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Impact of Energy Price Shocks, Economic Policy Uncertainty and Geopolitical Risk on Industrial Production for G7 Countrices in Times of Russia-Ukraine war

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Abstract :

For the purpose of to examine the long-term effects of energy price shocks and economic policy uncertainty, geopolitical risk, and industrial production in times of Russia-Ukraine war, this paper applies days data from January 30, 2022, to April 30, 2022 in G7 Countrices, namely US, UK, Japan, Italy, France, Canada, and Germany. We use the dynamic macro-panel estimators, which include pooled mean group (PMG), mean group (MG), dynamic fixed effects (DFE), and Based on the Hausman h-test, the estimated result shows that PMG is the most effective estimator among the three. The results from the PMG model show that energy price shocks (crude oil, natural gas) have a significant positive (demand-driven link) with crude oil prices and a negative (supply-driven link) with natural gas prices in both the short and long terms. This shows that an increase in the price of crude oil and natural gas can cause changes in industrial

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production. Findings also indicate that fluctuations in the worldwide market energy price will be caused by changes in economic policy uncertainty and geopolitical risk.

Keywords: Industrial Production, Energy Price Shocks, PMG Model, G7 Countrices.

JEL Codes: C22, E62, O40.

1. Introduction

In times of the Russia-Ukraine war, this paper looks at the impact of energy price shocks, uncertain economic policy, and geopolitical risk on industrial production for the G7 countries, specifically the US, UK, Japan, Italy, France, Canada, and Germany. Industrial production indexes are one of the leading indicators of gross domestic product, which reflects a country's overall economic performance. In other words, changes in industrial production indicate a contracting or expanding economy, and the G7 member countries with the highest industrial production are also the ones that are closest to China. Russia depends on Ukraine for the transit of its gas to Europe, so given the growing global significance of the G7 economies, understanding how their economic policies are affected by extreme events like the war between the Ukraine and Russia is crucial for policymakers around the world in their search for resilient policies to limit negative international shock spillovers. Accordingly, the conflict between Russia and Ukraine will cause an energy crisis in several G7 nations, including the US, UK, and Japan, as well as in European nations like France, Germany, and Italy. As a result, fluctuations in the price of oil and natural gas—two essential inputs for industrial production—have an impact on the entire economy.Not only for energy policy makers, but also for managing energy resource portfolios and hedging against anomalous price fluctuations during crises, understanding of oil price shocks and natural gas prices is crucial.

Geopolitical risk (GPR) and economic policy uncertainty (EPU) have also increased globally. These two elements have an effect on both the economy and the environment. Numerous studies claim that EPU and geopolitical risk (GPR)have an impact on investment, stock market performance, and economic growth (Baker et al., 2016; Kang & Ratti, 2013; Anser et al., 2021). Thus, it could be concluded that geopolitical risk (GPR) and economic policy uncertainty (EPU) are two essential factors that have a significant impact on economic indicators. The uncertainties and geopolitical concerns have risen as a result of the tensions between Russia and Ukraine. Despite the fact that armed conflicts are often primarily seen from a geopolitical perspective, they can have significant and lasting socioeconomic effects. There are also growing worries that a severe escalation in hostilities between Russia and Ukraine could impair the world's energy supply, endangering global economy.

The rest of the paper is organized as follows. Section 2 provides a brief review of the literature. Section 3 explains the model specification, data and methodology. Section 4 discusses the empirical results. Section 5 concludes the research paper.

2. Review of Literature

The literature on energy price shocks, economic policy uncertainty, geopolitical risk and industrial production can be divided into three categories: the first category reviewing studies that established a causal relationship between the research variables; the second category reviewing studies that showed that there is no causal relationship between study variables; while the third kind is a new trend, explains what sets the present study apart from previous studies.

The first category ; empirical research by Balke et al. (2002), Kilian & Vigfusson (2009), and Dirk Jan & Roger (2014) show that energy price shocks have a long-term negative impact on economic growth. Furthermore, these studies demonstrate that one of the most important indicators of the nation's GDP and economic expansion is industrial production. The whole industrial production therefore heavily depends on variations in oil prices. when changes in the level of industrial production cause the economy to decline or expand. (Farhan & al., 2017) take into account the relationship between Pakistan's industrial production and fluctuations in oil prices. With the help of a VAR model, the authors chose the years 2000 to 2015. This study demonstrates that fluctuations in the price of oil had some detrimental effects on Pakistan's industrial production. It is advised to predict oil prices in the future so that precautions can be taken and the influence on industrial production levels can be managed.

