The Effect of Oil Uncertainty Shock on Real GDP of 33 Countries: A Global VAR Approach

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Abstract

In this paper, we investigate the effect of oil price uncertainty shock on real Gross Domestic Product (GDP) of 33 developed and emerging economies using the Global Vector Autoregressive (VAR) framework that allows us to capture the transmission of global shocks while simultaneously accounting for distinct characteristics of individual countries. Utilizing quarterly data over the period of 1980Q1 to 2019Q2, we show that, in general, oil price uncertainty shock has a statistically significant negative impact on GDP for 28 out of the 33 countries, but with varying magnitude and persistence. Overall though, we find the adverse effect on real GDP to be relatively stronger for the developed group of countries than the emerging ones. Hence, our results suggest that policymakers must be ready to undertake expansionary policies (of varying order) in the wake of an oil price uncertainty shock to prevent deep recessions, except in the cases of Norway, Philippines and Saudi Arabia, for which output tends to increase in a statistically significant manner.

1.   Introduction

The (adverse) impact of oil price volatility (uncertainty) on economic activity has received considerable attention since the oil shocks of 1973 and 1979, and more recently in the wake of the outbreak of the COVID-19 pandemic. The negative effect of oil price uncertainty (volatility) on economic activity is generally explained by the real options theory (Bernanke, 1983), which suggests that decision making is affected by (oil price) uncertainty because it raises the option value of waiting. In other words, given that the cost associated with wrong investment decisions is very high due to irreversibility, (oil price) uncertainty makes firms and, in the case of durable goods, also consumers more cautious. As a result, economic agents postpone investment, hiring,

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and consumption decisions to periods of lower (oil price) uncertainty, which results in cyclical fluctuations in macroeconomic aggregates. Given this theoretical channel suggesting a decline in measures of real economic activity following a hike in oil price uncertainty, a large international empirical literature has evolved trying to validate these claims (see van Eyden et al., (2019) and Kocaarslan et al., (2020) for detailed reviews).

A common feature of this line of investigation is that it has involved real economic activity variables (output and unemployment) of individually-considered primarily developed economies like the United States (US), Canada, and other G7 countries, with an exception being the work of Aye et al., (2014), which looked into South Africa. We aim to add to this literature by analysing the effect of oil price uncertainty shocks on the real Gross Domestic Product (GDP) of 33 developed and emerging countries, which accounts for more than 90% of world GDP. It must also be noted that, the dominant econometric framework of the existing studies, following the work of Elder and Serletis (2010), has involved a Generalized Autoregressive Conditional Heteroskedasticity (GARCH)-in-mean Vector Autoregressive (VAR) model, which basically is bivariate and includes oil price (returns) and the economic variable under investigation. We differ also in this regard by relying on a Global VAR (GVAR) model of the 33 countries, as developed by Chudik and Pesaran (2016). The GVAR model simultaneously accommodates both domestic and external (foreign and common) factors in the estimation process, with oil uncertainty fitting in as a global factor, compared to other multivariate models that only deal with the latter and usually for country-specific analysis. In other words, while studying the role of a global oil price uncertainty shock on real GDP of the 33 countries, we are able to account for the interconnectedness between the economies, and by controlling for additional important domestic variables (like, inflation, interest rates, equity price, and exchange rate) to avoid omitted variable bias, we are able to obtain statistically correct inferences. Finally, instead of using a GARCH model to obtain a conditional estimate of oil price volatility, we use a model-free (unconditional) and observable metric of the same derived from realized volatility (RV), i.e., the sum of daily squared returns of oil over a quarter (Andersen and Bollerslev, 1998), which is known to be a more accurate estimate of volatility (McAleer and Medeiros, 2008)

To the best of our knowledge, this is the first paper to analyse the impact of oil RV shocks on 33 economies based on a GVAR model. The remainder of the paper is organized as follows:

Section 2 discusses the data and methodology, while Section 3 presents the results, and Section 4 concludes.

