The Effect of Oil Price Uncertainty Shock on International Equity Markets: Evidence from a GVAR Model
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Abstract
We contribute to the literature on the propagation of oil price uncertainty shocks on to real equity prices of 26 advanced and emerging countries using a Global Vector Autoregressive (GVAR) model, over the quarterly period of 1979:2 to 2019:4. Using a newly developed model-free robust estimate of oil price uncertainty, our findings reveal a statistically significant negative effect on 23 of the 26 stock markets considered, with stronger adverse responses observed for net oil-exporting and emerging economies. Our results have important implications for investors and policymakers.

Keywords: Oil Price Uncertainty Shocks, International Equity Markets, Global Vector Autoregressive Model
JEL Codes: C32, G15

1. Introduction
As pointed out by Bernanke (1983) and Pindyck (1991), investment under uncertainty and real options implies that high oil price uncertainty creates cyclical fluctuations in investment by lowering the firms’ incentive for current investment. This in turn affects cash flows generated by a firm and the discount rate that is used to calculate stock prices and, hence, negatively impact stock prices and/or stock returns (Swaray and Salisu, 2018). Moreover, since stock prices are the sum of discounted cash flows including dividends, oil price uncertainty can adversely affect stock prices by decreasing the overall profit that a firm generally uses to pay dividends, with this resulting from the fact that firms need to bear additional costs to avoid risk associated with oil price uncertainty (Demirer et al., 2015). The theoretical prediction that oil price uncertainty negatively impact stock prices and or/returns via the investment and dividends channels have been empirically evaluated for both developed economies (see, Sadorsky (1999), Masih et al., (2011), Alsalman (2016), Diaz et al., (2016), Rahman (2021)) and emerging countries† (see, Jiranyakul (2014), Aye (2015), Bass (2017), Benavides (2019)).

One must realize that uncertainty is a latent variable, and needs to be measured. Given this, majority of the above-mentioned studies relies on univariate or bivariate Generalized

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† Basher and Sadorsky (2006) employed a multi-factor model to show that oil price risk tends to strongly affect a large set of emerging stock market returns.
Autoregressive Conditional Heteroskedasticity (GARCH) models applied to the oil price, to derive metrics of oil price uncertainty. In other words, GARCH-based oil price uncertainty is fully determined by changes in the level of oil price, and as a result it is not possible to disentangle uncertainty about the oil price and changes in the oil price level (Jo, 2014). Given this, Rahman (2021) proposes a new measure of oil price uncertainty by utilizing Stochastic Volatility (SV) in a Structural Vector Autoregressive (SVAR) model (involving oil and stock prices, and a monetary policy instrument). In this model, oil price uncertainty is the conditional variance of the oil price change forecast error, and thus it evolves independently of any change in the oil price level. Using this framework, Rahman (2021) provides evidence that increased oil price uncertainty has a negative effect on (real) stock returns of the United States (US). Despite the innovativeness of this approach over GARCH-based models in measuring oil price uncertainty, the metric is not free from the structure of any specific theoretical model.

Given these empirical issues in constructing an appropriate metric of oil price uncertainty, Nguyen et al., (2021), has proposed a novel construction of the oil price uncertainty index that is unconditional on a model. These authors develop a measure of oil price uncertainty as the one-period-ahead forecast error variance of a forecasting regression with SV in the residual terms. The novelty of this construction approach lies in its flexibility in including a large number of additional information that is important in explaining fluctuations in oil prices namely, exchange rate, oil production, global economic condition and comovement in the fuel market. In this sense, the index is able to capture uncertainty in oil price rather than volatility as measured by both GARCH and SV models.

Using this more robust metric, we aim to extend the literature on the nexus between oil price uncertainty and stock prices by analysing the impact of oil price uncertainty shock on 26 developed and developing economies simultaneously, over the quarterly period of 1979:2 to 2019:4, with these countries covering 90% of the world Gross Domestic Product (GDP). For our purpose, we rely on the Global Vector Autoregressive (GVAR) framework, originally proposed by Pesaran et al., (2004), which can account for international transmission of shocks (in our case, oil price uncertainty) based on a large panel of country-level macroeconomic data (i.e., output, inflation, short- and long-term interest rates, real exchange rate, over and above the real equity prices) and global exogenous variables (like commodity prices). To the best of our knowledge, this is the first attempt to analyze the impact of oil price uncertainty 26 stock markets considered
together by controlling for a wide-array of domestic and global macroeconomic and financial variables, which are known to drive international stock markets (Jordan et al., 2016, 2017; Sousa et al., 2016; Aye et al., 2017). In the process, our paper provides more accurate inferences regarding the size of the impact of oil price uncertainty on global equity markets by preventing the omitted variable bias.

The remainder of the paper is organized as follows: Section 2 presents the methodology and data, with Section 3 devoted to the discussion of results, and Section 4 concluding the paper.

