Common and country-specific uncertainty fluctuations in oil-producing countries : Measures, macroeconomic effects and policy challenges

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Abstract : In the wake of recent political developments around the world, the prospects of future oil supplies have become doubtful and the uncertainty has come to play a non-negligible role in determining the dynamics of major macroeconomic variables. This study carries out a factor model with time-varying loadings to decompose the variance of a set of important macroeconomic and financial series for the top ten oil-producing countries into contributions from country-specific uncertainty and common uncertainty. The relative importance of the uncertainty estimates in explaining the volatility of production, investment, total exports, exchange rate and stock prices seems to differ over time, with evidence of alternating periods of high and low persistent uncertainties. The global uncertainty plays the primary role for output growth, investment, exports and stock prices in all countries. The globalization and trade openness contribute in amplifying the international transmission of volatility, explaining therefore the increasing importance of the global uncertainty factor.

Keywords : Common uncertainty, country-specific uncertainty, top ten oil-producing countries, dynamic factor model.

JEL classifications : C15, C32, E32, G11.

I. Introduction

Concerns about uncertainty have exacerbated in the onset of the global financial crisis and the serial crises in the Eurozone. Ten years after the the unprecedented 2008 global financial collapse, the world continues to remain in a state of great disequilibrium, both with respect to the global economy and geopolitics. The election of Donald Trump as the U.S. president has created an unprecedented era of staggering uncertainty for the world's economy that has already been fragile. In fact, the escalating trade tensions between the U.S. and China, the rift between the U.S and Iran, the recent Venezuela crisis and the resulted U.S. sanctions have given rise to the prospect of four scenarios for the oil market. First, the failure of the United States and China to conclude a trade agreement has led to imposing additional tariffs, thereby recuscitating the specter of a long-running trade war. Investor sentiment and confidence is highly impacted by the heightened trade war between the U.S. and China. There is also a deep belief that if these trade tensions continue to escalate, the world would plunge into recession, leading in turn to less oil demand growth. Second, the escalation in the rift between the U.S. and Iran is showing no signs of abating. Iranian crude, which is facing dwindling demand in the market owing to the U.S. sanctions, has a potential to pose huge risks. Third, Venezuela is under very punitive U.S. sanctions since the U.S. government attempted to urge all countries to cut oil production from both Iran and Venezuela. Venezuelan oil exports have been damaged by the U.S. embargo as the latter is the largest purchaser of Venezuelan oil, Venezuela is hugely sensitive to these cuts because of its high reliance on oil revenues. Fourth, the persistent degradation of conditions in Venezuela (intensified by new nationwide power outages and escalated political tensions) has risen due to very large concerns over supply disruptions in Iraq and Iran.

Hence the relevance for a better understanding of how uncertainties about the economic outlook are significantly related to macroeconomic variables in top oil-producing countries. Together, the uncertainty surrounding the aformentioned events could decide the fate of global oil markets. In this world of growing globalisation, these events can have a global impact on investor sentiment and energy market performance.

Uncertainty can have a significant effect on the macroeconomy, depending on whether it reflects major natural exogenous factors like natural disasters or geopolitical risks perceived as a source of political and macroeconomic fluctuations, or whether it emerges as an endogenous reaction to other potential macroeconomic drivers, including aggregate demand shocks or aggregate supply shocks, thus excerbating the uncertainty impacts. In fact, high uncertainty can transmit through the macroeconomy by influencing spending decisions of households and firms, leading to a suspension of consumption and investment, and a harm to financial markets. Moreover, the economic policy uncertainty may have a substantial impact on the appropriateness of economic policies. For example, economic downturns which are characterised by a heightened uncertainty may necessitate a deeper monetary policy stimulation package to effectively support the economy.

Consequently, the evaluation of economic uncertainty and its possible effects is very much at the centre of attention of policymakers (see for example, Bernanke 2007 ; Kose and Terrones 2012 ; Haddow et al. 2013 ; Carney 2016, among others). Individual and institutional investors, governments and central bank officials have long considered policy uncertainty indispensable determinant of macroeconomic fluctuations (see for example, Arnold and Vrugt 2008 ; Bloom 2009, 2014; Christiano et al. 2014; Liu and Zhang 2015). Arnold and Vrugt (2008) and Liu and Zhang (2015) showed that there exists a positive relationship between policy uncertainty and stock market volatility. Moreover, Kang et al. (2014) and Gulen and Ion (2016) indicated that great uncertainty yields to a decline in investment and output growth. All countries face shocks that may harmfully affect their public finances. These shocks can limit revenues and lead to inflationary pressures. In such scenarios, most countries are forced to take emergency fiscal tightening measures. Such emergency measures are more likely to inhibit investment and economic development, as they are usually based on measures that generate short-term financial benefits at the expense of long-term efficiency (Pástor and Veronesi, 2013). The increased globalization stresses out the paramount prominence of sound fiscal policies.

Our investigation is related to the existing literature which focuses on economic, macroeconomic and financial uncertainties that are specific to certain individual developed economies and those that are common to a wide group of those economies (see, for example, Aloui et al. 2016 ; Balcilar et al. 2016 ; Beckmann et al. 2018 ; Bouoiyour et al. 2018, among others). Nevertheless, the present research seeks to assess the macroeconomic impacts of country-specific and common uncertainties in selected top oil producers which have received uncertainties from multiple sources as explained before. It must be stressed at this stage that this issue has been solely explored for some OECD countries. Mumtaz and Thedoridis (2017) decomposed the volatility of real economic activity, inflation and other financial series for eleven OECD countries into conribution froma country-specific unretainty and a contribution common to all OECD countries under study. In the same context, Mumtaz and Musso (2018) disentangled the variance of a wide set of macroeconomic and financial variables for 22 OECD countries into contributions from country-specific uncertainty, region-specific uncertainty and global uncertainty. They found that all the uncertainty estimates play a significant role in explaining the volatility of real economic activity, inflation, interest rates, stock prices and exchange rate for most countries,but as time passes, the effect of common uncertainty becomes stronger.

Rather than analyzing the impact of structural oil price shocks on economic uncertainty, this study goes beyond that by exploring the dynamic impacts of country-specific and common uncertainties y on a wide set of macroeconomic and financial series in ten biggest oil producing countries. As far as we are aware, this is the first research which estimates the roles of macroeconomic uncertainty in driving oil dependent countries and aspires to explain the time variation in the contributions of distinct uncertainty types. Multiple studies have touched upon the dependence between uncertainty and oil prices. Nevertheless, mostly they concentrate on oil price uncertainty instead of macroeconomic uncertainty (for example, Pindyck, 2004 ; Bredin et al., 2011 ; Elder and Serletis, 2010). Although prior studies have been useful to gain insights into the sources of shocks behind oil price movements, these analyses were not well-suited to uncover contributions from country-specific and common uncertainty for the oil-producing countries. We focus on the top ten oil-producing countries, accounting for more than 80% of the total world's crude oil production, as we believe that understanding the responses of these countries to common and country-specific uncertainty is evidently very important in terms of oil price forecasting and has also political and regualtory implications. Given the past history of oil supply disruptions resulting from several geopolitical events, the oil market participants should often assess the possibility of future disruption and the possible consequences of such an uncertainty. Those participants should take into consideration the ability of the non-affected oil producers to counterbalance a probable oil supply deficit. Our concern here is not with how policy makers respond to oil price uncertainty as it is often done in the literature, but with the evolving financial and macroeconomic effects of different uncertainty sources in top ten-oil producing countries (i.e., the United States, Saudi Arabia, Russia, Iraq, Iran, Canada, China, UAE, Kuwait and Venezuela, in this order[1]).