2. Data and Methodology

As indicated above, for our econometric analysis, we rely on e a dynamic multi-country GVAR model of 33 interconnected economies covering the quarterly period of 1980Q1 to 2019Q2, drawn from the dataset of Mohaddes and Raissi (2020).[1] Each economy comprises of six domestic (endogenous) variables namely, log real GDP, y_{it}, the rate of inflation, dp_{it}, short-term interest rate, r_{it}, long-term interest rate, lr_{it}, the log real exchange rate, ep_{it}, and log real equity prices, eq_{it}, and an external common factor involving base metals prices ($pmetal_t$). As part of global variables, we introduce our main driving force, i.e., oil uncertainty measured as RV of the log-returns of the West Texas Intermediate (WTI) oil price,[2] and also a metric of global financial cycle (GFCy)[3], which allows us to control for the state of the world market for risky assets, since it is known to impact world business cycles (Miranda-Agrippino and Rey, 2020), as witnessed during adverse financial market events such as the Russian default, the Long-Term Capital Management (LTCM) bailout, the East Asian Crisis, burst of the dot-com bubble, and the Global Financial Crisis (GFC).

Our GVAR model takes the form:

$$x_{it} = \sum_{\ell=1}^{p_i} \Phi_{i\ell} x_{i,t-\ell} + \Lambda_{i0} x_{it}^* + \sum_{\ell=1}^{q_i} \Lambda_{i\ell} x_{i,t-\ell}^* + \Gamma_{i0} C_{it} + \sum_{\ell=1}^{s_i} \Gamma_{i\ell} C_{i,t-\ell} + \varepsilon_{it} \qquad (1)$$

where x_{it} is a $k_i \times 1$ vector of variables specific to cross-section unit i ($i = 1,2,\dots,N$) in period t ($t = 1,2,\dots,T$); x_{it}^* is the corresponding $k_i^* \times 1$ vector of foreign variables which are typically constructed as $x_{it}^* = \sum_{j=1}^{N} w_{ij} x_{jt}$ where $\sum_{j=1}^{N} w_{ij} = 1$, and $w_{ii} = 0$; $\Phi_{i\ell}$, for $\ell = 1,2,\dots,p_i$, is a $k_i \times k_i$ matrix of unknown parameters for domestic variables; $\Lambda_{i\ell}$, for $\ell = 0,1,2,\dots,q_i$, is a $k_i^* \times k_i^*$ matrix of unknown parameters for foreign variables; $\Gamma_{i\ell}$, for $\ell = 0,1,2,\dots,s_i$, $k_i \times k_i$ matrix of unknown parameters for external common factors which are repeated for all the cross-sections

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while ε_{it} is a $k_i \times 1$ vector of errors. Both the foreign and global factors are treated as weakly exogenous. The estimation of country models in equation (1) is the first step of the GVAR approach, while the second step of the GVAR approach consists of stacking estimated country models to form one large GVAR model from which the impact of the oil uncertainty is teased out.

3.   Results

This study presents country-specific impulse responses for the impacts of oil price uncertainty on real outputs for thirty-three countries covering both developed and emerging economies as captured in the Global VAR framework. Figure 1 presents the impulse response functions of real GDP to a one standard deviation shock to oil price uncertainty. The median response is represented in solid lines while the 16%–84% lower and upper bootstrapped error bands are shown in dotted lines. The impacts are measured by percentage points after multiplying the values indicated by the solid lines by 100. The forecast horizon extends over forty periods (quarters). The results for most of the economies considered confirm the earlier hypothesis that shock to oil price uncertainty can engender declines in the level of output.

Notably, a one standard deviation shock to oil uncertainty results in reduction in real output in 28 of the 33 countries, albeit with varying magnitudes and persistence.[4] In general, we find that the impact of the shocks dies out over the forecast horizon of eight quarters following the shock, with a peak around the 4th quarter after the shock for most of these economies. The five exceptions are Indonesia, Netherlands, Norway, Philippines and Saudi Arabia, whereby the effects are positive, though for the first two the impact is statistically insignificant. As indicated by Pan et al., (2017), negative supply shocks, possibly due to geopolitical events in the Middle-East, can increase oil uncertainty, but the associated higher price is possibly driving the positive effect on real GDP of Saudi Arabia, and also Norway (barring a short-lived negative effect at the 1st and 2nd quarters following the shock) and Philippines, given the importance of oil rents for the latter two in their respective GDPs.

[INSERT FIGURE 1]

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[4] Interestingly, while the initial impact on Chile is significantly negative, it depicts a significantly positive impact thereafter. At the same time, India, is found to witness a sharp short-lived negative impact followed by an initial rise in real GDP.