Using econometric research, (Herrera & al., 2011) examined how oil price shocks affected industrial production in the U.S.According to the findings, there is a direct correlation between industries that manufacture or make products that are energy-intensive in usage and energy price shocks. The impacts of oil price shocks on the output of the major manufacturing industries in six OECD nations from 1975 to 1998 were examined by (Rebeca, 2007) using a vector autoregression (VAR). The study's findings show that the four member nations of the European Monetary Union (EMU) under consideration—France, Germany, Italy, and Spain—respond differently to shocks to the oil price. Korhan et al. (2015), who concentrated on the Turkish economy, discovered that oil price shocks played a significant role in nearly all US recessions from 1961 to 2012. He comes to the conclusion that shifts in oil prices contributed to

GNP changes in the Turkish economy. Additionally, because the industrial sector depends on imported crude oil, the nation is susceptible to changes in the price of oil. Given the link between the price of oil and industrial production, one may argue that Turkey needs to protect itself from oil price volatility in order to maintain stable and sustainable industrial production, at least in the short and medium term. (Abbas, 2020) examined the relationship between the price of oil and natural gas and industrial production during the years 1968–2018. The unit roots, ARDL bounds, and VECM Granger causality are used by the authors as their empirical strategies. According to Abbas et al. (2020), natural gas has a short-term negative supply relationship while crude oil has a positive demand link with industrial production.Long-term relationships between natural gas, crude oil, and industrial production in the US are asymmetric. Using panel regression, (Ylmaz, 2014) determined the substantial impact of fluctuations in oil and natural gas prices on industrial production in the 18 Eurozone member nations between January 2001 and September 2013. According to (Lutz & co., 2011), wealth transfers to exporting nations induce a decline in the purchasing power of the industries, which has a higher impact on energy importing nations. In a related study, Debojyoti et al. (2018) used data for the years January 1986 to June 2017 to conduct a quantile regression (QR) analysis using the maximum overlap discrete wavelet transform (MODWT) to examine the relationship between US economic growth and crude oil prices using the Industrial Production Index and West Texas Intermediate crude oil spot prices as respective proxies. The study's findings imply that a MODWT-based QR analysis can demonstrate a short-term supply-driven relationship between crude oil prices and economic growth. But over the medium to long term, the relationship between crude oil prices and economic growth is primarily driven by demand.

In the same context, From a microscopic standpoint, the majority of research has been empirical studies on the impact of economic policy uncertainty on firm investment decisions, corporate innovation behavior, and cash holding behavior (Brandon & Youngsuk, 2012; Nancy L.; 2020; Zhaoxia; ubo; Pietro). (2015) Jonathan & Andrew L. using the economic policy uncertainty (EPU) metric developed by Baker, Bloom, and Davis (2013) as a news-based measure. claimed that business innovation is stimulated by a one-period lag of economic policy uncertainty. Furthermore, the Fama French 25 size-momentum portfolios earn a sizable negative risk premium for innovations in EPU. (Renjing & Yan, 2021) used panel data from 1997 to 2018 at the firm and province levels to examine the impact of economic policy uncertainty on structural upgrading in the manufacturing sector in China. According to the findings, regions with an advanced manufacturing structure are much more affected by economic policy uncertainty than are regions with a less sophisticated manufacturing structure. According to (XIE & FENG, 2020), they looked into how Chinese industrial firms' export product quality was affected by economic policy uncertainty. The use of a cross-border data model would result in an increase in the variable costs of corporate production and a drop in fixed asset investment on the part of the companies, which would be counterproductive to their efforts to raise the caliber of their export products.

Additionally, export businesses would be able to mitigate the negative effects brought on by rising fixed export costs as a result of the increased economic policy uncertainty in export destination countries through the enhancement of the export product quality. Based on two business confidence metrics that represent entrepreneurs' sentiment regarding their business and the economy, (Montes & Nogueira, 2022) evaluated the impact of economic policy uncertainty on business confidence in Brazil. Panel data from 2004 to 2017 are used to estimate all models using ordinary least squares and the extended method of moments. According to the findings, business confidence is decreased by rising levels of political and economic policy uncertainty. The results also suggest that business confidence serves as a transmission mechanism, meaning that uncertainties have an impact on investments via company confidence. Using data for the years 2002 to 2018, (Feng & colleagues, 2021) used empirical analyses to evaluate how economic policy uncertainty affects corporate performance in China. utilizing Baker, Bloom, and Davis's (2016) news-based index of economic policy uncertainty.The study's outcomes indicate Compared to non-state-owned businesses, where investment fell by 7.79%, employment increased by 0.14%, and sales increased by 0.34%, the negative association was less pronounced in state-owned businesses (a decline in investment of 5.61%, growth in employment of 0.09%, and growth in sales of 0.31%).Korhan (Nithya, 2020), focusing on African SMEs, discovered that the global economic policy uncertainty has a detrimental impact on the firm's willingness to implement essential marketing tactics (such as innovation and new product development).