To our best knowledge, the aspect of common uncertainty has been relatively unaddressed for the case of oil-producing countries which have a large impact on oil prices

[1] For more details about the % share of world's total crude oil production, please refer to Figure A1, Appendix.

and the world's economy.[2] The noticeable increase in oil price volatility over the past decade sparked an intensive debate about its potential determining factors. Many works indicate that the excessive oil price fluctuations are highly explained by the interplay between oil supply and demand (for instance, Baumeister and Peersman, 2012; Hamilton, 2009 ; Kilian and Murphy, 2010 ; Selmi et al. 2019), while others argue that speculation may also play a significant role (Tang and Xiong, 2011 ; Singleton, 2012). A factor which has been neglected in this debate is that in periods of high oil price volatility, uncertainty surrounding the macroeconomic outlook is typically very high. It is largely claimed that heightened uncertainty can affect the decision behavior of economic agents (for instance, Bloom et al. 2007). Indeed, substantial uncertainty leads to a delay in the production or consumption decisions, thereby reducing the quantity response and rising the price impact of shocks. Uncertainty could exert a significant impact on the responsiveness of oil prices and production to fundamental oil shocks, and thereby change oil price volatility. The large changes in world oil prices in the past decade underscore how all of this uncertainty factor can affect oil prices, and demonstrate the difficulty in making projections for oil prices. There is also a huge difficulty in adequately identifying all the possible consequences related to the increased uncertainty surrounding the unpredictable relations between the United States, China, Iran and Venezuela as well as further developments in the Middle East (for example, Saudi Arabia's fears over a revival of Iran's nuclear programme). Moreover, there are distinct thoughts regarding public information with respect the future course of economic events can prompt greater price volatility, price drifts and even booms and busts in prices (Singleton, 2012). Having new and accurate information about contributions from country-specific and common uncertainty for the top ten oil-producing countries can have a wide impact on oil

[2] It is largely known that oil price shocks affect the economy by changing relative prices and redistributing income, causing significant effects on consumption, investment, production and welfarewhich have drawn the close attention of policy makers.

prices as investors learn about the economic environment. These considerations have motivated us to revisit the role of uncertainty in oil dependent countries.

Our findings indicate that both common uncertainty and country-specific uncertainty are likely to exert a non-negligible impact on the financial and macroeconomic series in most cases, but such contributions vary over time.

The study is organised as follows : Section II introduces the empirical model and includes detailed information on the dataset. The results are summarized in Section III. Section IV discusses the main findings and concludes.

II. The empirical model and data

Currently, the rising complexity of the data employed in research and business analytics requires flexible, robust, and scalable econometric tools. Accordingly, the present research performs relatively new techniques that meet these requirements. Specifically, to determine the country-specific and common or global uncertainty proxies, we apply a dynamic factor model with stochastic volatility and time-varying factor loadings. The factor model is denoted as :

$$X_{it} = B_i^C F_t^C + B_i^G F_t^G + \omega_{it} \qquad (1)$$

where X_{it} is a panel of macroeconomic and financial data for the set of the top ten oil-producing countries under study.

This panel of data is summarised by three main components: a set of factors common to all countries (F_t^G) and a set of country-specific factors (F_t^C) for each country and idiosyncratic components (ω_{it}). The global and the country-specific factors pursue VAR processes :

$$F_t^G = C^G + \sum_{j=1}^{p} \beta_j^G F_{t-j}^G + (\Omega^G)^{1/2} \varpi_t \tag{2}$$

$$F_t^C = C^C + \sum_{j=1}^{p} \beta_j^C F_{t-j}^C + (\Omega^C)^{1/2} \vartheta_t \tag{3}$$

Where ϖ is the common factor in idiosyncratic volatility, and ϑ is the country-specific factor in idiosyncratic volatility.

It must be stressed that Equations (2) and (3) enable the global and cross-country factors to have a dynamic relationship. The idiosyncratic components has an AR transition equation denoted as:

$$\omega_{it} = \sum_{j=1}^{J} \rho_j \omega_{it-j} h_{it}^{1/2} + \varepsilon_{it} \tag{4}$$

Where $\varpi_t, \vartheta_t, \varepsilon_{it} \sim N(0,1)$; Where ϖ corresponds to the common factor in idiosyncratic volatility, whereas ϑ represents the country-specific factor in idiosyncratic volatility.

Based on Mumtaz and Thedoridis (2017)'s study, we enable for the time-varying factor loadings. Collecting the factor loadings at time *t* in the matrix $B_{it} = \left[B_{it}^G, B_{it}^C\right]$, the law of motion depicting their time-variation can be expressed as follows :

$$B_{it} = B_{it-1} + (Q_i^B)^{1/2} U_t \tag{5}$$

Where the error terms in Equations (2), (3), (4) and (5) are heteroscedastic. Following Mumtaz and Musso (2018), the error covariance matrices in the VAR models (2), (3) and (4) are denoted as :

$$\Omega_t^J = (AJ)^{-1} H_t^J (AJ)^{-1'} \tag{6}$$

where $J = G, C.$ AJ are lower triangular and H_t^J are diagonal matrices given by :

$$H_t^J = diag(S_K^J \lambda_t^J) \tag{7}$$

The time-varying volatility is detected by λ_t^J with S_k representing scaling factors for k = 1,…, K. The total volatilitesevolve as AR(1) process expressed as follows:

$$\ln \lambda_t^J = \alpha^J + \beta^J \ln \lambda_{t-1}^J + (Q^J)^{1/2} + \xi_t^J \tag{8}$$

Equation (6) indicates that the volatility component detects the entire volatility in the orthogonalized residuals of the VAR models. As claimed by Carriero et al. (2015), the common volatility can be defined as the average of the variance of the shocks with equal weight given to individual volatilities. We should point out at this stage that the errors to these equations represent the shocks to global and country-specific factors. Therefore λ_t^G, λ_t^C detect the average volatility of the unpredictable part of the common and the cross-country components. These volatilities can be considered as relevant indicators of uncertainty associated with global and country-specfic economic circumstances.