To get a better overall understanding, in Figure 2 we present the impact of one standard deviation shock to oil uncertainty for country groups categorized (based on the classification of Morgan Stanley Capital International (MSCI)) as developed and emerging. As can be seen, the real GDP of the former group is affected relatively more adversely than that of the latter set of countries, which in turn is more likely due to comparatively higher oil dependence of developed economies than that of emerging ones (De Michelis et al., 2020).

[INSERT FIGURE 2]

4.   Conclusion

Crude oil as a major source of energy and intermediate input has been associated with economic activities, thus uncertainty in the crude oil price is expected to have a reverberating negative effect on real output. A plethora of individual country-level studies, primarily dealing with developed economies, have in general also followed this line of submission. We contribute to this strand of the literature by employing the GVAR approach given the peculiarity of crude oil as a global factor with probable spillover effect on individual economies. Moreover, the GVAR framework allows us to capture the transmission of shocks among economies given the level of their interconnectedness, while simultaneously accounting for the inherent macroeconomic conditions of individual countries. Thus, this paper investigates how the crude oil price uncertainty affects real output of 33 developed and emerging economies between 1980Q1 and 2019Q2. Overall, our findings show that unanticipated increases in oil uncertainty result in a statistically significant negative impact on the real output of most (28) of the economies considered, with varying magnitude and persistence. Interestingly, out of the remaining 5 countries, the high oil-reliant economies of Norway, Philippines and Saudi Arabia depicts a statistically significant positive impact, which is possibly due to higher oil prices, along with higher uncertainty, resulting from negative supply shocks. The overarching conclusion though is that, relative to the emerging economies taken together, the club of developed countries encounter a bigger negative transient impact (which lasts for at most 2 years) following the positive oil uncertainty shock. In other words, taken together, policymakers in developed countries need to respond more strongly in terms of expansionary policies to prevent recessions, than their emerging counterparts, though the individual country-level response would require to be markedly heterogeneous.

As part of future research, it would be interesting to extend our GVAR analysis to study the impact of oil uncertainty shocks on financial markets.