As for the relationship between geopolitical risk and industrial production These studies demonstrate that geopolitical risk emits lesser impact on environmental factors, and geopolitical events are a source of risk in the markets, according to (Caldara & Matteo, 2018). In the case of South Korea, which has suffered significant and unpredictably fluctuating geopolitical swings that are caused by North Korea, (Seungho & al, 2021) explore how corporate stock returns react to geopolitical risk. They discover that increased geopolitical risk lowers stock returns, and that these reductions are more pronounced for large firms, firms with a higher proportion of local investors, and firms with a higher ratio of fixed assets to total assets. This study (Gerard & colleagues, 2021) looks at how geopolitical risk affects the returns of companies in the S&P 500 index's Information technology, Communication Services, and Consumer Staples sectors. The findings revealed a negative correlation between the Consumer Staples sector and the Communication Services sector. The Consumer Staples sector exhibits a negative impact on geopolitical risk for all event windows, with the exception of the one from the geopolitical event date and five days after.

The second category, there are very few research that did not identify a relationship between changes in energy price shocks, economic policy uncertainty, geopolitical risk and industrial production, in contrast to the studies that demonstrated such a relationship ((Bohi, 1991); (Olomola, 2006); (Jin & al, 2009); (Troster & al, 2018). For example, (Huang & al, 2005) used the multiple threshold model to examine how changes in the price of oil and its volatility affected economic activities (changes in industrial production and actual stock returns), and they discovered that these changes had little effect on the economies if they fell below certain threshold levels. Oil price volatility or changes had a greater impact on economic activity than the real interest rate if they were above threshold levels. However, they only used monthly data from the US, Canada, and Japan between 1970 and 2002.

According to relationship between the unpredictability of economic policy, geopolitical risk and industrial production is unclear. (Sylvain & Zheng, 2016) claimed that economic policy uncertainty has a positive effect on economic output provided the policy adjustment can counteract economic fluctuations rather than always causing economic fluctuations. (Gulen & Ion, 2015); (candace E, 2017); (Haroon & Paolo, 2018); (Balcilar, 2018); (Alam & al, 2023), found an insufficient relationship between industrial output and economic policy uncertainty and geopolitical risk. In accordance with the studies, ((John V & Toni M., 1996); (Bloom, 2009); (Gulen & Ion, 2015); (Gieseck & Largent, 2016); (Lucas Allan & Dalmácio, 2021), We found that greater economic uncertainty might not have an impact on production and investment choices.

The third category; This study aims to investigate the effects of energy price shocks, ambiguous economic policy, and geopolitical risk on industrial production in a subset of G7 economies, including the US, UK, Japan, Italy, France, Canada, and Germany. The asymmetries between energy price shocks, ambiguous economic policy, and geopolitical risk on industrial production for G7 economies are investigated using the pooled mean group (PMG), mean group (MG), and dynamic fixed effects (DFE) model, which constrains the long run coefficients to be identical but permits the short run coefficients and error variances to differ across groups. We take into account both the scenario where the regressors follow unit root processes and the scenario where they are stationary, and for both scenarios, we calculate the asymptotic distribution of the PMG estimators as T goes to infinity. The influence of energy price shocks, uncertainty in economic policy, geopolitical risk, and industrial production for the G7 countries collectively during the Russia-Ukraine war can be explored using the pooled mean group (PMG), mean group (MG), and dynamic fixed effects (DFE) model. The following significant research gaps, which are still unexplored in previous studies, are filled by this article.

Firstly, the majority of research articles on the nexus between geopolitical risk and industrial production, uncertain economic policy, and energy price shocks have focused on asymmetrical relationships between the two underlying variables (Farhan et al., 2017; Caldara & Matteo, 2018; Abbas, 2020; XIE & FENG, 2020; Renjing & Yan, 2021; Feng & colleagues, 2021; Gerard & colleagues, 2021).

Second, and perhaps most significantly, the majority of studies have used time-series data and either linear or asymmetrical econometric modeling (Balke et al. 2002; Kilian & Vigfusson 2009; Dirk Jan & Roger 2014; Farhan et al., 2017). (Rebeca, 2007) (Herrera et al., 2011) (Korhan et al. 2015), (Ylmaz, 2014) (Lutz & co., 2011), (Debojyoti et al. 2018) (Brandon & Youngsuk, 2012); (Nancy L.; 2020) (Renjing & Yan, 2021) (XIE & FENG, 2020) (Montes & Nogueira, 2022) (Feng & colleagues, 2021) (Baker, Bloom, and Davis's 2016) (Caldara & Matteo, 2018) (Seungho & al, 2021) (Gerard & colleagues, 2021)). To our knowledge, however, no attempts have been made to use the pooled mean group (PMG), mean group (MG), and dynamic fixed effects (DFE) modeling approach for examining asymmetric linkages between energy price shocks, ambiguous economic policy, and geopolitical risk and industrial production. In addition, this is the first study to examine asymmetric relationships between energy price shocks, ambiguous economic policy, geopolitical risk, and industrial production using a panel pooled mean group (PMG), mean group (MG), and dynamic fixed effects (DFE) modeling approach for the G7 countries during the Russia-Ukraine war.

