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The Spillover Effect of Global Uncertainty on BRICS Stock Markets

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Abstract

Using monthly data spanning from 1993 to 2021 and employing the DCC-GARCH model, this study examines the role of Economic Policy Uncertainty (EPU) as a potential exogenous factor impacting the correlation of Brazil, Russia, India, and China (BRIC) economies' stock markets, which is new to the literature. Further, this dynamic correlation series is used as a dependent variable while EPU of BRIC and USA is used as an independent variable by utilizing the autoregressive distributed lag (ARDL) model. The study finds a positive and significant short-run as well as the long-run impact of Russia's and the US's EPU on their stock markets. In other words, as the EPU of the USA increases, the correlation of BRIC with the USA Stock Market and the World Stock Market increases, suggesting minimum diversification opportunities for the investors. The study also recommends that investors diversify their portfolios by considering cross borders assets avenues to gain maximum returns and reduce portfolio risk.

Keywords:
Economic Policy Uncertainty; BRICs; DCC_GARCG; ARDL; Stock Markets

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INTRODUCTION

Stock markets and the banking system are two main players in the development of any economy, but stock markets play a vital role in the development of any economy (Ake, 2010; Arestis et al., 2001). Alfaro et al. (2004) found that economies with developed financial markets attract more Foreign Direct Investment (FDI). The study conducted by Levine & Zervos (1998) concluded that well-functioning stock markets predict long-term economic development. They also found that stock markets correlate with any economy's current and future economic growth. So, the role of stock markets is obvious and important for any economy, and it is important to determine the factors influencing stock markets. Extensive studies have been conducted to determine the factors impacting stock markets (Al-Shubiri, 2010; Garcia & Liu, 1999; Yartey, 2010).

Being an important part of any economy, the role of stock markets, institutions and the banking system is obvious (Ake, 2010; Alfaro et al., 2004; Arestis et al., 2001; Levine & Zervos, 1998; Nugroho et al., 2019). Stock markets are important for the home economy as well as for the stock markets across the border (Chiang & Zheng, 2010; Hiang Liow, 2012; Lin et al., 2012; Neaime, 2012; Zhang et al., 2013). Developed stock markets impact their economy and the stock markets of developing and underdeveloped economies. Similarly if any global issue arises, stock market behaves in integrated way like in the case of Covid-19 (Chavali et al., 2021). Extensive studies have concluded that stock markets are correlated across borders, and the performance of one stock market impacts the rest of the stock market. Stock market correlation (SMC) or integration is sensitive to many factors (Arestis et al., 2001; Bracker et al., 1999; Chavali et al., 2021; Dorodnykh, 2014b; Engelberg & Parsons, 2011; Eun & Shim, 1989; Ferguson et al., 2015; Johnson & Soenen, 2003; Levine & Zervos, 1998; Narayan et al., 2004; Panda, 2015; Tetlock, 2007)

Ferguson et al. (2015) found that the tone and volume of firm-related news provide sufficient information about future stock returns. They worked on UK media from 1981 to 2010 and found that tone and volume predict next period abnormal returns. A news-based trading strategy statistically returns from 14.2 to 19 basis points. The same impact may be found in stock markets if the media talks about policy-related news. To further quantify the news related to economic policies, Baker, Bloom, and Davis (2016) developed an Index called Economic Policy Uncertainty Index (EPU Index).

Some studies have found the impact of media on stock exchanges using economic policy uncertainty in the context of developed and developing countries (Antonakakis et al., 2013; Dash et al., 2021; Ghirelli et al., 2021; Kang & Ratti, 2013; Ma et al., 2022; Pastor & Veronesi, 2012; Pástor & Veronesi, 2013; Youssef et al., 2021). The literature has concluded that Economic Policy Uncertainty (EPU) is a significant factor in determining the performance of stock markets (Al-Thaqeb et al., 2022; Chiang, 2021; Dash et al., 2021). In the literature, the leading newspaper bases economic policy uncertainty (EPU) index, developed by Baker et al. (2016) has been used extensively to measure its impact on stock returns. Literature supports the stock market correlation of BRIC countries among themselves and with the rest of the world. However, the

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EPU of developed countries has not been used to measure their impact on regional, neighboring, or developing countries. This paper updates the literature by exploring EPU as a significant factor impacting cross borders stock markets correlation.

In literature, substantial work has been done on stock market correlation and comparatively less on determinants of stock market correlation. Many scholars have found the significant stock market correlations across world stock exchanges and among national stock exchanges (Arestis et al., 2001; Bracker et al., 1999; Dorodnykh, 2014b; Eun & Shim, 1989; Johnson & Soenen, 2003; Levine & Zervos, 1998; Narayan et al., 2004; Panda, 2015). Dorodnykh (2014a) shows that financial harmonization, cross-membership agreements, for-profit corporate structure, trading engine, and regional integration are important drivers of stock exchange integration.

