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Global Economic Policy Uncertainties and International Oil Price Volatility Under Alternative Market Conditions

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This study mainly investigates the predictability prowess of global economic policy uncertainty (GEPU) for oil price volatility under different market episodes. The results clearly show that the GEPU-oil price volatility nexus is episodic in nature. While evidence of mean reverting stance is confirmed across the sectionalized market phases, the long-term impact of GEPU in the nexus holds true for the Covid-19 pandemic, Russia-Ukraine war, and oil price shock episodes.

I. Introduction

The connection between economic policy uncertainty and volatility of crude oil prices has been copiously emphasized in the literature (see Bourghelle et al., 2021; Chen et al., 2020; Li et al., 2022; Liang et al., 2020; Lin & Bai, 2021; Sun et al., 2020; Zhang et al., 2023) with rather more emphasis on uncertainty index of Baker et al., 2016 (see Ma et al., 2019; Mei et al., 2019). It has been clearly emphasized that various variants of economic policy uncertainty, including those of the global economy, monetary policy uncertainty, and geopolitical risk, have positive and significant effects on oil price volatility. However, this analysis has often been done over time without specifically paying attention to various episodes of market conditions. Analysis with emphasis on alternative market conditions is rather noteworthy and expected to give a stance on the sensitivity of each market condition, which, in a real sense, is capable of causing a shift in investment activities.

This study diverts from the analysis of Ma et al. (2019) by sectionalizing the market periods into different phases. Importantly, more consideration is given to the period of the first oil price shock of 2005, the period of the global financial crisis of 2007, the second oil price shock of 2010, and the recent health crisis and Russia-Ukraine war from 2020 to date. Thereafter, the study considers the full sample analysis, which is done for the entire period. The main interest here is to understand the behaviour of economic policy uncertainty in those phases, particularly in predicting oil price volatility. The study is further motivated with the use of GARCH-MIDAS, which allows to capture the fundamental inherent features of data series without losing its information contents to data slicing or aggregation.

Specifically, the outcome from this analysis suggests that the GEPU-oil price volatility nexus is episodic in nature. While evidence of a mean reverting stance is confirmed across the sectionalized market phases, the long-term impact of GEPU with respect to oil price volatility rather holds true for the recent global crisis and oil price shocks. The result essentially indicates that higher policy uncertainty will constitute a major factor that heightens oil price volatility, particularly during a turbulent global crisis. This provides implications for the intensity of the recent Covid-19 pandemic, Ukraine war, and oil price crises in a heightened oil market. However, this section is followed by discussing the appropriate methodology and by discussing the study's result. In the later section, conclusion of the finding is offered.

II. Methodology

This study uses the Generalized Autoregressive Conditional Heteroscedasticity, whose variant is Mixed Data sampling (i.e. GARCH-MIDAS) methodology, for its analysis. Importantly, this becomes a necessity given the variation in the frequencies of the study's data. While the oil price volatility occurs as daily data, the frequency of global economic policy uncertainty (GEPU) is on a monthly basis. A way to bypass using MIDAS will require either aggregating or slicing the data to have a similar frequency. However, this will result in a loss of information content inherent in the data composition. In other to avoid this setback, GARCH evaluation of the MIDAS variant is employed. In that regard, it will allow eliciting information in the high-frequency series by ensuring the low-frequency explanatory

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variable enters smoothly into the specification of the long-term component (see Salisu & Gupta, 2021).

Going with the focus of this study, the daily oil price returns is defined as:

$$r_{i,t} = 100 * (\ln(P_{i,t}) - \ln(P_{i-1,t})), \quad (1)$$

where in equation (1), $P_{i-1,t}$ stands for oil price on a day i and month t , and by which its frequency runs as $t = 1, \dots, T$ and the frequency of day, as $i = 1, \dots, N_t$ and N indicates the number of days in month t . Following this, the model for daily oil price returns that exhibit constant conditional mean and conditional variance can be defined as follows:

$$r_{i,t} = \mu + \sqrt{\tau_t \times h_{i,t} \times \varepsilon_{i,t}}, \quad \forall i = 1, \dots, N_t \quad (2)$$

with $\varepsilon_{i,t} | \Phi_{i-1,t} \sim N(0, 1)$, where $\Phi_{i-1,t}$ stands for the available information set at day $i - 1$ of period t . As for the conditional variance, as stated in Equation (2), the part represented by $h_{i,t}$ is the short-term fluctuations, and the other part τ_t is the long-term volatility in a rolling window framework. However, the short-term component varies at daily frequency, and it follows a unit-variance GARCH (1,1) process, which can be stated as follows:

$$h_{i,t} = (1 - \alpha - \beta) + \alpha \frac{(r_{i-1,t} - \mu)^2}{\tau_i} + \beta \bar{h}_{i-1,t} \quad (3)$$

where μ is the unconditional mean of the oil price returns, $\alpha > 0$, $\beta \geq 0$, and $\alpha + \beta < 1$. The long-term component, which varies at monthly frequency, is altered to vary at a daily frequency. The days across periods t are rolled back without keeping track of it and it is denoted by:

