rd largest consumer of oil per person among the world's most economically advanced countries. This is primarily due to the transportation sector. The relatively sparse population, number of vehicles on the road, and the long distances people and goods must be transported to cross the country, may explain Canada's relatively high transportation fuel consumption per capita. In the industrial sector, Canada has relatively large mining, oil and gas extraction, and manufacturing sectors, which tend to be oil-intensive. Lastly, the commercial and agricultural sectors use refined petroleum products and very little crude oil combusted directly in its raw form, with increased demand during the relatively cold Canadian winters. Canadian oil imports come from a wide range of countries, including the U.S., Algeria, Iraq, Norway, Kazakhstan and Nigeria. (Doluweera et al. [2017] and Donayre and Wilmot [2016]) This could explain the negative effect of oil supply shocks on economic growth in this oil exporting country.

When evaluating the dynamic behavior of the system, the results show that oil price shocks generate asymmetric responses in output growth. First, the response of output growth differs greatly depending on the structural shock driving the oil price change. Second, the change in output growth is larger in expansions than in recessions except for when global economic activity drives the oil price shock. Third, the responses to positive and negative oil price shocks are symmetric in all cases except for the price increase that is due to global consumption demand shocks in the high state of the economy, but only in response to the large shocks. The asymmetry in this case, is in favor of positive oil price shocks, that is positive oil price shocks are found to have a stronger effect on output prowth than negative oil price shocks. Therefore, after a positive oil price shock, when the increase in profitability in the oil sector is dominated by the increase domestic consumption increase, the monetary authorities should respond to oil price increases more strongly than oil price decreases.

Our results, echo the results from studies that have more precise focus on the effects of oil price on Canadian economy. In this regard, Donayre and Wilmot [2016] evidence the asymmetric response of Canadian economy to oil price shocks in favour of positive shocks. However, they report that this asymmetry is significant in recessions, but lessened during expansions. This can be due to different time span of study, methodology and model, as they have not decomposed oil price shocks into its supply-demand driving factors.

6.2 Norway

When the economy begins in the high growth state, a positive oil price shock increases output growth, only when it is due to oil market specific demand shocks and this increase is very small and short-lived. Conversely, when the economy begins in the low growth state, a positive oil price shock increases output growth when it is derived by global consumption demand shock. The dynamic behavior of the system show that oil price shocks generate asymmetric responses in output growth depending on the underlying cause behind the shock and depending on the state of the economy. The responses, however, are almost symmetric to positive and negative oil price shocks in all cases.

Over 80 percent of Norway's exports go to the EU. With Europe and Germany experiencing slow economic growth, this leaves Norway exposed. Norway has also persistently high property prices and one of the highest ratios of debt-to-income among the OECD economies. In the low state of the economy, this could contribute to a sharp fall in property prices and a drop in household demand for goods and services. This may explain why Norwegian economy is more responsive to oil supply and demand shocks in recession than expansion.

Oil revenues increase consumption possibilities. However, it is a challenge to manage these resources in a way that increases welfare for both current and future generations. To manage its resources, Norway has created the Government Petroleum Fund, which receives revenues from the petroleum sector, transfers the amount necessary to produce a balanced government budget and invests the surplus abroad. Norway's petroleum income has been regulated to be phased into the economy on par with expected returns on the Government Petroleum Fund. This may have made the effect of oil prices less pronounced in the high economic activity regime. In line with this, Moshiri [2015] in a study of the effect of oil shocks on the economic performance of selected oil-exporting countries, finds that higher revenues from higher price of oil do not translate into sustained economic growth in Norway and attributes this finding to the fact that the economic structure of the advanced countries like Norway is well-diversified.

6.3 Russia

The impulse response of the Russian economy to different structural shocks to the price of oil in figure 2 shows that a positive oil price shock raises output growth in both high and low economic activity periods, when it is due to different demand shocks. When a supply shock increases the price of oil, output growth decreases in both regimes. The dynamic behavior of the responses show that oil price shocks generate asymmetric responses in output growth. First, the response of output growth differs depending on the structural shock driving the oil price change. Second, the change in output growth is almost the same size in both regimes except for when consumption demand drives the oil price shock where the responses are more persistent in recessions than in expansions. Third, the responses to positive and negative oil price shocks are symmetric in all cases except for the price increase that is due to global consumption demand shocks but only the case of large shocks. The asymmetry in this case, in both states of the economy, is in favor of negative oil price shocks. These results raise doubt about the conventional view saying that for a net exporter of oil, the negative demand effects associated with a positive oil price shock more than offset the positive supply effects.

The positive response of the Russian economy to the positive oil price shocks driven by increasing consumption demand in both regimes could be seen as a consequence of a number of facts. The regulation of the domestic petroleum market, by Russian government with the aim of keeping refined product prices low for domestic consumers and avoiding shortages, especially during seasonal peak demand periods, makes the domestic energy consumption inelastic to different oil price shocks.[13]. Given the fact that oil accounts for a large part of exports, moreover, energy export revenues crucially contribute to the government budget, output will be positively linked with oil prices. This result is in line with the finding of Alekhina and Yoshino [2018] who estimate a VAR model and find a positive effect of oil price increases on Russian economy. They relate this positive effect to the fact that when oil prices experience a positive shock, the budget revenues and therefore investment opportunities increase which consequently stimulates output growth. In a is study of the output growth of oil exporters, Beidas-Strom and Lorusso [2019] also finds that in Russia the exploitation of natural resources can leads to a sustained increase in output through the reallocation effects of input factors when combined with fiscal and monetary policy reforms.