Roll (1992) find that the industrial composition of national stock indices is a potential source of international co-movements of stock exchanges. A study by Bracker et al. (1999) documents that stock exchanges integrate at the international level due to macroeconomic variables, i.e., bilateral trade. Johnson & Soenen (2003) and Yu et al. (2010) provide evidence of positive cointegration among Asian and USA stock markets. Chiang & Zheng (2010) found herding behavior in global markets and concluded that crises trigger herding behavior in the crisis-originating country, spreading this behavior to neighboring countries. Stock volatilities and global crises are a factor causing covariance among the real estate stock markets (Hiang Liow, 2012). Working on the influence of financial development and international trade correlation on stock market integration, Vithessonthi & Kumarasinghe (2016) show that a country's financial development positively affects its stock market correlation with the world's stock market.

An & Brown (2010) measured the correlation of BRIC countries with the USA stock market. They took the monthly and weekly indexes of the USA, Brazil, Russia, India, and China from 1995 to 2003. Dimitriou et al. (2013) found that the correlation between BRICS and USA stock markets has increased since early 2009, which is stronger in bullish compared to bearish periods. The correlation between stock markets is extensively studied in the literature (An & Brown, 2010; Arestis et al., 2001; Bhar & Nikolova, 2009; Eun & Shim, 1989; Johnson & Soenen, 2003). Stock market correlation has been studied by different variables like financial development and bilateral trade agreements (Vithessonthi & Kumarasinghe, 2016). We have studied it uniquely and innovatively via the Economic Policy Uncertainty Index developed by Baker et al. (2016).

Economic policy is a set of tools and actions that a government follows to improve its economy, which includes changing the interest rates, tax rate, spending decisions, and achieving a high employment rate and low inflation rate. An effective economic policy is necessary to sustain a country in this world. Countries devise economic policies to achieve maximum benefits via foreign direct investment or to create an attractive opportunity for international investors. Uncertainty in any country's economic policy impacts its correlation with the rest of the world in the shape of trade agreements, exchange rates, and even stock market correlation. The economic policy also has a direct effect on the country's stock markets.

Media is a significant predictor of stock returns; it is necessary to measure the impact of media on stock market correlations of developing countries with developed countries' stock exchanges. This will reduce portfolio risk through diversification; the interests of investors rely on the weak correlation among stock markets. The benefits of international diversification depend on the extent to which different stock markets are correlated. So, this study recommends that investors in portfolio formations with a strong correlation will reduce diversification and lower portfolio returns.

In this study, we focused on measuring the impact of the Economic Policy Uncertainty of BRIC and the USA on the correlation of BRIC with the USA and the World MSCI index. Stock markets are integrated and measuring the impact of developed economies' economic policy uncertainty on the performance of developing economies is our contribution to the literature. Further, we measured this impact in both the long and short runs. We also contributed by providing the adjustment rate of any shock in the long run. We used the EPU index of the USA and BRIC to measure their impact on correlations of stock exchanges of BRIC countries with developed countries.

First, this study contributes to the literature by using EPU of developed countries as a predictor of correlation between developed and developing countries, which is missing in the literature. Secondly, the EPU of BRIC is also used as a predictor of such stock market correlation. Although the literature supports the direct impact of EPU on stock markets, it is the very first time indirect impact is measured, i.e., on correlation. Thirdly, this study measures the impact of EPU both in the short and long runs. Fourthly, this study also measures the adjustment rate to the equilibrium, which is lacking in the literature.

Many studies have explored the association between Economic Policy Uncertainty (EPU) with stock markets directly (Oliyide et al., 2021; Su et al., 2021), but there is a lack in the literature where EPU of an individual country is investigated as the determinant of its stock market correlation with other developed economies for diversification opportunities. The study finds a positive and significant short-run as well as the long-run impact of Russia's and the US's EPU on their stock markets. In other words, as the EPU of the USA increases, the correlation of BRIC with the USA Stock Market and the World Stock Market increases, suggesting minimum diversification opportunities for the investors. The study also recommends that investors diversify their portfolios by considering cross borders assets avenues to gain maximum returns and reduce portfolio risk.

METHODS

Based on the availability of the data and objectives of the study, we used the monthly data of stock market returns for the four emerging markets, i.e., BRIC countries, which include Brazil, Russia, India, and China. The starting date of each country is matched with the availability of the EPU index. The starting period for Brazil is May 1993, for Russia is September 1995, for India in January 2003, and for China in January 1995.