We suppose that the variance of the shocks to the idiosyncratic component to be heteroscedastic with h_{it} evolving as a stochastic volatility process. We have :

$$\ln h_{it} = a_i + b_i \ln h_{it-1} + q_i^{1/2} \zeta_{it} \tag{9}$$

The structure of the model suggests that the unconditional variance of each variable can be expressed as a function of $\Omega_t^J \; (J = G, C)$ and h_t. Specifically,

$$\mathrm{var}(X_{it}) = (B_{it}^G)^2 \, \mathrm{var}(F_t^G) + (B_{it}^C)^2 \, \mathrm{var}(F_t^C) + \mathrm{var}(\omega_{it}) \tag{10}$$

Where the variance terms in the Equation (10) are measured by means of a standard VAR formula for unconditional variance. These variance terms are time-varying as they are functions of λ_t^G, λ_t^C and h_{it}.

Note that the volatility of each variable in our panel is determined by uncertainty that is common to all countries, an uncertainty that is country-specific as well as a residual term that captures data uncertainty. In other work, we assess how volatilities of a set of macroeconomic and financial series (including real economic activity, investment to GDP, exports to GDP, exchange rate and stock prices) are driven by common and cross-country uncertainties. The time-varying factor loadings allow one to examine the dynamic contributions of each of the global, country-specific and idiosyncratic uncertainty components.

We use a quarterly data on the top ten oil-producing countries accounting for more than 80% of the total world's crude oil production. In particular, we consider data for the United States, Saudi Arabia, Russia, Iraq, Iran, Canada, China, UAE, Kuwait and Venezuela. Understanding whether the volatility of the oil and non-oil series are diven by the common or cross-country uncertainty is of paramount importance for countries that depend substantially on oil and petroleum products, especially when oil dependence has remained invariant over time. For each country under study, the data runs from 1997Q1 to 2018Q4. Our attention is limited to this period because of the availability of oil-related financial and macroeconomic variables. These variables include the real economic activity, investment to GDP, exports to

GDP, real effective exchange rate and stock prices. Quantifying the time-varying impacts of various types of uncertainty on the volatility of these five-time series and analyzing the transmission of uncertainty shocks across countries incorporates a rich information set and captures uncertainty along different dimensions for market participants.Table 1 provides a list of these time series and the data sources.

Table 1. Data, definitions and sources

Variables	Definition	Links of data sources
GDP	The contribution of oil to real Gross Domestic Product (GDP). The composition of GDP by sector of origin is available at Econstats or at the Central Intelligence Agency. The distribution gives the percentage contribution of each sector to total GDP including oil sector.	Econstats:http://www.econstats.com/index_gl.htm https://www.cia.gov/library/publications/the-world-factbook/fields/214.html
INV	Oil investments to GDP	Bank for International Settlements and Brueguel research: http://www.bruegel.org/datasets/
EXP	Oil exports to GDP	Econstats: http://www.econstats.com/index_gl.htm
REER	The sectoral real effective exchange rate, in particular, oil sector	Bank for International Settlements and Brueguel research: http://www.bruegel.org/datasets/
SPI	disaggregated stock price index, in particular oil sector	Bloomberg: https://www.bloomberg.com/markets/stocks

Table 2 provides the descriptive statistics of the quarterly returns of the variables of interest,which show that the average quarterly returns of all the time series under study is positive. The real effective exchange rates and the stock indices of most countries are characterized by high volatility (i.e., strong standard deviation). The skewness coefficients of all the variables arenegative and the kurtosis coefficients areabove three, indicating that the probability distributions of the considered return series are skewed and leptokurtic, thereby rejecting normality. All the return series are non-normal as indicated by the Jarque-Bera test.

Table 2. Descriptive statistics return series

	GDP	INV	EXP	REER	SPI
			UNITED STATES		
Mean	0.0345	0.0419	0.0223	0.0317	0.0359
Median	0.0132	0.0189	0.0209	0.0254	0.0267
Std. Dev.	0.0234	0.0145	0.0416	0.1452	0.1398
Skewness	-0.2456	-0.1867	- 0.1423	-0.1356	-0.1672
Kurtosis	4.1092	3.9168	3.6734	3.5542	4.1024
Jarque-Bera	61.224	49.376	52.167	46.713	44.429
p-value	0.0000	0.0001	0.0014	0.0009	0.0002
			SAUDI ARABIA		
Mean	0.0148	0.0216	0.0265	0.0201	0.0345
Median	0.0127	0.0186	0.0257	0.0228	0.0512
Std. Dev.	0.0223	0.1134	0.0393	0.1214	0.1341
Skewness	-0.1950	-0.0500	-0.086	-0.2017	-0.0371
Kurtosis	3.6266	3.6500	3.6753	4.1951	4.2356
Jarque-Bera	24.778	11.263	11.493	15.855	13.892
p-value	0.0138	0.0014	0.0068	0.0345	0.0039
			RUSSIA		
Mean	0.0069	0.0148	0.0216	0.0265	0.0411
Median	0.0047	0.0127	0.0186	0.0257	0.0321
Std. Dev.	0.0118	0.1956	0.0310	0.1393	0.1156
Skewness	-0.3251	-0.1950	- 0.0500	-0.0863	-0.0672
Kurtosis	3.4754	3.6266	3.6500	3.6753	4.1024
Jarque-Bera	19.328	24.778	11.263	11.493	19.052
p-value	0.0114	0.0097	0.0693	0.0628	0.0234
			IRAQ		
Mean	0.0037	0.0216	0.0265	0.0345	0.0148
Median	0.0027	0.0186	0.0257	0.0512	0.0127
Std. Dev.	0.0486	0.1134	0.0393	0.0341	0.1956
Skewness	-0.2351	-0.0500	-0.086	-0.0371	-0.1950
Kurtosis	6.0366	3.6500	3.6753	4.2356	3.6266
Jarque-Bera	78.682	11.2636	11.4933	13.892	24.778
p-value	0.0056	0.0014	0.0068	0.0039	0.0097
			IRAN		
Mean	0.0061	0.0451	0.0301	0.0098	0.0103
Median	0.0055	0.0299	0.0345	0.0426	0.0127
Std. Dev.	0.0932	0.1413	0.0311	0.0301	0.0456
Skewness	-0.1567	-0.1176	-0.0707	-0.0255	-0.0691
Kurtosis	4.1092	4.2456	4.1567	4.5678	3.8192
Jarque-Bera	23.843	19.883	22.982	18.795	25.678
p-value	0.0000	0.0002	0.0004	0.0000	0.0003
			CANADA		
Mean	0.0345	0.0621	0.0913	0.0513	0.0814
Median	0.0047	0.0245	0.0711	0.0432	0.0333
Std. Dev.	0.0672	0.0663	0.0810	0.1456	0.1193
Skewness	-0.1567	-0.0876	- 0.3412	-0.6123	-0.1569
Kurtosis	3.1789	4.0981	4.2341	4.1892	3.9123
Jarque-Bera	36.897	33.145	24.986	29.404	25.134
p-value	0.0067	0.0081	0.0014	0.0000	0.0038
			CHINA		
Mean	0.0451	0.0337	0.0281	0.0510	0.0449
Median	0.0234	0.0432	0.0319	0.0276	0.0411
Std. Dev.	0.0415	0.0567	0.0489	0.1159	0.1423
Skewness	-0.2345	-0.1345	-0.1671	-0.1824	-0.1455