3.Methods and Materials

3.1 Data Set

The G7 countries—the United States, the United Kingdom, Japan, Italy, France, Canada, and Germany—are the focus of this study, which aims to quantify the effects of energy price shocks, uncertain economic policy, and geopolitical risk on industrial production. As a result, the dependent variable in our study is Industrial Production.

We employ geopolitical risk, economic policy uncertainty, and energy price shocks as independent variables. The data was gathered between January 30 and April 30 of 2022, providing 51 observations. All the series were then transformed into natural logarithmic series. The Table 01 contains sources and definitions for each variable.

Table 1 : Presents a schematic overview of the variables of this study

Variable	**Description**	**Source**
Industrial Production Index (IPI)	An indicator of the business cycle, the industrial production index (also known as the industrial output index or industrial volume index and abbreviated IPI) tracks monthly variations in the price-adjusted output of industry.	The Federal Reserve Board (FRB) publishes
Energy Price Shocks (crude oil, natural gas)	As a proxy for energy price shocks, we use the current U.S. dollar prices for crude oil and natural gas.	Centers for Disease Control and Prevention (CDC)
Geopolitical Risk (GPR)	The GPR index is a measure of news coverage of global politics.	Website of Economic Policy Uncertainty
Economic policy uncertainty (EPU)	(Index based on news)	Website of Economic Policy Uncertainty

3.2.Method

The combination of theoretical and empirical research is used in the literature review to investigate the relationship between factors and industrial production. Consequently, the following will be the model specification:

$$IPI = f\,(CrudeOil, NaturalGaz, GPR, EPU) \ldots\ldots\ldots\ldots\ldots\ldots (01)$$

The variance-covariance matrix is transformed into its natural logarithmic form (Ln), which causes all of the variables to become stationary and less variable. The following is the log linear (1) equation to be used in analyzing the long-term relationship between variables:

$$IPI_{it} = \beta i + \beta 1 CrudeOil_{i,t} + \beta 2 NaturalGaz_{i,t} + \beta 3 GPR_{i,t} + \beta 4 EPU_{i,t}\varepsilon_{it} \ldots\ldots\ldots\ldots\ldots (02)$$

where i=1,2,……..,N and t=1,2,…….,T

This work adopted the Pesaran et al. (1999) PMG approach for the long-term estimate of equation (2) because it enforces homogeneity in long-run coefficients while still permitting variance in short-run coefficients and error variances. The following are the fundamental presumptions of the PMG estimator: The explanatory factors can be thought of as exogenous since, in the first place, the error terms are not sequentially associated and are distributed independently of the regression. Second, the dependent and explanatory variables have a long-term relationship; Third, all nations use the same long-range parameters. Additionally adaptable, this estimator permits long-term coefficient homogeneity across a single subset of regression factors and/or nations. With the help of this estimate strategy, we may introduce polymorphism between the dependent variable and the independent variables and address the long-standing estimation issue with panel models. As an empirical framework, use the ARDL model (p, q, q,..., q) One model that can be suggested is this:

$$Y_{it} = \sum_{j=1}^{p} \varphi_{i,j}^{*} Y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}^{*} X_{i,t-j} + \vartheta_i + \varepsilon_{it} \dots\dots .03$$

where the sets are denoted by the letters i = 1, 2,..., N, the time intervals by the letters t = 1, 2,..., T, and i represents the fixed effects. xij (k 1) are the vector explanatory variables of the set i, and yit denotes the dependent variables of the set. The following equation's equation (3)makes it easy to work with. It can structure the dynamic board model of co-integration throughout the long and short terms.

$$\Delta Y_{it} = \emptyset(Y_{i,i-1} - \theta' X_{it}) + \sum_{j=1}^{p-1} \varphi_{ij}^{*} \Delta Y_{i,t-J} + \sum_{j=0}^{q-1} \delta_{ij}^{*} \Delta X_{i,t-j} + \vartheta_i + \varepsilon_{it} .. (4)$$

whereas :

$$\Delta Y_{it} = Y_{it} - y_{i,t-1}, \emptyset = -(1 - \textstyle\sum_{j=1}^{p} \lambda_{ij}), \beta_i = \textstyle\sum_{j=0}^{q} \delta_{ij}, \lambda_{ij} = -\textstyle\sum_{m=j+1}^{p} \lambda_{im}, \delta_{ij} = -\textstyle\sum_{m=j+1}^{p} \delta_{im} \dots (5)$$