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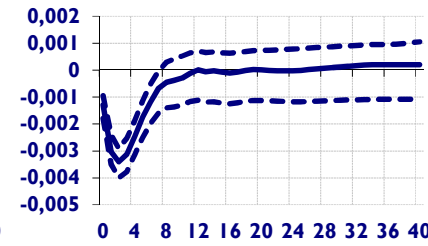
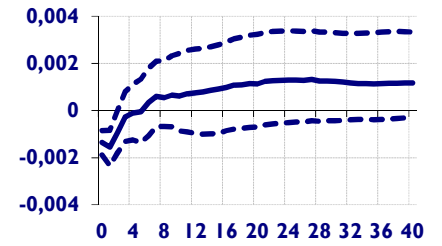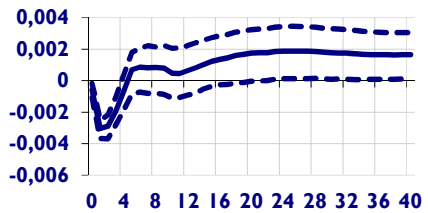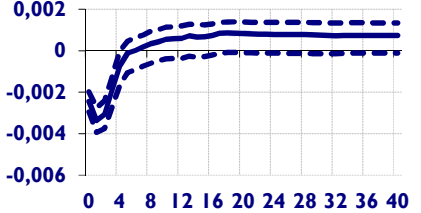# Figure 1: The country-level effects of oil uncertainty shock on (natural logarithms of) real GDP
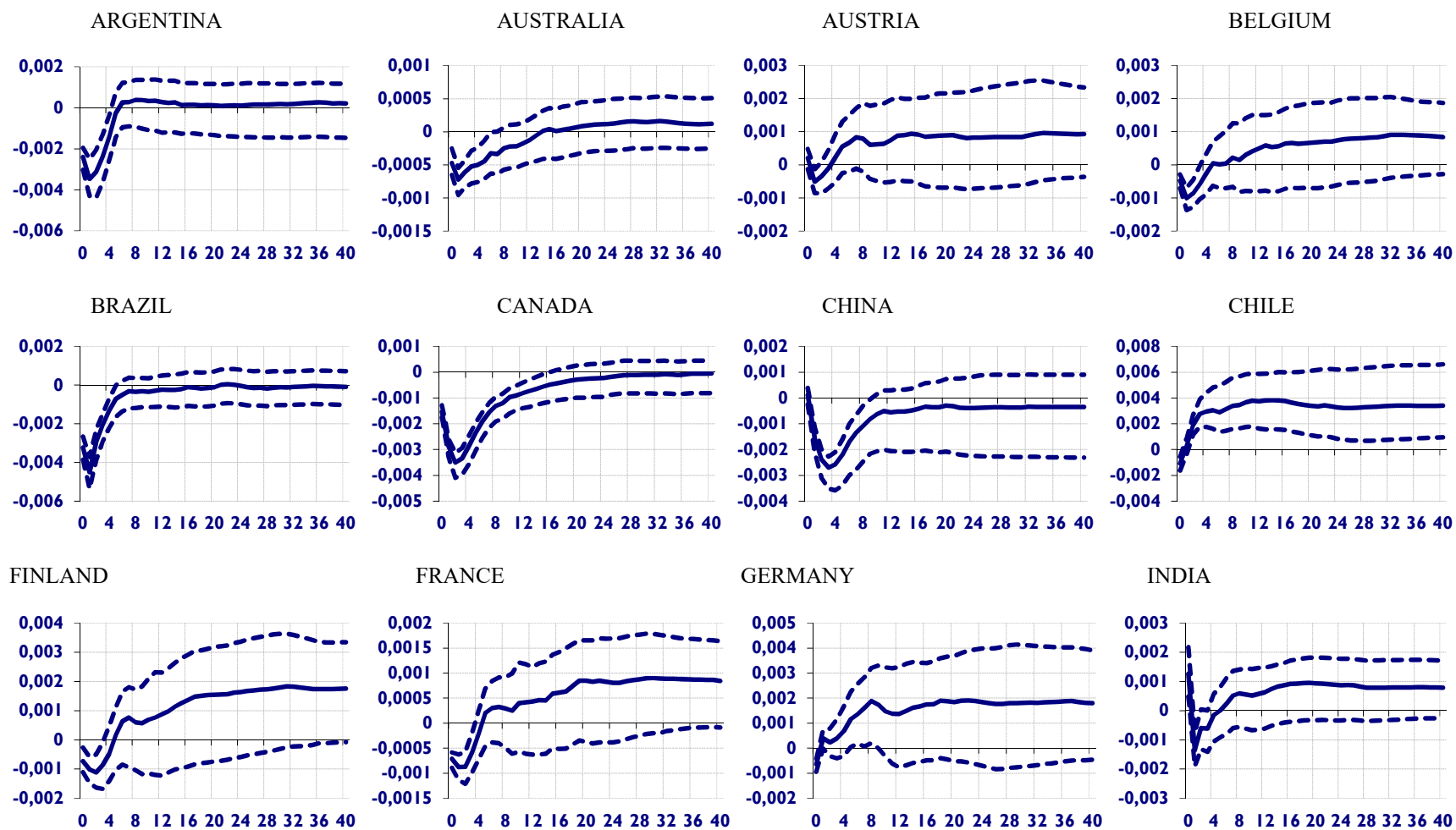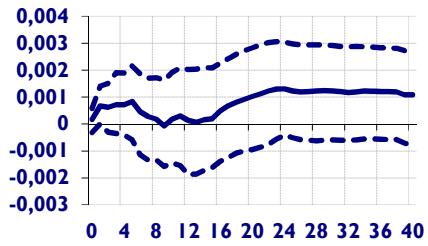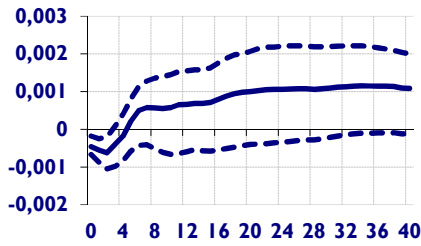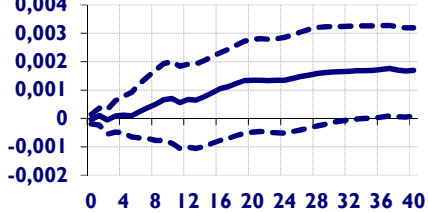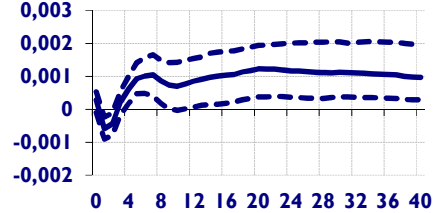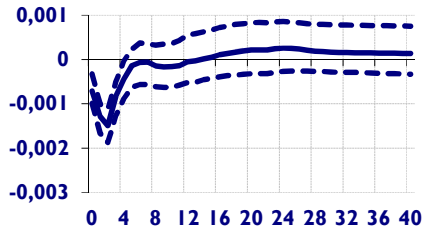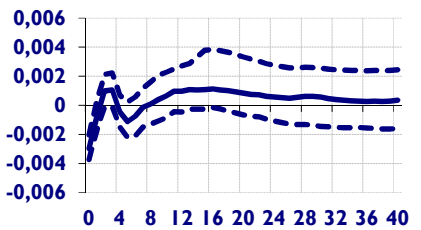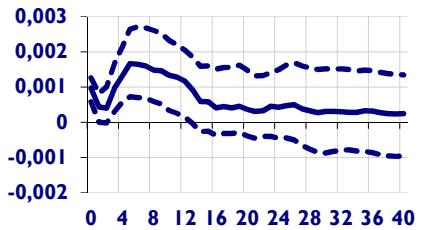
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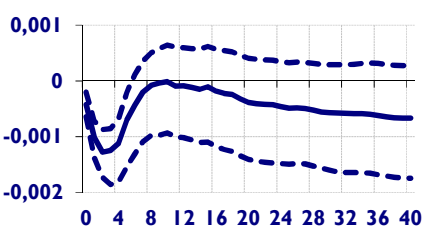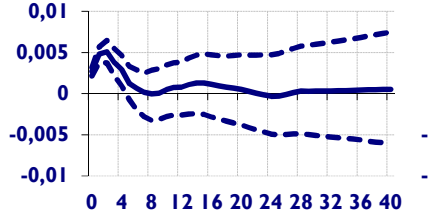