Kurtosis	5.1032	4.5617	4.9821	5.1146	3.9287
Jarque-Bera	36.821	45.125	59.130	67.227	34.891
p-value	0.0000	0.0000	0.0001	0.0042	0.0007
			UAE		
Mean	0.0237	0.0599	0.0168	0.0810	0.0521
Median	0.0227	0.0766	0.0808	0.0721	0.0598
Std. Dev.	0.0486	0.0378	0.0458	0.0346	0.0192
Skewness	-0.2351	-0.0380	-0. 1764	-0. 5006	-0.1783
Kurtosis	6.0366	4.6392	4. 5175	4. 6639	3.8523
Jarque-Bera	78.682	11.439	15.855	24. 822	29.076
p-value	0.0003	0.0001	0.0000	0.0000	0.0000
			KUWAIT		
Mean	0.0411	0.0168	0.0345	0.0414	0.0503
Median	0.0321	0.0808	0.0225	0.0381	0.0476
Std. Dev.	0.0156	3.0458	0.0991	0.1292	0.1438
Skewness	-0.0672	-0. 1764	-0.4516	-0.3894	-0.2578
Kurtosis	4.1024	4. 5175	4.1567	4.0234	3.9156
Jarque-Bera	19.052	15.855	21.489	22.611	23.098
p-value	0.0234	0.0000	0.0000	0.0000	0.0010
			VENEZUELA		
Mean	0.0245	0.0291	0.0304	0.0312	0.0407
Median	0.0211	0.0197	0.0205	0.0216	0.0389
Std. Dev.	0.0345	0.0358	0.0429	0.1578	0.1891
Skewness	-0.4134	-0.3179	-0.1569	-0.2672	-0.1981
Kurtosis	4.1578	3.6500	3.6753	4.1951	4.2356
Jarque-Bera	29.832	10.923	14.553	24.618	25.092
p-value	0.0104	0.0115	0.0007	0.0052	0.0102

Notes: Std. Dev. symbolizes the Standard Deviation; the p-value corresponds to the test of normality based on the Jarque-Bera test.

III. Empirical results

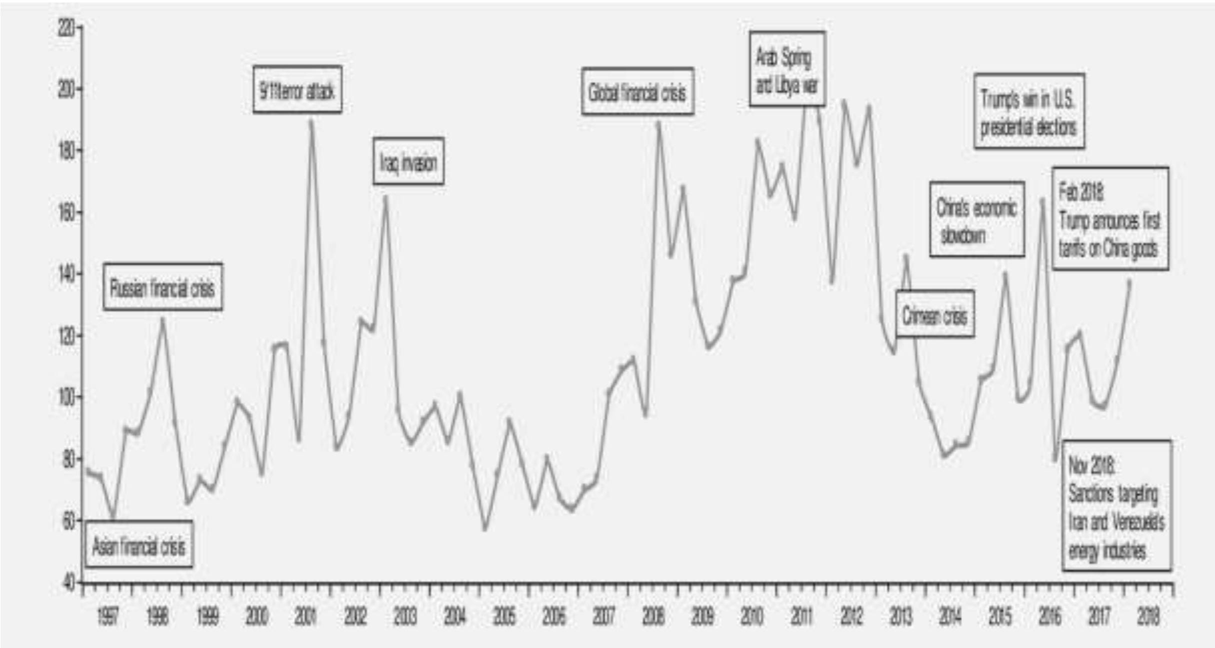
A. Estimates of uncertainty components

The uncertainty measure derived from the dynamic factor model is displayed in Figure 1 by the posterior estimates of the common standard deviation of the shocks to the global factors $(\lambda_t^G)^{1/2}$, along with various selected events, eitherrelating to major economic events or associated to major geopolitical events with significant implications for global oil prices. We interpret this as an uncertainty indicator that is common across the countries under consideration. The figure indicates that global recessions are preceded or accompanied by noticeable spikes in the global uncertainty factor. Specifically, we clearly show that the measure of the global uncertainty reaches its highest levels over Asian financial crisis (July

1997), the global financial crisis (September 2008), the China's economic slowdown (July 2015), as well as the escalated U.S.-China trade tensions (February 2018).

Summing up, several key geopolitical events relevant for the oil demand-side and supply side dynamics are highlighted in the figure below including : (i) the 2007-2008 global financial crisis; (ii) the Libyan war (2011); (iii) the 2014 Crimean crisis and the ensuing Russian sanctions (October 2014); (iv) the relative period of increased tensions between the U.S. and China (since February 2018) that, in turn, would drag down crude oil demand ; and (v) the increased US-Iran tensions (November 2018) and the Venezuelan presidential crisis and the additional economic sanctions applied by the United States to the Venezuelan petroleum and mining industries (December 2018). It must be stressed at this stage that it is still unclear whether Iran and Venezuela can mitigate the detrimental consequences of the recent U.S. sanctions by seeking partnerships with friendly countries. For instance, China and Russia continue to provide political and economic support for Iran and Venezuela, regardless of the U.S. sanctions. It's a matter of time until we are able to have sufficient information about the consequences of the U.S. sanctions on Iran and Venezuela.