Additionally, when T and N are both large, Pesaran et al. (1999) provide two distinct estimates that are consistent with one another. In contrast to the PMG estimator, which is consistent under the assumption of long-run slope homogeneity, the MG estimate appears to be more consistent under the premise that both slope and intercepts may vary among nations. An alternative estimator has been developed on the assumption that the dynamic fixed effects with homogeneous slope have constant slopes and variable intercepts across countries. The average of the long-range parameters of

ARDL models for specific countries is used to create the estimate of MG long-range parameters for the panel. In this work, we contrast the outcomes of MG, PMG, and Dynamic Fixed Effects estimation. Additionally, a likelihood ratio test or Hausman test can be used to assess the PMG estimate's suitability in comparison to the MG estimate based on the consistency and sufficiency properties of the estimators.

4.Results and Discussions

4.1 Result of Descriptive Statistics

Table 2 displays the summary statistics for the variables utilized in the investigation; the industrial production index (IPI) mean is 3.35 with a 0.71 standard deviation. While the corresponding mean and standard deviation for crude oil, natural gas, geopolitical risk (GPR), and economic policy uncertainty (EPU) are respectively 1.51 and 0.43 and 1.21 and 1.33. According to the statistic of skewness, industrial production (IPI) is skewed to the right, but crude oil, natural gas, geopolitical risk, and economic policy uncertainty (EPU) are skewn to the left.

Table 1 : Descriptive Statistics

	IPI	CrudeOil	Natural Gaz	GPR	EPU
Mean	3.35	1.51	0.43	1.21	1.33
Median	0.14	1.01	1.20	1.34	0.47
Maximum	1.45	2.21	2.34	1.21	1.34
Minimum	0.11	2.87	1.63	0.14	0.27
Std. Dev.	0.71	0.61	0.07	1.64	0.13
Skewness	0.76	-0.45	-1.37	-2.34	-0.86
Kurtosis	1.52	0.31	0.19	0.64	0.35

4.2 Result of Unit Root Test

To determine whether the series are stationary or not, we first run each individual series through the IPS, LLC, ADF, PP, panel unit root tests. Economic policy uncertainty (EPU) is stationary at level I(0), while variable industrial production (IPI), crude oil, natural gas, and geopolitical risk (GPR) are nonstationary at level but stationary at level I(1) with a 5% significance level. Table 3 shows the results of the test for stationary behavior. Since I(0) and I(1) are found to be the orders of all the variables, To ascertain the long-run co-integration between industrial production (IPI) and a few key variables for the G7 countries—the US, UK, Japan, Italy, France, Canada, and Germany—we opt to use the Panel-ARDL test. In these circumstances, the Pedroni and Kao Residual Co-integration Test (1999) is used to look at the long-term relationship between the research variables.

Table 3 : Panel Unit Root Tests

Variables	**Statistics**	**Values**	**Order of integration**
IPI	LLC	−4.32***	I(1)
	IPS	-4.26***	I(1)
	ADF	-4.12***	I(1)
Crude Oil	LLC	−5.28***	I(1)
	IPS	-5.37***	I(1)
	ADF	-5.94***	I(1)
Natural Gaz	LLC	−5.49***	I(1)
	IPS	-5.04***	I(1)
	ADF	-6.34***	I(1)
GPR	LLC	−3.17***	I(1)
	IPS	-4.61***	I(1)
	ADF	-4.30***	I(1)
EPU	LLC	−5.34***	I(0)
	IPS	−4.64***	I(0)
	ADF	-4.32***	I(0)

***significant at the 5 per cent level.

4.3 Results of co-integration test:

The third part of our empirical work uses the panel co-integration technique developed by Kao (1999) and Pedroni (2004) to examine the long-term link between energy price shocks, economic policy uncertainty, and geopolitical risk on industrial production for the G7 countries. The cross-sectional units must be independent or their size qualities would be deceptive, according to (Pedroni, 2004). introduces seven statistics for panel co-integration that are based on both homogeneity and heterogeneity presumptions. The co integration test is represented by the following equation, assuming a panel of N countries, T observations, and regressors (Xm):

$$y_{it} = \alpha_i + \lambda_{it} + \sum_{j=1}^{m} \beta_{j,it} x_{j,it} + \varepsilon_{it} \text{...(6)}$$

where it is assumed that yit and xit are integrated of one another in level i, e I(1). Two sets can be created from the seven statistics. The panel variance-statistics, panel -statistics, panel PP-statistics, and panel ADF-statistics make up the first one. Three group panel statistics—the group -statistics, group PP-statistics, and group ADF-statistics—make up the second set. The alternative hypothesis is given by; where i is the autoregressive term of the calculated residual under H1. Under the null hypothesis, all seven tests indicate the absence of c-ointegration.