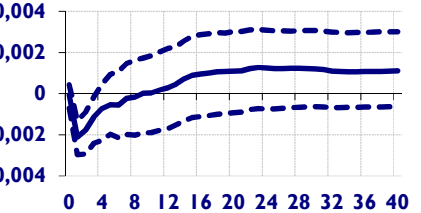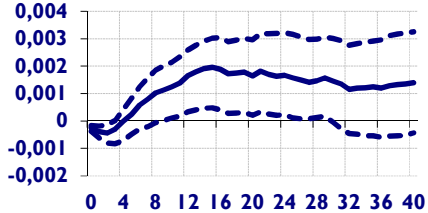MALAYSIA   MEXICO   NETHERLANDS   NORWAY
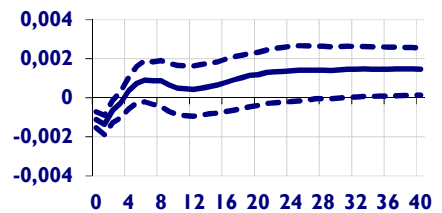
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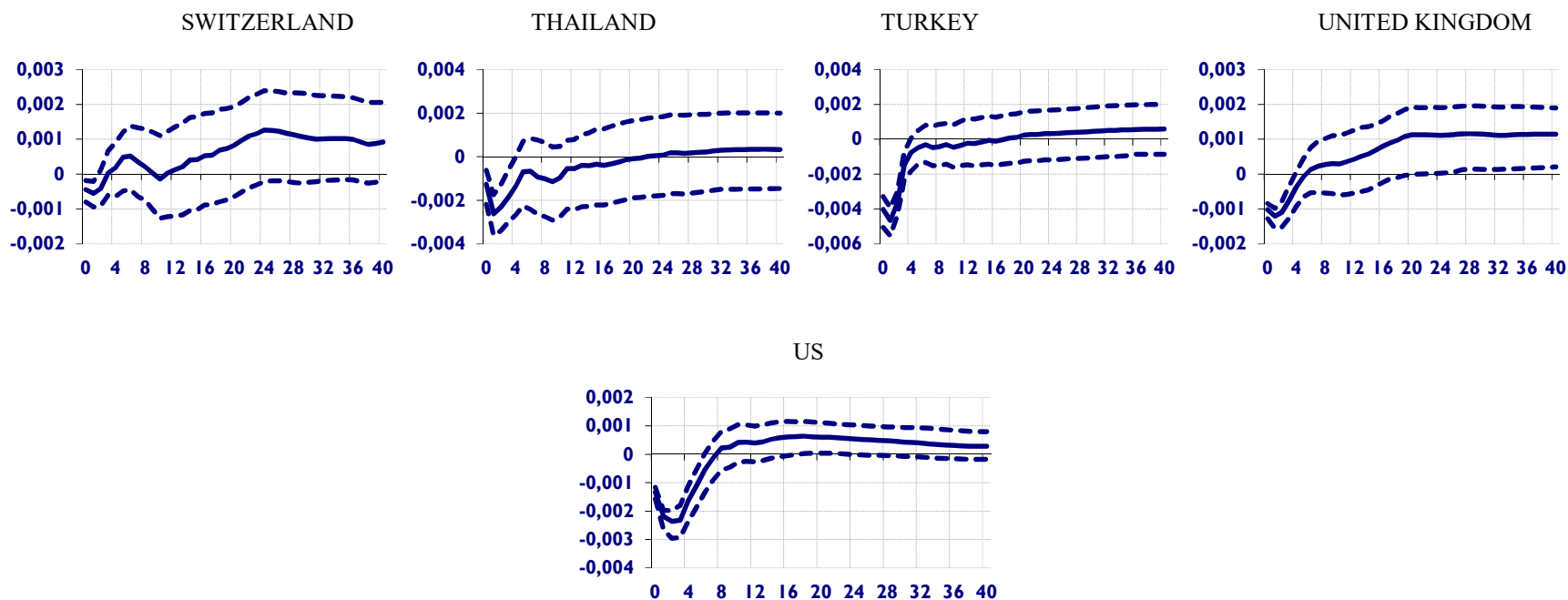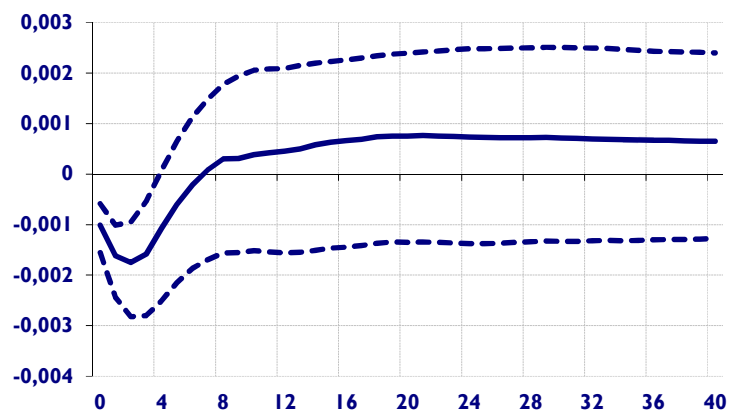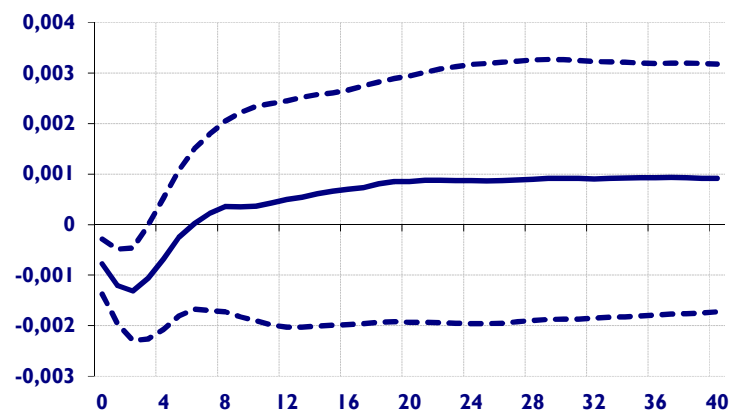SWITZERLAND   THAILAND   TURKEY   UNITED KINGDOM

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Note: The figure presents the impulse response functions of real GDP to a one standard deviation increase in oil uncertainty. The median impulse response is presented in solid lines, while the 16%–84% lower and upper bootstrapped error bands are shown in dotted lines. The impact is measured percentage points multiplying the estimates in the figure by 100 and the horizon is quarterly.

Figure 2: The effects of oil uncertainty shock on (natural logarithms of) real GDP of developed and emerging economies

Developed Markets   Emerging Markets

Note: The figure presents the impulse response functions of real GDP to a one standard deviation increase in oil uncertainty. The median impulse response is presented in solid lines, while the 16%–84% lower and upper bootstrapped error bands are shown in dotted lines. The impact is measured percentage points multiplying the estimates in the figure by 100 and the horizon is quarterly.