Figure 1. The posterier estimate of the common standard deviation of shocks to the global factors



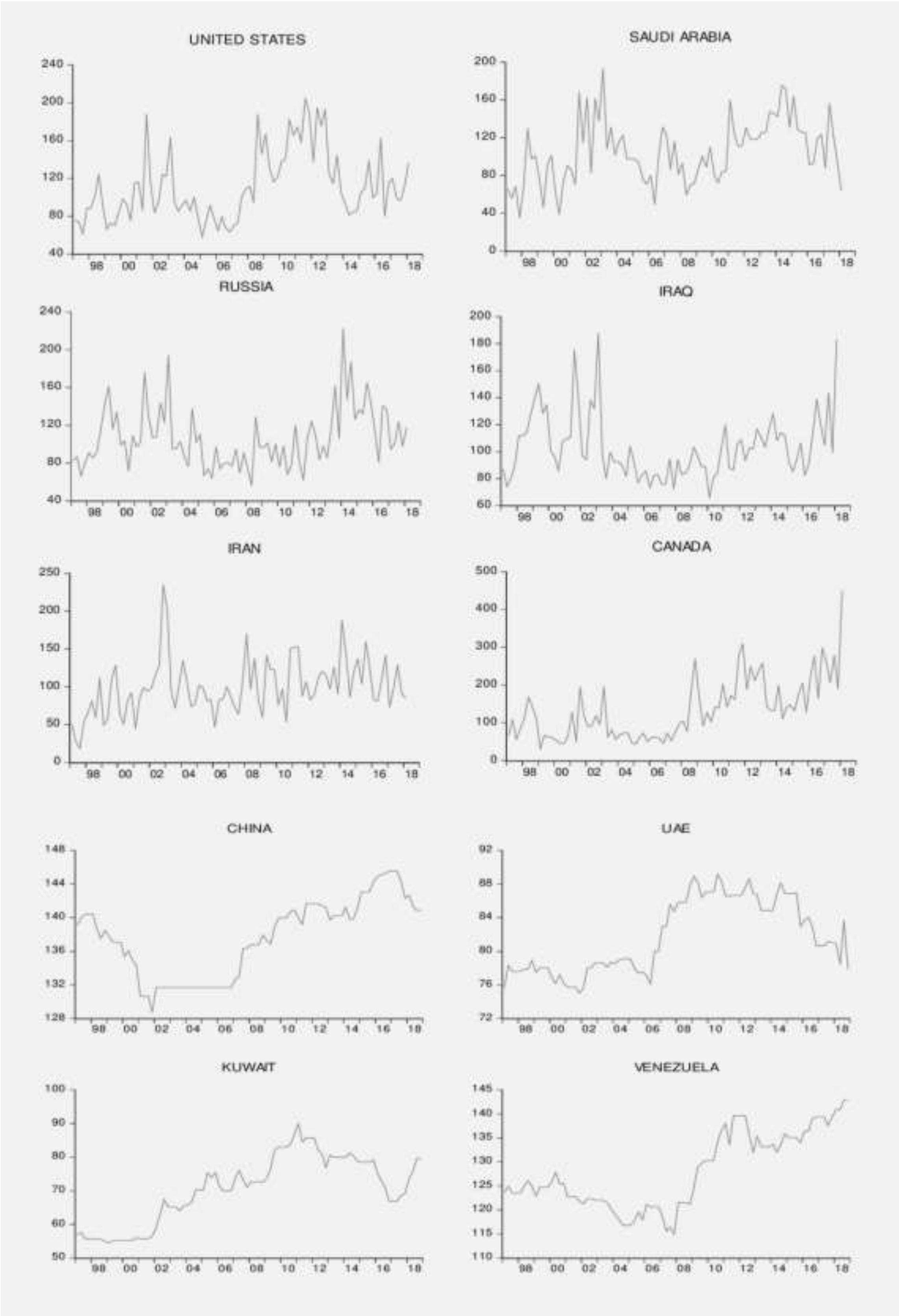
The posterior estimates of the common standard deviation of shocks to country-specific factors $(\lambda_t^C)^{1/2}$, for c=1,…, 6, are depicted in Figure 2. The cross-country estimates of macroeconomic uncertainty suggest that most recessionary periods are generally accompanied by a noticeable increase in the country-specific macroeconomic uncertainty, unless they coincide with an increase in the common uncertainty. Nevertheless, some periods of great uncertainty can also be capturedcoinciding with other events which are not viewed as recessions. An example of such episode is represented by the ASEAN-Canada Enhanced Partnership adopted in Phuket, Thailand on July 2009, which yields to a substantial increase in the Canadian uncertainty measure. For all the country-specific uncertainty indicators, it is remarkable that the Asian financial crisis (July 1997), the global financial collapse (summer 2007), and with large extent the second Persian Gulf war (March 2003), the Arab Spring (end-2010), the Crimean crisis (February 2014), the China's economic slowdown (July 2015), the

Trump's win (November 2016) and the escalation of the U.S.-China trade war (February 2018) led to the greatest extent of volatility.

Not surprisngly, one of the most evident causes of political disruption that has harmfully affected the oil market through the years is the turmoilin the Middle East and North Africa (MENA) region. This is attributed to the paramount importance of the region for global oil supplies. The MENA region includes some of the world's largestproducers of oil, including Saudi Arabia, Iran, Iraq, the United Arab Emirates (UAE), Kuwait and Libya. The increased volatility of the region has prominent implications forthe supply of oil. The stability of oil producing countries is crucial to maintaining a global supply line and then to mitigate rising macroeconomic uncertainty. It must also be stressed out that the Crimean action and the resulted U.S. sanctions have proven very expensive for Moscow.

In addition, the oil investor sentiment and confidence is highly impacted by the heightened trade war between the U.S. and China. As the world's major importer of oil, China accounted for approximately 20.2% of the world's crude imports in 2018, giving the country noticeable negotiating power in the global oil market (Bouoiyour and Selmi, 2018). There is an atmosphere of high uncertainty over oil demand, stemming from increased doubts of a collapsing economic activity at the global level.There is also a deep belief that if these trade tensions continue to escalate, the world would plunge into recession, leading in turn to less oil demand growth. Even though Canada was not the focus of Trump's anti-trade rhetoric during the campaign, but as a member of NAFTA, if the president-elect pursues renegociation, it will prompta high deal of uncertainty for the $51 billion in goods that cross the border every month (Georges 2017). Such observations highlight the importance to undertake such an assessment with a historical sample spanning several years to evaluate the coincidence between uncertainty dynamics and the recent developments in a broader perspective.