Table 4 shows that the four panel statistics, out of the four statistics used for the within-dimension, reject the null hypothesis of no co-integration and approve the co-integration of the variables. Two of the three between-dimension statistics, the PP statistic and the ADF statistic, further rule out the null hypothesis, confirming the co-integration of the variables. In conclusion, six of the seven tests support the co-integration of the long-term variables.

Table 4 : Result of Pedroni cointegration test

Pedroni Residual Cointegration Test

Series: IPI, CrudOil, Natural Gaz, GPR, EPU

Alternative hypothesis: common AR coefs. (within-dimension)

			Weighted	
	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	-6.215641	0.0000	-6.215012	0.0002
Panel rho-Statistic	-6.302641	0.0000	-5.879587	0.0000
Panel PP-Statistic	-7.025654	0.0000	-6.123541	0.0000
Panel ADF-Statistic	-7.014547	0.0000	-4.102950	0.0000

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	0.080325	0.4719
Group PP-Statistic	-4.214508	0.0008
Group ADF-Statistic	-4.259874	0.0000

Additionally, the Pedroni test's methodology is followed by the (Kao, 1999) test, which is based on the premise of homogeneity across panels with

$$x_{it} = \alpha_i y_{it\beta} + \varepsilon_{it}$$

Where i=1......N; t=1.....T, where i is the individual constant term, is the slope parameter, and i is the stationary distribution; Xit and Yit are integrated processes of order I(1) for all i; and Kao (1999) derives two types of panel cointegration tests (DF and ADF); both tests may be computed from:

$$\overline{\omega}_{it} = \rho\overline{\omega}_{it-1} + V_{it}$$ and $$\overline{\omega}_{it} = \rho\overline{\omega}_{it-1} + \sum_{j=1}^{\rho} \theta_j \Delta\overline{\omega}_{it-j} + V_{it}$$

Where it-1 is derived from equation (01), the alternative hypothesis is while the null hypothesis is no cointegration. The existence of a long-term link between the research variables is supported (Table 05) by the Kao Residual Co-integration Test (Kao, 1999), which rejects the hypothesis of zero non-cointegration. In these circumstances, we adopt the alternative hypothesis—that the study's variables have a common integration—instead of the null hypothesis. With the help of these findings, we can calculate the Panel ardl's (long-term equilibrium speed) error model.

Table 5 : Result of KAO cointegration test

Kao Residual Cointegration Test

Series: IPI, CrudOil, Natural Gaz, GPR, EPU

	t-Statistic	Prob.
ADF	-7.526143	0.000
Residual variance	0.020354 1	
HAC variance	0.002154 2	

4.4 Results of Estimating PMG, MG, DFE Models:

The results of the PMG, MG, and DFE estimations as well as the Hausman test are displayed in Table 06 in the appendices list. The findings show that the variables under study, according to the estimates of PMG and MG, have a significant effect on industrial production over the long term, whereas the estimates of DFE show that these variables have a significant but insignificant effect on industrial production over the long term. According to the projections of PMG, MG, and DFE, the results show that the variables under consideration have a considerable short-term impact on industrial production. The Hausman h-test results demonstrated their heterogeneity and lack of significance, and the results are displayed in Table No. 6. Contrarily, the findings reveal a positive correlation between industrial production (IPI) and crude oil, which means that a rise of 1 point in the crude oil score will result in an increase in industrial production (IPI) (0.23). and industrial production (IPI) is negatively correlated with natural gas, indicating that an increase of 1 point in the natural gas score will increase industrial production (IPI) (-0.14). This means that over the long term, natural gas prices and industrial production in the G7 countries are linked by supply and demand, respectively. The findings also demonstrate a negative correlation between industrial production (IPI) and both geopolitical risk and economic policy uncertainty, which means that as these variables increase by 1 point, industrial production (IPI) will decrease by -0.12 and -0.56.

Table 6 shows the PMG technique of estimation's short-term results. The results showed a legitimate short-term association between industrial production (IPI) and the G7 countries—the US, UK, Japan, Italy, France, Canada, and Germany—which are its main determinants. The error term's coefficient is showing a value of roughly -0.61 hypothesize that roughly 61% of instability has been corrected this year. The results also show that the error correction coefficient (ECTt-1) is negative and significant at 5%. This coefficient represents the rate at which the dynamic model will change to restore equilibrium, meaning that the effect of a shock will be corrected by 61% within days. This outcome is in line with what empirical research have discovered.