7 Conclusions

The main goal of this study is to investigate the relationship between output growth and oil market shocks in net oil exporting countries. First, we estimate a one-regime SVAR model of oil market variables and output growth for each country. We consider also the role of monetary policy of the countries as the transmission channel, as well reported in the literature. Second, we apply a threshold structural vector autoregressive model approach to capture the nonlinearity and asymmetry of the relationship associated with the business cycle phase, the size, the sign and the underlying reason behind oil price shocks. More importantly we identify different supply and demand components of the oil price from monetary shocks of different oil exporting countries.

The results imply that, the effect of an oil price shock on oil exporting economies differs

[13] See Yermakov et al. [2019]

across countries and given the very small cross-correlation coefficient of the residuals this relationship could be investigated for each country separately, without loss of any information. Moreover, this relationship differs depending on the size, sign and underlying cause of the oil price shock as well as the state of the economy in which the shock occurs. Hence, the conventional linear and/or one-regime based models are not sufficient to explain the impact of oil price shocks and output growth. Finally, we find little evidence of asymmetric response of output to the sign of oil price shocks. More interestingly the asymmetry shows up in the response to the large shocks.

These results warn the decision makers in the area of macroeconomic planning that when making decisions based on the oil price variation, the underlying cause of the variation as well as the state of the economy in which the oil price shock occurs, should be taken into account.

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Table 1: cross-correlation of the residuals

Cross-Country	dependent variable of the equation		
	interest rate	exchange rate	output growth
Canada - Norway	0.134296336	0.390626994	0.052156231
Canada - Russia	0.067302614	0.050779571	0.237556893
Norway - Russia	-0.06388579	-0.06388579	-0.00227724

Notes: This table reports the pairwise correlation coefficients of the residuals from estimation of the one-regime SVAR model for each country. In each row the correlation between the residuals from estimating the model for the two countries are reported. The columns indicate the dependent variable of the equation for which the residuals are correlated.

Table 2: Threshold specifications

Country	Threshold specifications		Statistics		
	Threshold variable	Threshold value	sup-Wald	avg-Wald	exp-Wald
Canada	Economic activity	0.608564	134.24***	111.44***	63.61***
Norway	Economic activity	-0.685054	168.20***	136.97***	79.40***
Russia	Economic activity	-0.838412	392.13***	194.28***	191.10***

Notes: *** indicates statistical significance at the 1% level.

Figure 1: Impulse Responses of output growth to different oil price shocks

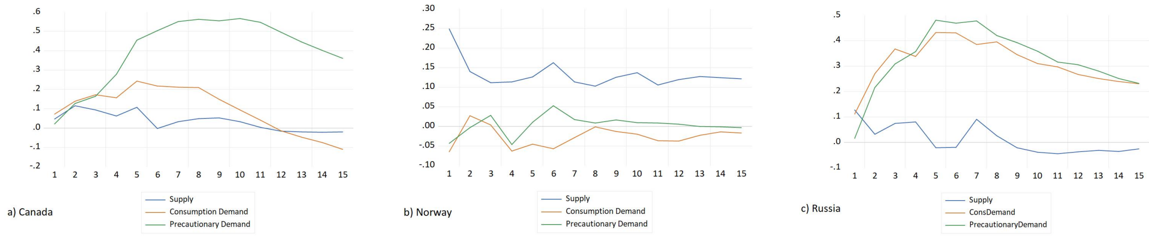
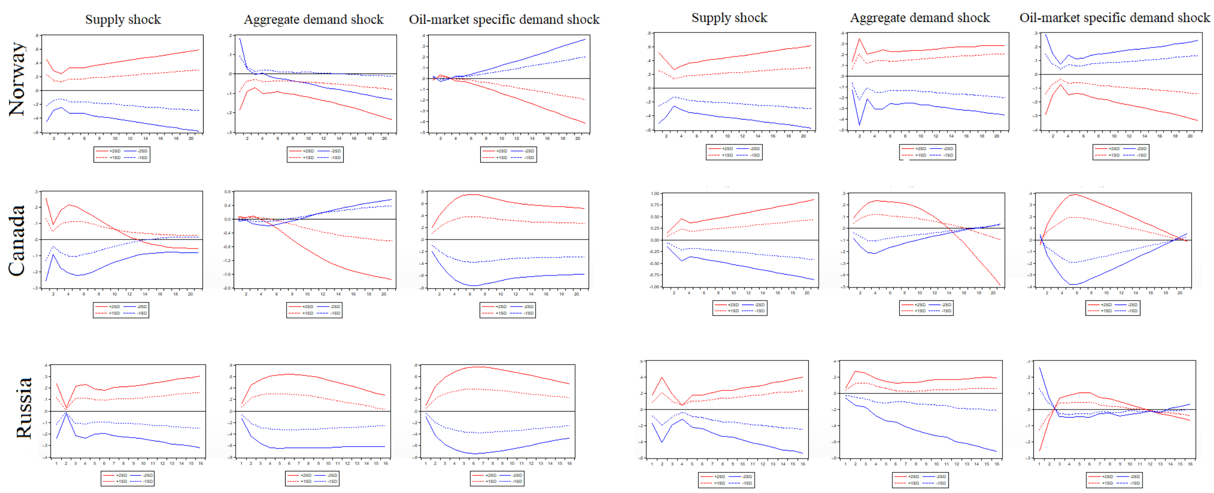


Figure 2: Impulse Responses of output growth to different oil price shocks

(a) High Economic Activity Regime

(b) Low Economic Activity Regime



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