Figure 2. The posterior estimate of the common standard deviation of shocks to country-specific factors



B. Variance decomposition

In order to examine the extent to which shocks to the various uncertainty components drive the overall volatility of key macroeconomic and financial variables, the forecast error variance decompositions are accounted for. Specifically, using Equation (10) the unconditional variance of each variable is disentangled into the contributions of the various uncertainty components (global and country-specific) with the residualcapturing the idiosyncratic, or variable-specific volatility. Because the variances in the model are time-varying, the implied decomposition changes over different time-horizons as well, and it is instructive to investigate both the average contributions over the whole sample period and the evolution of these contributions over time.

a) Whole sample

Table 3 summarizes the average variance decomposition for a set of oil-specific macroeconomic and finacial variables, namely the real economic activity, investment to GDP, real exports to GDP, real effective exchange rate and stock prices. For most oil-producing countries idiosyncratic uncertainty is the most important source of volatility of real economic activity, but also the other two uncertainty components play a significant role in most cases. Regarding investments to GDP and exports to GDP, on average for the majority of countries, idiosyncratic uncertainty is also the most prominent determinant of volatility, with the common uncertainty representing the second most important component in most cases. In contrast, the real effective exchange rate volatility seems dominantly driven by the specific-country-specific uncertainty and the idiosyncratic component; the contribution of the common uncertainty appears relatively moderate. Moreover, the stock price volatility also seems to be driven first and foremost by the global uncertainty followed by the idiosyncratic uncertainty, for most countries but with some exceptions (i.e., Iran, Iraq, UAE and Kuwait).

Table 3. Contributions of the common, country-specific and idiosyncratic components to the variance of output growth, investments, exports, exchange rate and stock prices (whole sample)

	Real economic activity			Investments to GDP			Exports			Real effective exchange rate			Stock price index		
	G	*C*	*I*	*G*	*C*	*I*	*G*	*C*	*I*	*G*	*C*	*I*	*G*	*C*	*I*
UNITED STATES	23%	14%	63%	25%	11%	64%	22%	11%	67%	18%	17%	65%	47%	4%	49%
SAUDI ARABIA	18%	10%	62%	22%	8%	70%	20%	7%	73%	15%	26%	59%	71%	8%	21%
RUSSIA	24%	11%	65%	19%	13%	68%	23%	8%	69%	16%	19%	65%	49%	10%	41%
IRAN	15%	9%	76%	12%	13%	75%	21%	9%	70%	14%	10%	76%	18%	15%	67%
IRAQ	12%	15%	73%	16%	14%	70%	13%	16%	71%	19%	15%	66%	17%	22%	61%
CANADA	21%	6%	73%	29%	11%	60%	26%	9.5%	64.5%	20%	27%	53%	51%	6%	43%
CHINA	39%	8%	53%	33%	9%	58%	41%	13%	46%	17%	24%	59%	47%	3%	50%
UAE	27%	11%	62%	30%	13%	57%	29%	10%	61%	24%	11%	65%	26%	16%	58%
KUWAIT	15%	8%	77%	20%	12%	68%	23%	22%	50%	19%	11%	70%	29%	15%	54%
VENEZUELA	16%	5%	79%	14%	8%	78%	17%	6%	77%	14%	18%	68%	73%	9%	18%

Notes : *G* : global or common uncertainty component ; *C* : Country-specific uncertainty component ; I : Idiosyncratic component (residual).

b) Time-varying contributions

This study adopts the same strategy of Mumtaz and Musso (2018) by focusing on the average of macroeconomic contributions of various uncertainty sources under different periods. This could help to capture the changes in contributions from one period to another. The factor model of Equation (10) is estimated via Gibbs sampling, thereby providing details on the contribution of each uncertainty component at all time points. Gibbs sampling is a Markov chain Monte Carlo algorithm for obtaining a sequence of observations which are approximated from a multivariate probability distribution. In doing so, we find that the macroeconomic uncertainty common to all countries has gradually become more pronounced on average, whereas the country-specific and idiosyncratic uncertainty components are likely to play a gradually less potential role.

Looking at the contribution of uncertainty to the volatility of output growth, investments to GDP, exports to GDP, real effective exchange rate and stock prices (Figure 3(a), 3(b), 3(c), 3(d) and 3(e), respectively), we note that for all the considered countries, the idiosyncratic uncertainty is the most important driver of volatility, with global uncertainty representing the second most potential component in all cases. However, country-specific uncertainty appears to explain relatively moderate fractions of volatility, with the exception of Venezuela where the country-specific uncertainty seems also important. Moreover, we observe a marked elevation in the volatility of these time series in the last ten years, dominantly explained by the global uncertainty. We also document a sharp decline in the contributingroles of individual and idiosyncratic components (with the exception of real effective exchange rate).

Overall, the decomposition of uncertainty into different components (i.e., global, country-specific and idiosyncratic) can be very useful and beneficial towards the design of more appropriate regulatory frameworks and can also limit systemic risks during stressed market scenarios. In fact, if the volatility of macroeconomic variables are mainly determined by the country-specific uncertainty component, then a range of domestic policy measures might in turn represent the most effective response to lessen possible damageable consequences. In contrast, when the macroeconomic variables are predominantly explained by the common uncertainty, this might be beyond the control of national policy authorities if they act in isolation and might need under certain scenarios, coordinated policy responses at global level. But with the recent political developments which exacerbate uncertainty (especially, the Trump's win in the US presidential election) and the Trump's neo-mercantilist attitude revolving around tearing up trade deals and instituting tariffs, the heightened U.S.-China trade tensions as well as the U.S. sanctions on Venezuela's oil industries and the escalation in the rift between the US and Iran, coordinatingpolicies become hard, if not impossible, to achieve.

But if the uncertainty is common for two or more countries with closer relationship (like the relations China-Russia, China-Venezuela, Russia-Venezuela, etc.), then coordinating policy measures by national authorities of that countries seem warranted. Further, as these countries become more interconnected, thanks to globalisation, they should strengthen prudential regulations to mitigate rising risks of volatility spillovers. Also, as the stock prices are most affected by the global uncertanty, it seems of paramount importance to foster more liquid capital markets to help enhance the resilience of emerging markets against shocks.