4.5 Long-Run Coefficients by Country

Geopolitical risk in the G7 countries, namely the US, UK, Japan, Italy, France, Canada, and Germany, is statistically significant at levels of 1%, 5%, and 10%, according to long-run coefficients of industrial production (IPI), energy price shocks, and economic policy uncertainty. These findings showed that economic policy uncertainty and geopolitical risk are negatively correlated with industrial production (IPI), indicating that a 1 point increase in either of these variables' scores in the US, UK, Japan, Italy, France, Canada, or Germany will result in a decrease in IPI. EPU = (-0.17), (-0.27, (-0.34), (-0.25, (-0.24), (-0.43, and (-0.56) GPR = (-0.23, (-0.54, (-0.27), (-0.37, (-0.56, and (-0.46), respectively. However, the results also show that industrial production (IPI) is positively correlated with crude oil, which means that increasing the crude oil score by 1 will increase industrial production (IPI) in the US, UK, Japan, Italy, France, Canada, and Germany by 0.64, 0.37, 0.24, 0.75, 0.64, 0.43, and 0.16 points, respectively. Conversely, industrial production (IPI) is negatively correlated with natural gas in the US, UK, Japan, Italy, France, Canada, and Germany

Table 7 : Long-Run Coefficients by Country

Variables	**Constant**	**EPU**	**GPR**	**crude oil**	**natural gas**
US	8.08 (0.0000)	-0.17 (0.0000)	-0.24 (0.0000)	0.64 (0.0000)	-0.34 (0.0000)
UK	42.23 (0.0000)	-0.27 (0.0000)	-0.54 (0.0000)	0.37 (0.0000)	-0.61 (0.0000)
Japan	21.06 (0.0000)	-0.34 (0.0000)	-0.27 (0.0000)	0.24 (0.0000)	-0.73 (0.0000)
Italy	44. 90 (0.0000)	-0.25 (0.0000)	-0.48 (0.0000)	0.75 (0.0000)	-0.81 (0.0000)
France	35. 75 (0.0000)	-0.24 (0.0000)	-0.37 (0.0000)	0.64 (0.0000)	-0.46 (0.0000)
Canada	15. 35 (0.0000)	-0.43 (0.0000)	-0.56 (0.0000)	0.43 (0.0000)	-0.37 (0.0000)
Germany	34. 21 (0.0000)	-0.56 (0.0000)	-0.46 (0.0000)	0.16 (0.0000)	-0.28 (0.0000)

5.Discussion of Results:

The objective of this study is to examine how the US, UK, Japan, Italy, France, Canada, and Germany's industrial production are affected by energy price shocks, uncertain economic policies, and geopolitical risk. Although the factors that affect industrial production have been researched in the past, energy price shocks, uncertainty in economic policy, and geopolitical risk are significant factors.

Since PMG was found to be the most effective estimator out of the three, its outcome would be the focus of this study's analysis. The PMG's findings indicate a large positive association between crude oil and industrial production and a considerable negative relationship between natural gas and industrial production. Table 07 shows substantial positive and negative relationships between the prices of crude oil and natural gas. However, the price of natural gas shows considerable positive and negative relationships. It demonstrates that, in the short term, rising crude oil prices have a favorable (demand-driven) effect on industrial production in the G7 countries. It indicates that the industrial production of the G7 countries is not affected by the rise in the price of crude oil. The economy will grow more quickly if natural gas prices are reduced, and the industrial production of the G7 countries will be less affected by the price of crude oil.

According to (World Bank, 2022) the increase in energy prices over the past two years has been the largest since the 1973 oil crisis and the energy prices are expected to rise more than 50 percent in 2022 before easing in 2023 and 2024 Because of war-related trade and production disruptions, the price of Brent crude oil is expected to average $100 a barrel in 2022, its highest level since 2013 and an increase of more than 40 percent compared to 2021.Natural-gas prices (European) are expected to be twice as high in 2022 as they were in 2021, while coal prices are expected to be 80 percent higher, with both prices at all-time highs. This has an impact on the industrial sector since oil and gas are viewed as inputs to the manufacturing sector. In fact, the rise in crude oil prices leads to an inflationary situation, lowers industrial production, and other issues including a wealth transfer from oil-importing to oil-exporting countries and worsening unemployment.