$$r_i^{(rw)} = m_i^{(rw)} + \theta_i^{(rw)} \sum_{k=1}^K \varnothing_k(\omega_1, \omega_2) X_{i-k}^{(rw)} \quad (4)$$

where X_{i-k} stands for the explanatory variable of interest for global economic policy uncertainty considered, the superscripted “ rw ” implies that the rolling windows framework is employed and $\varnothing_k(\omega_1, \omega_2)$ is the weighing scheme. In this case, one parameter weighing scheme is employed because of its flexibility and popularity in the literature. The weighing scheme is defined as:

$$\varnothing_k(\omega_1, \omega_2) = \frac{\left[\frac{k}{(K+1)}\right]^{\omega_1-1} \times \left[1 - \frac{k}{(K+1)}\right]^{\omega_2-1}}{\sum_{j=1}^K \left[\frac{j}{(K+1)}\right]^{\omega_1-1} \times \left[1 - \frac{j}{(K+1)}\right]^{\omega_2-1}} \quad (5)$$

Given this specification, the sum of the weights $\varnothing_k(\omega_1, \omega_2) \geq 0$, $k = 1, \dots, K$ is 1, such that the parameters of the model are identified. This specification thus gives a basis to the study's estimation.

III. Results and Discussion

A. Summary and Preliminary Analysis

Table 1 presents basic information on the nature of the series used for analysis in this study. While the mean value of oil price ranges between \$70 and \$75 dollar a barrel, the average value of oil price returns is 0.02 for the two variants. By standard deviation, they were relatively dispersed and positively skewed, except for Brent price volatility that has moderate height, with values tending to the threshold of 3. The study further finds evidence of heteroscedasticity

and autocorrelation through the ARCH test and Q statistics, which are shown in Panel B and C, respectively. This outcome further suggests the appropriateness of the GARCH-MIDAS methodology for the study.

B. Oil Volatility Predictability through GEPu

In this analysis, attention is paid to the predictability of oil price volatility through economic policy uncertainty under different market episodes. The idea is to see how uncertainty resulting from economic policy contributes to oil market volatility and to verify the extent of the persistence of the impact. In a way to have a comprehensive analysis, I take the evaluation to different phases. The study examines the period of the first oil shock, which occurred between January 2005 and December 2008. This analysis is immediately followed with the episode of the financial crisis, which occurred between January 2007 and December 2010. The second oil shock, which occurred between January 2010 and December 2014, is further examined. The other episode is the recent global crisis, which hosts the Covid-19 pandemic and the ongoing Russia-Ukraine war and covers from January 2020 to November 2023. In the final analysis, the study evaluates full sample, which is from January 2005 to November 2023. The results in Table 2 are the evaluation for the oil price volatility from WTI oil price variant.

The unconditional mean for the oil price volatility (μ) is found to be positive and significant for the episodes of the first oil shock and the period of financial crisis but negative for the second oil price shock. While the unconditional mean for the oil price volatility is positive but not significant for the episode of the second oil shock, it is rather positive and significant for the full sample analysis. I further find elements of persistence across the episodes and this persistence is mean reverting, holding only for the short term. This is upheld as the summation of ARCH (α) and GARCH β terms is less than unity in all the episodes considered. However, the idea of the predictability stance, especially in the long run, is more established in the recent time (i.e. the second oil shock and the recent global recession). The value of the slope parameter, θ , of the MIDAS filter is rather significant all through except for the episodes of the first oil shock and the financial crisis. This rather offers evidence of the high intensity of policy uncertainty resulting from the oil price shock between 2010 and 2014, the global pandemic and the Russia-Ukraine war, which heightened global oil market. This result thus underscores the implication of a turbulent economic crisis in generating economic uncertainty, which further protracts oil price volatility.

C. Alternative Oil Volatility Predictability through GEPu

To ensure the robustness of this analysis, I consider alternative oil price (i.e., Brent) volatility and then use global economic policy uncertainty as a predictor. The outcome, therefore, further emphasizes the findings of the main analysis. While evidence of persistence is found across various episodes suggesting that the impact is mean reverting, the long-term predictability of global economic policy un-