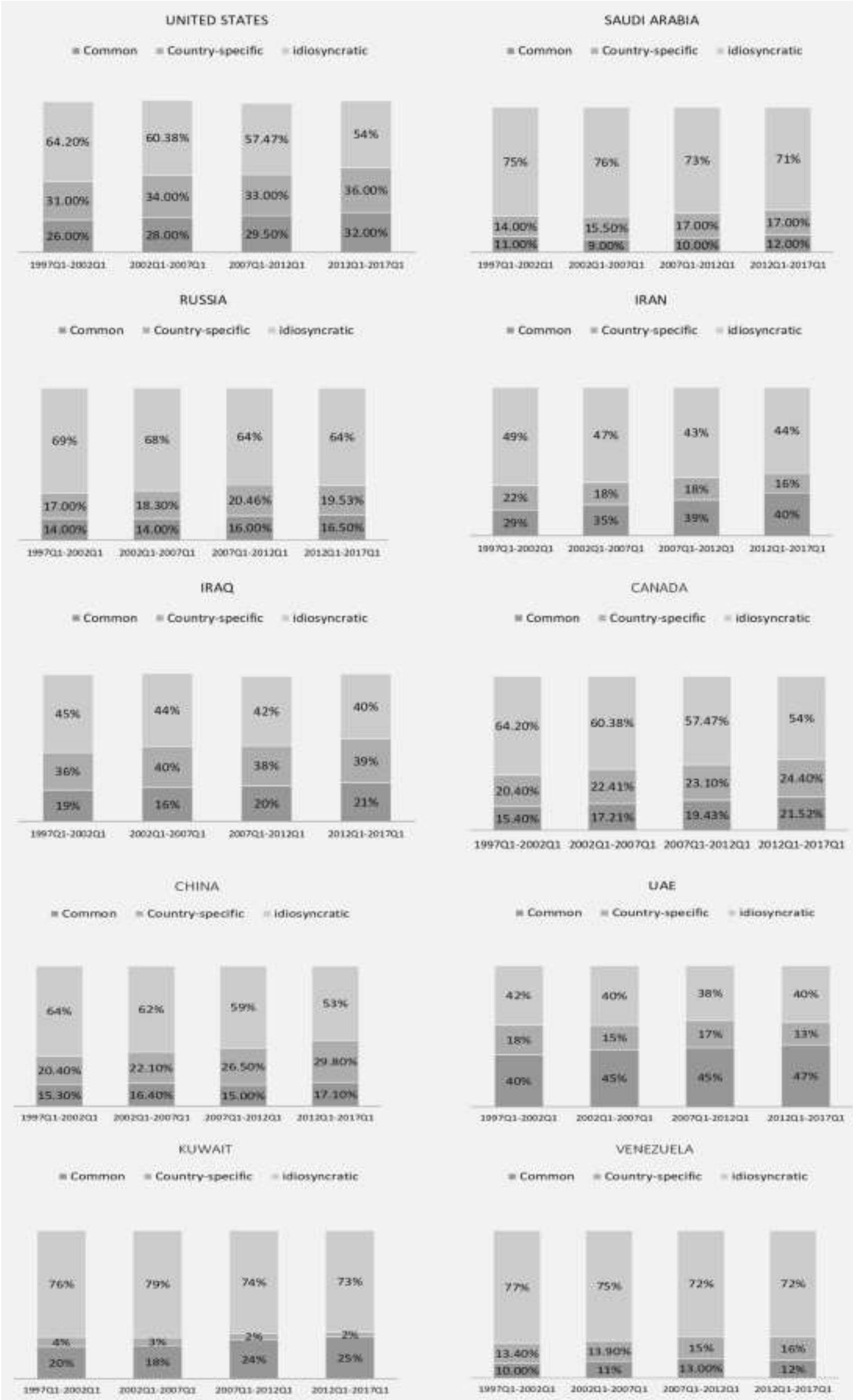
Figure 3. Variance decompositions: contributions of uncertainty components to the volatility of output growth, investments, exports, exchange rate and stock prices over time

3(a). Output growth

3(b).Investments to GDP

3(c).Exports to GDP

3(d). Real effective exchange rate



3(e). Stock prices

To ascertain the time-varying common and country-specific uncertainty impacts on the oil-related variables, we used a multiple structural change model developed by Bai and Perron (2003) in order to identify the exogenous changes that may affect the time series under study. Table 4 reports the main findings. We note that most of the break points are observed with the onset of the global financial crisis (2007: Q4), the Crimean crisis (2014: Q1), the noticeable collapse of oil market (2014:Q2) and the Trump'win in the 2016 US presidential election (2016:Q4).

Table 4. Dates of break points in time series for the top 10 countries

	GDP	INV	EXP	REER	SPI
			UNITED STATES		
1	2001 :Q3	2007:Q4	2007 :Q4	2007 :Q4	2001 :Q3
2	2007 :Q4	2016 :Q4	2016 :Q4	2016 :Q4	2007 :Q4
			SAUDI ARABIA		
1	2007 :Q4	2014:Q2	2007 :Q4	2014 :Q2	2007 :Q4
2	2014 :Q2		2014 :Q2		2014 :Q2
			RUSSIA		
1	2007 :Q4	2014Q2	1998:Q3	1998 :Q3	2007 :Q4
2	2014 :Q1		2014 :Q1	2014 :Q1	2014 :Q1
			IRAN		
1	2007 :Q4	2018 :Q2	2016 : Q4	2016 : Q4	2016 : Q4
2	2018 : Q4		2018 :Q2	2018 :Q2	2018 :Q2
			IRAQ		
1	2003 :Q2	2003 :Q2	2003 :Q2	2003 :Q3	2003 :Q2
2	2014 :Q2		2014 :Q1	2014 :Q2	2014 :Q2
			CANADA		
1	2007 :Q4	2007 :Q4	2007 :Q4	2014 :Q2	2007 :Q4
2	2014 :Q2	2014 :Q2	2016 :Q4	2016 :Q4	2016 :Q4
			CHINA		
1	2015 :Q3	2007 :Q4	2007 :Q4	2015 :Q3	2015 :Q3
2	2018 :Q2	2015 :Q3	2015 :Q3	2018 :Q2	2018 : Q3
			UAE		
1	2007 :Q4	2007 :Q4	2007 :Q4	2007 :Q4	2007 :Q4
2	2014 :Q2	2014 :Q2	2014 :Q2	2014 :Q2	2014 :Q2
			KUWAIT		
1	2003:Q2	2014:Q2	2003:Q2	2003 :Q2	2007:Q4
2	2014 :Q2		2014 :Q2	2014 : Q2	2014 :Q2
			VENEZUELA		
1	2007:Q4	2018Q4	2007 :Q4	2016 :Q4	2007:Q4
2	2017 :Q4		2018 :Q4	2018 :Q4	2018 :Q4

Notes : The break points are determined by the sequential L+1 breaks vs. L method of Bai and Perron (1998, 2003). Parameters of the break test are set as follows : Trimming 15%, Maximum breaks 5, and Significant level 5%. Statistics of the break test use the HAC covariance estimation, including prewhitening with lag one, Quadratic-Spectral kernel, and Andrews bandwidth. The break test allows heterogeneous error distributions across the breaks.

By considering the detected breaks, the key findings are preserved. In particular, the global uncertainty is estimated to be the most potential determinant of the volatility of oil-related output growth, investments, exports and stock prices, with its average contribution increasing substantially after the global financial crisis. In contrast, the exchange rate volatility is largely driven by the individual country uncertainty. A country's social and economic outlookinluences its national exchnage rates. National goverments can influence but can regalute their exchaneg rates. However in China, the Chinese govermentdrictely changes its exchanegrate.