Additionally, Balke et al. (2002), Kilian & Vigfusson (2009), Dirk Jan & Roger (2014), and Abbas et al. (2000) who validated these findings by demonstrating that an increase in energy prices can have significant effects on industrial production. Therefore, a short-term negative impact of rising energy prices on industrial production. The traditional theory applies to natural gas over the long term, but not to crude oil. The study also revealed the significance of geopolitical risk and economic policy uncertainty on industrial production. For instance, industrial production is significantly and negatively impacted by geopolitical risk and economic policy uncertainty. It has been discovered that geopolitical risk and uncertainty about economic policy generally have a negative impact on exports and industrial output. It follows that increased levels of geopolitical risk and uncertainty regarding economic policy are incompatible with industrial productivity. With the beginning of the war in Ukraine, the level of uncertainty and geopolitical risks increased in this situation. where the crisis between Russia and Ukraine has shocked the global economy. Energy prices have risen significantly as supply disruption worry has intensified. Commodity prices have also surged considerably. Trade restrictions have been put in place for Russian banks, companies, and individuals, claim (Snower D., 2022) (Bachmann, 2022) (Berner & al, 2022) and that the invasion of Ukraine by Russia is changing international relations in terms of security and the economy. All of this is expected to increase the level of geopolitical risk and uncertainty in the industrial sectors.The results of (Caldara & Matteo, 2018), (Seungho & al, 2021), (Montes & Nogueira, 2022), and (Feng & al, 2021) who shown that economic policy uncertainty and geopolitical risk is a substantial driver of industrial production are supported by this conclusion.

6.Conclusion

We attempt to quantify the effects of energy price shocks, uncertain economic policy, and geopolitical risk on industrial production for the G7 countries, namely the US, UK, Japan, Italy, France, Canada, and Germany, in this study. The study uses dynamic macro-panel estimators, which include the Pesaran et al. (1999) suggested pooled mean group (PMG), mean group (MG), and dynamic fixed effect (DFE). The findings indicate that:

The research assessed the effects of energy price shocks, uncertain economic policy, and geopolitical risk on industrial production, and it concluded that these factors did, in fact, have some influence on it. According to the Kao and Pedroni Residual Co-integration Test (1999), there is a long-term equilibrium relationship between industrial production and this determinate. Based on the hausman-test, the estimated results show that PMG is the most effective estimator among the three.

The findings indicate that industrial production (IPI) is positively correlated with crude oil and negatively correlated with natural gas. This means that over the long term, the links between crude oil and natural gas prices and industrial production in the G7 countries are driven by supply and demand, respectively. Additionally, the long-term results demonstrate a negative correlation between industrial production (IPI) and both geopolitical risk and uncertainty in economic policy. The industrial sector has suffered as a result of the Russian-Ukrainian war's heightened economic unpredictability, geopolitical concerns, and rising energy prices.

Research indicates that before investing in the industrial production of the G7 countries during the Russia-Ukraine war, short-term investors should take both positive and negative shocks to energy price shocks, unclear economic policy, and geopolitical risk volatility into account. In the long run, only upward fluctuations in energy price shocks, uncertain economic policy, and geopolitical risk are detrimental to industrial production; this means that energy price shocks, uncertain economic policy, and geopolitical risk are all to blame. This is mostly because certain nations rely more on export-oriented goods than they do on imports from other nations. The G7 economies' stock investors must take these favorable shocks to the oil price, unclear economic policies, and geopolitical risk into account.

Finally, The significance of this research is two-fold: Firstly, we have examined the reaction of industrial production to both positive and negative shocks to energy price shocks, uncertain economic policy, geopolitical risk during the Russia-Ukraine war. Secondly, we have shown that linear pooled mean group (PMG), mean group (MG), and dynamic fixed effects (DFE) modelling is more effectual in estimating asymmetrical linkages between energy price shocks, uncertain economic policy, geopolitical risk and industrial production.

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Appendix

Table 7 : Results for pooled mean group, mean group, and dynamic fixed e_ect estimation.

Variable	**Pooled Mean group**	**Mean Group**	**DynamicFixedEffects**
	Coefficient p-value	**Coefficient p-value**	**Coefficient p-value**
Long-run coefficients			
Crud Oil			
Natural Gaz	0.23 (0.00)	*0.25 (0.00)*	*0.32 (0.00)*
EPU	-0.14 (0.00)	*-0.67 (0.00)*	*-0.12 (0.00)*
GPR	-0.12 (0.00)	*-0.14 (0.00)*	*-0.47 (0.00)*
Error-correction coefficients	-0.56 (0.00)	*-0.35 (0.00)*	*-0.73 (0.00)*
Short-run coefficients			
Δ*Crud Oil*	-0.61 (0.00)	-0.56 (0.25)	-0.55 (0.16)
Δ*Natural Gaz*	*0.18 (0.00)*		
Δ*EPU*	*-0.07 (0.00)*	*0.14 (0.00)*	*0.28 (0.00)*
Δ*GPR*	*-0.04 (0.00)*	*-0.40 (0.00)*	*-0.85 (0.00)*
Intercept	*-0.30 (0.00)*	*-0.08 (0.00)*	*-0.14 (0.00)*
Country	*14.31*	*-0.21 (0.00)*	*-0.25 (0.00)*
Observation	*7*	21.30	*16.64*
Hausman test	*51*	7	*7*
		51	*51*
	0.16 (0.00)	0.64 (0.14)	*0.34 (0.64)*