Table 1. Summary Statistics and Preliminary Analyses

Panel A: Summary Statistics					
Variable	Mean	Std. Dev.	Skew	Kurt	N
Oil Price (WTI)	71.629	22.033	0.293	2.555	4931
Oil Returns (WTI)	0.027	2.721	0.859	36.522	4931
Oil Price (Brent)	75.790	24.786	0.309	2.186	4784
Oil Returns (Brent)	0.016	2.695	-2.280	93.500	4784
EPU	160.686	77.752	0.753	2.951	227
EPU Returns	0.587	18.140	0.513	4.195	227
Panel B: Conditional Heteroscedasticity					
Variable	ARCH(1)	ARCH(5)	ARCH(10)	ARCH(20)	ARCH(25)
Oil Price (WTI)	0.461***	0.069***	-0.005	0.004	0.005
Oil Returns (WTI)	0.253***	0.019***	-0.141***	0.038**	-0.095***
Oil Price (Brent)	0.112***	0.127***	0.050***	0.014	0.004
Oil Returns (Brent)	0.359***	0.039***	0.127***	-0.021	0.001
EPU	0.041	0.095	-0.069	0.053	-0.039
EPU Returns	-0.244***	0.169**	-0.075	-0.005	-0.111
Panel C: Autocorrelation					
Variable	Q(1)	Q(5)	Q(10)	Q ² (5)	Q ² (10)
Oil Price (WTI)	-0.132***	-0.037***	-0.001***	0.009***	0.006***
Oil Returns (WTI)	-0.012	-0.071***	-0.016***	0.192***	0.165***
Oil Price (Brent)	0.029**	0.001*	0.002***	0.198***	0.153***
Oil Returns (Brent)	0.001	-0.003**	-0.060***	0.062***	0.173***
EPU	-0.233***	-0.065***	0.024***	0.139***	-0.009***
EPU Returns	-0.041	-0.011**	0.036*	0.037	0.169*

Note: The table presents the summary of statistics for oil prices, oil returns and Economic Policy Uncertainty (EPU) in panel A. The ARCH and Q-statistics tests are also presented in panel B and C respectively.

Table 2. Oil Price (WTI) Volatility and GEPU

Variable	μ	α	β	θ	w	m	Scope
Full sample	0.001** [0.000]	0.109*** [0.005]	0.869*** [0.006]	0.007*** [0.001]	1.454*** [0.260]	0.001*** [0.000]	Jan. 2005 to Nov. 2023
Oil shock I	0.001* [0.001]	0.126*** [0.019]	0.847*** [0.027]	-0.000 [0.001]	19.870 [58.667]	0.001*** [0.000]	Jan. 2005 to Dec. 2008
Financial Crisis	0.001* [0.001]	0.094*** [0.014]	0.899*** [0.017]	0.001 [0.001]	49.969 [79.109]	0.001** [0.000]	Jan. 2007 to Dec. 2010
Oil shock II	-0.000 [0.000]	0.048*** [0.008]	0.947*** [0.008]	0.001*** [0.000]	14.155*** [4.760]	0.000*** [0.000]	Jan. 2010 to Dec. 2014
Global Recession	0.001 [0.001]	0.108*** [0.029]	0.811*** [0.053]	0.004** [0.002]	2.021** [0.945]	0.001*** [0.000]	Jan. 2020 to Nov. 2023

Note: The results here are the estimated parameters of a monthly ($N = 22$) rolling window GARCH–MIDAS estimation using economic policy uncertainty at different market episodes. Parameters: μ is the unconditional mean for stock return; α and β are the ARCH and GARCH terms, respectively, where the latter indicates the degree of persistence; θ is the sum of weighted rolling window realized volatilities; w is the adjusted beta polynomial weight; and m is the long-run constant term. The version of oil price here is the WTI.

certainty is rather upheld positively for the recent global crisis and ongoing war in Ukraine.

IV. Conclusion

This study investigates the predictability of oil price volatility using GEPU under different market episodes. Importantly, more emphasis is placed on the periods of oil shocks, financial crisis, and the recent global recession.

While the results suggest that rising oil price volatility through policy uncertainty is temporary, the value of the MIDAS filter indicates that the long-term predictability prowess is significantly positive mainly for the recent global and on-going war crisis in Russian and Ukraine and for the second oil price shock between 2010 and 2014. This implies that the impact of GEPU is episodic and temporal in predicting global oil volatility. However, to further avoid volatile global economic conditions, some level of restraint

Table 3. Alternative Oil Price (Brent) Volatility and GEPU

Variable	μ	α	β	θ	w	m	Scope
Full sample	0.001** [0.000]	0.093*** [0.005]	0.899*** [0.006]	0.008** [0.003]	1.933** [0.751]	0.001*** [0.000]	Jan. 2005 to Nov. 2023
Oil shock I	0.001 [0.001]	0.027*** [0.010]	0.969*** [0.013]	0.010** [0.005]	1.002*** [0.157]	0.001*** [0.000]	Jan. 2005 to Dec. 2008
Financial Crisis	0.001* [0.001]	0.053*** [0.012]	0.947*** [0.013]	-0.001 [0.003]	5.112 [13.801]	0.001*** [0.000]	Jan. 2007 to Dec. 2010
Oil shock II	-0.001 [0.000]	0.052*** [0.011]	0.944*** [0.012]	0.000 [0.000]	45.365 [49.266]	0.001** [0.000]	Jan. 2010 to Dec. 2014
Global Recession	0.001 [0.001]	0.087*** [0.026]	0.835*** [0.055]	0.005** [0.002]	3.645*** [1.404]	0.001*** [0.001]	Jan. 2020 to Nov. 2023

Note: The version of oil price here is Brent. See further note in [table 2](#).

needs to be exercised on issues that can trigger a global crisis, such as war and other related crisis.

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