A summary of the results will be available for interested researchers upon request.

We have also assessed the occurrence of nonlinearities in the developed common, country-specific and idiosyncratic and the different financial and macroeconomic variables (in particular, GDP, INV, EXP, REER and SPI) by using the BDS test (Brock et al., 1996)of nonlinearity on the residuals recovered from the VAR models. The BDS test is the most popular test for nonlinearity. It was originally designed to test for the null hypothesis of the independent and identical distribution for the purpose of capturing non-random chaotic dynamics. When carried out on the residuals from a fitted linear time series model, the BDS test can be employed to control for a possibly omitted nonlinear structure. If the null hypothesis is rejected, this implies that the fitted linear model is misspecified. The test shows strong evidence of nonlinearity, as itrejects the null hypothesis of an independent and identical distribution (i.i.d).

More precisely, the results suggest that the three uncertainty components and GDP, INV, EXP, REER and SPI are non-linearly dependent, which is one of the indications of a chaotic behavior, and thus justifies the appropriateness of time-varying factor model for assessing the time-varying contributions of different uncertainties' indicators to a set of financial and macroeconomic time series. To keep the clarity of our presentation, the results are available upon request.

IV. Conclusions

The present research builds a dynamic model with time-varying factor loadings and stochastic volatility to measure uncertainty that is common across the top ten oil producers which accountsfor more than 80% of global crude oil production, as well as country-specific uncertainty that is related to the individual oil producers. Bothuncertiantiescan have a significant effect on the macroeconomy.Then, we quantify their impacts in explaining the volatility of the different financial and macroeconomic variables (in particular, the overall output growth, investments to GDP, exports to GDP, the real effective exchange rate and the stock prices) and evaluate their changing roles over time.

We obtain three main findings. First, all the uncertainty measures are characterized by alternating episodes of high and low risks. Second, the peaks in common and country-specific uncertainties coincide with turmoil in the Middle East region, the Crimean crisis, China's slowdown, Trump's winin 2016 U.S. presidential elections, the current U.S. China trade war, the escalated US-Iran tensions and Venezuela's presidential crisis. Third, the common uncertainty plays a foremost role for output growth, investment, exports and stock prices in all countries. But the importance of the different uncertainty components in explaining the volatility of the oil-related series appears to change over time and across the considered countries. The important role that the global uncertainty plays as a driver of the volatility of real economic activity, investments, exports and stock prices can be explained by the increased finacial liberalization, trade openness, the internationalization of national capital markets and the reduction of barriers to foreign investments. The process of financial integration has been accompanied by an increased trend of international and regional trade agreements among these countries. While the progress of financial and trade integration has not been symmetric across the economies under study, with some countries showing more dynamism than others, the growing importance of the global uncertainty factor in driving the volatility of several macroeconomic and finacial series underscores that these countries have become much more integrated over the last ten years. Besides, most countries are driven by similar factors that are specific to the oil producers'status, given their great dependence onoil and their lack of diversification. Last but not least, the changing role of the various uncertainty components derived from the factor model to explain the volatility of several core financial and macroeconomic series suggests that it is relevant to monitor both the common and country-specific uncertainties, in order to better understand developments in macroeconomic fluctuations and financial cycles, and then well inform the economic policy process.

Recently, the agreement by the OPEC and other countries to cut production (June 2019) underscores that geopolitics could have a significant impact on oil prices over the next months and maybe years. Further, the the escalated U.S.-Iran tension is showing no signs of abating. Risks for oil supply distruptions could be stronger if Tehran takes actions in trying to shut down the Strait of Hormuz, which is a very important transit point for the global crude oil trade. The widespread contamination of oil pumped through the Druzhba pipeline, the world's longest oil pipeline and one of the biggest oil pipeline networks in the world, as well as drone attacks to pumping stations on the East-West pipeline route in Saudi Arabia, has added heavily to the concern.

Our results appear to be very timely and relevant for both individual and institutional investors as the global oil market continues to be persistently rocked by unpredictable and extremely destabilizing events. With the multiplicity of oil supply disruptions resulting from geopolitical events, an effective defense is to be well informed. The dynamic factor model used in this paper helps to detail the risk-facing market participants by providing them with precise information over different time horizons. This would, in turn, help oil producers to counterbalance a probable oil supply loss.

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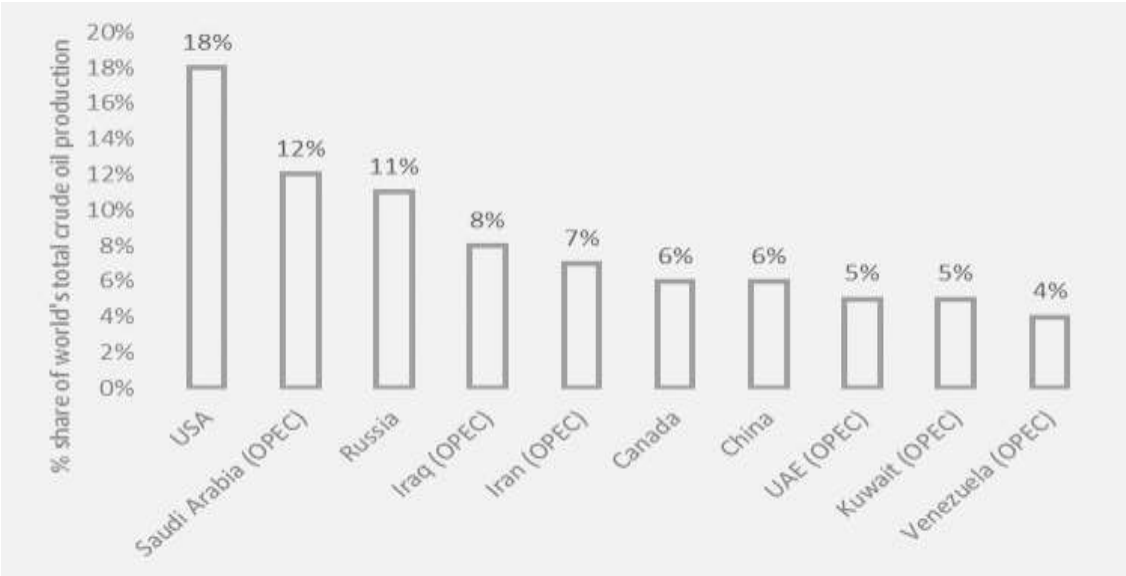
Appendix

Figure A1. Global oil shares of the Top ten oil producing countries



Source: U.S. Energy Information Administration; OPEC: the organization of the petroleum exporting countries. OPECis an intergovernmental organization of 14 nations accounting for 44% of global oil production, giving them a significant influence on crude oil prices.