2. Methodology and Data

We specify the nexus between oil uncertainty and real stock prices within a GVAR framework of Chudik and Pesaran (2016) that accommodates the transmission of global shocks such as those associated with oil price uncertainty to domestic variables, while also accounting for the characteristics of individual economies comprising of both the developed and emerging countries. Thus, the GVAR framework enables us to capture the interconnectedness among the various markets while tracing the propagation of global shocks and this is the attraction to the modelling framework relative to other multivariate models. In setting up the GVAR model for twenty-six countries, we consider six domestic (endogenous) variables namely, log real GDP, the rate of inflation, short-term interest rate, long-term interest rate, the log real exchange rate, and log real equity prices, and three external (common) factors involving the base metals prices, agricultural commodity prices and oil price uncertainty. We however focus on the results that highlight the impact of the oil price uncertainty shock on real stock prices and utilize the updated GVAR dataset by Mohaddes and Raissi (2020) covering 1979Q2 to 2019Q4.

We construct the GVAR model as:

\[ x_{it} = \sum_{\ell=1}^{\rho_{i}} \eta_{i\ell} x_{i,t-\ell} + \tau_{i \omega} x^{*}_{i,t-\ell} + \sum_{q=1}^{Q_{i}} \tau_{i q} x^{*}_{i,t-\ell} + \sigma_{i \omega} \omega_{i,t} + \sum_{r=1}^{R_{i}} \sigma_{i r} \omega_{i,t-\ell} + \mu_{it} \]  

(1)

The oil price uncertainty index is based on the conditional volatility of the unpredictable component of the real price of oil as measured by the Consumer Price Index (CPI)-deflated nominal values of the conventional US refiners’ acquisition cost for imported crude oil. The reader is referred to Nguyen et al., (2021) for further technical details.

Data is available at https://www.econ.cam.ac.uk/people-files/emirpes/mhp1/GVAR/GVAR.html. However, data for the oil uncertainty index is not captured in the GVAR dataset and can be obtained from https://sites.google.com/site/nguyenhoaibao/oil-market-uncertainty?authuser=0. Note that, the monthly values of the oil price uncertainty index is converted to quarterly values by taking three-month averages over a quarter to match the quarterly frequency of the GVAR dataset.
where $x_{it}$ is a $k_i \times 1$ vector of variables specific to cross-section unit $i$ ($i = 1,2, ..., N$) in period $t$ ($t = 1,2, ..., T$); $x^*_{it}$ is the corresponding $k_i^* \times 1$ vector of foreign variables constructed as $x^*_{it} = \sum_{j=1}^{N} w_{ij} x_{jt}$ where $\sum_{j=1}^{N} w_{ij} = 1$, and $w_{ii} = 0$; $\eta_{ij}$ is a $k_i \times k_i$ matrix of unknown parameters for domestic variables where $\ell = 1,2, ..., p_i$; $\sigma_{ij}$ for $\ell = 0,1,2, ..., q_i$, is a $k_i^* \times k_i^*$ matrix of unknown parameters for foreign variables; $\sigma_{ii}$ is a $k_i \times k_i$ matrix of unknown parameters for external common factors for all the cross-sections as $\ell = 0,1,2, ..., \zeta_i$, and $\mu_i$ is a $k_i \times 1$ vector of error terms. Finally, both the foreign and global factors are treated as weakly exogenous. The GVAR approach to estimating transmission of shocks involves two steps. First of which is the estimation of country models as contained in equation (1), thereafter, the estimated country models are stacked together to form a large GVAR model from which the impact of oil uncertainty on real stock prices is measured.

3. Results

In this section, we present the results of country-specific impulse response functions to assess the impact of shock emanating from the crude oil price uncertainty on the real stock prices across the considered 26 economies as captured in our GVAR analysis. The impulse responses of real stock prices (at country- and group-levels) to a one standard deviation shock to oil price uncertainty are presented in Figures 1 and 2, respectively for country-specific and group analyses. Note that the median response is represented in solid lines while the (16%–84%) lower and upper bootstrapped error bands are depicted with dotted lines. In addition, the impacts are measured in percentage by multiplying the values indicated by the solid lines with 100. As indicated in the introduction, our hypothesis is that, higher oil uncertainty should negatively impact stock prices. Specifically, we observe that a one standard deviation shock prompted by oil uncertainty causes a statistically significant initial decline in the real stock prices of 23 out of the 26 countries considered, with the exception of Italy, Philippines and Spain (for which the effect is insignificantly negative). In addition to this outcome, we are able to establish the following from the impulse response functions in Figures 1 and 2. First, while the impact of the shock to oil uncertainty is significantly negative for virtually all the economies, the stock market recovery differs with longer observed periods for countries like Argentina, Canada, Malaysia and Norway, understandably because they are largely oil-dependent, and also for Japan and Korea, which can
be partly attributed to the drag oil uncertainty exerts on industrial activities with consequences on profits and dividend thereby affecting the value stock (see Figure 1). A closer review of some stylized facts suggests that Japan and Korea rank higher in economic complexity than their peers with high oil consumption, therefore, any shock to oil which serves as a major input to the unique variety of products would have far reaching effects on production and by extension share price.

Secondly, we find that the magnitude of impacts differs across countries ranging from 1% to 10% with higher magnitudes observed for the net oil-exporting countries as well as those with high economic complexity as previously mentioned. Interestingly, the highest magnitude attributed to Argentina may have been accentuated by the incessant economic and political turmoil in the country which has continued to take a toll on the energy sector. Thirdly, in Figure 2, we present the impact of one standard deviation shock to oil price uncertainty for country groups based on developed and emerging markets classification, and whether a country is a net oil-exporting or net oil-importing. This consideration, particularly for the latter, is motivated by the evidence in the literature suggesting heterogeneous response of stock markets of net oil-exporters and net oil-importers to oil price shocks (see for example, Wang et al. (2013); Salisu and Isah (2017), among others). The results as contained in Figure 2 confirm what is obtainable under country-specific analyses, with the shock to oil price uncertainty resulting in an initial reduction in real stock prices across all the groups, with the impact being felt the most by the net oil-exporting economies. Specifically, a one standard deviation shock to oil price uncertainty results in about 5.4% and 1.7% reductions in the real stock prices of net oil-exporting and net oil-importing groups respectively (at the 2nd quarter following the shock), while it results in about 1.8% and 2.3% reduction respectively for the developed and emerging economies respectively (at the same forecast horizon). The outcome for the groups based on oil classification suggests that regions that depend

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4 See the link for the ranking and discussion of economic complexity [https://www.visualcapitalist.com/countries-ranked-by-their-economic-complexity/](https://www.visualcapitalist.com/countries-ranked-by-their-economic-complexity/). Highly ranked countries in terms of economic complexity imply a high diversity of exported products and sophisticated and unique exported products (i.e. few other countries produce similar products).

5 See the link for the ranking of countries by oil consumption per capita [https://www.eia.gov/tools/faqs/faq.php?id=709&amp;t=6](https://www.eia.gov/tools/faqs/faq.php?id=709&amp;t=6).


7 The classification of countries into emerging and developed economies is drawn from the market classification by the Morgan Stanley Capital International (MSCI) (see [https://www.msci.com/market-classification](https://www.msci.com/market-classification)), while the World Fact Book of the Central Intelligence Agency (CIA) is used to group countries into net oil exporting and net oil importing countries.
more on oil are more likely to be negatively impacted by oil price uncertainty than those with less
dependence on oil. Similarly, while the overall impact is negative for all the classifications, real
stock prices of emerging markets show some level of resilience against the shock, as the impact
later turns positive, albeit at a long horizon, even though the initial negative impact is stronger than
developed equity markets.

4. Conclusion

In this study, we examine the nexus between a novel model-free measure of oil price
uncertainty and real stock prices within a GVAR framework covering 26 countries representing
both the developed and emerging markets. We document some specific results for both the
individual countries and country-groups. We show that the shock to oil price uncertainty dampens
real stock prices in virtually all the countries, with the effect found to be more persistent for those
with higher economic complexity, greater reliance on oil, as well as developed markets, even
though the initial deepness of the adverse effect is stronger in emerging stock markets, but is
associated with a quicker recovery. This outcome offers useful pointers for possible hedging
options during periods of high oil uncertainties. For instance, investors may consider having a long
position in stocks of emerging countries and a short position in those of developed economies
during periods of high oil price uncertainties, *ceteris paribus*. Moreover, with stock prices being a
leading indicator of macroeconomic variables (Stock and Watson, 2003), the impact of oil price
uncertainty on equity markets is likely to prolong the direct effects of the same on economic
activities (van Eyden et al., 2019). Hence, authorities in oil-rich and emerging economies
specifically, should be ready to undertake more comprehensive expansionary policy measures.

Disentangling oil uncertainty based on whether the uncertainty is demand- or supply-
oriented in line with the thought process of Demirer et al., (2020), and implementing the
disentangled oil uncertainty series within the GVAR framework would further offer better insights
into the heterogeneous responses of stock markets to an oil price uncertainty shock. This is an area
we reserve for future research, besides analysing second moment effects of oil uncertainty on other
financial markets as in Liu et al., (2013).
References


Figure 1: The country-specific effects of oil price uncertainty shock on (natural logarithms of) real stock prices

ARGENTINA

AUSTRALIA

AUSTRIA

BELGIUM

CANADA

CHILE

FINLAND

FRANCE

GERMANY

INDIA

ITALY

JAPAN
Note: The figure depicts the country-specific impulse response functions of real stock prices to a one standard deviation increase in oil price 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 in percentage points (by multiplying the estimates in the figure with 100) over the quarterly horizon.
Figure 2: The effects of oil price uncertainty shock on (natural logarithms of) real stock prices across regions

Note: The figure depicts the impulse response functions of real stock prices of country-groups to a one standard deviation increase in oil price 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 in percentage points (by multiplying the estimates in the figure with 100) over the quarterly horizon.