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The stock market data is obtained from the Bloomberg database. The monthly EPU index of BRIC, as developed by Baker et al. (2016), is obtained from www.policyuncertainty.com. The literature-supported determinants of stock market correlation are used as the control variables, which include GDP growth, Financial Openness, and Interest Rate Spread (Vithessonthi & Kumarasinghe, 2016).

Economic Policy Uncertainty (EPU) index measurement is developed by Baker et al. (2016). In this method, the frequency of articles is calculated in leading newspapers of countries for a different combination of words, i.e., "economic" or "economy"; "uncertain" or "uncertainty"; and one or more of "Deficit," "Federal Reserve," "legislation," "regulation." This index rises when any fiscal decision or economic policies change or develop. EPU of USA is developed by covering ten large newspapers in the USA, which include USA Today, the Miami Herald, the Chicago Tribune, the Washington Post, the Los Angeles Times, the Boston Globe, the San Francisco Chronicle, the Dallas Morning News, the New York Times, and The Wall Street Journal (Baker et al., 2016). A normalized index of the volume of the news article is developed, which discusses economic policy uncertainty. We used a newspaper-based economic policy uncertainty index for this study. However, this measure may raise the issues of newspaper liability, bias, accuracy, and consistency. For verification, other measures are taken, which include this index compared with other measures of economic uncertainty. Other economic policy measures include light-leaning and left-leaning newspapers and the frequency of usage of world economic policy by the Federal Reserve System. As mentioned by the author, an audit is also conducted to cross-check the frequency of words in measuring economic policy uncertainty.

Russian EPU index is measured by using only one newspaper because of restrictions on the press by Government. India EPU is calculated by finding specific words in newspapers, including Economic Times (2003), Times of India (2003), Hindustan Times (2004), The Hindu (2003), Financial Express (2003), and Indian Express (2003). For China, the South China Morning Post was searched by Proquest. In the case of Brazil, the newspaper Folha de Sao Paulo is used for the said index. To develop this index, number of articles containing the terms "incerto" or "incerteza", "econômico" or "economia", and one or more of the following policy-relevant terms: regulação, déficit, orçamento, imposto, banco central, alvorada, planalto, congresso, senado, câmara dos deputados, legislação, lei, tarifa are counted. To incorporate the change of articles with time, a raw count of articles containing these words is divided by the no of total articles in that newspaper and the same month. Then the series is normalized for each newspaper to get the unit standard deviation from starting month onward. These normalized values obtained from multiple papers are summed to get an index. As the last step, this series is again normalized on the average value of 100 from the starting month. This same method is followed in all countries with an EPU index (Baker et al., 2016).

The dynamic conditional correlations are calculated in the first stage using the DCC-GARCH model. Engle (2002) developed the Dynamic Conditional Correlation (DCC) Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model to

measure the changing correlations and volatilities in financial markets. As specified in the DCC-MGARCH model, it is based on return series $r_{i,t}$ with time-varying covariances, variances, and means for stock market *i* at time *t* (Lean and Teng (2013). The main equation of the DCC GARCH model is given below for two stock market returns.

$$r_{i,t} = \mu_{i,t} + \varepsilon_{i,t}, \text{ and } \mu_{i,t} = E\left(r_{i,t}|\Psi_{t-1}\right) = E_{t-1}\left(r_{i,t}\right), \varepsilon_{i,t}|\Psi_{t-1} \sim N(0, H_t).$$

The symbol Ψ_{t-1} indicates the information given in the last period. The above expression $H_t = D_t R_t D_t$ shows the conditional variance-covariance matrix H_t, also known as a conditional correlation estimator. D_t indicates the (n x n) diagonal matrix of conditional standard deviations at time *t*, which is time-varying.

The correlation estimator $\rho_{ij,t}$ for DCC (1, 1) is estimated as follows:

$$\rho_{ij,t} = \frac{(1-\alpha_{DCC}-\beta_{DCC})\bar{q}_{ii} + \alpha_{dcc}\varepsilon_{i,t-1}\varepsilon_{j,t-1} + \beta_{dcc}q_{ij,t-1})}{\sqrt{(1-\alpha_{DCC}-\beta_{DCC})\bar{q}_{ii} + \alpha_{dcc}\varepsilon^2_{i,t-1} + \beta_{dcc}q_{ii,t-1})((1-\alpha_{DCC}-\beta_{DCC})\bar{q}_{jj} + \alpha_{dcc}\varepsilon^2_{j,t-1} + \beta_{dcc}q_{jj,t-1})}}$$

The coefficient of $\rho_{it,t}$ specifies the power of correlation, whereas its sign shows the direction of correlation.

After calculating the correlation series, we employ the Autoregressive Distributed Lag (ARDL) model developed by Pesaran, Shin, and Smith (2001). ARDL model incorporates the variables which are not stationary at the same level, i.e., few are stationary at level but others at first difference. If a variable is stationary at the level, then we can use simple OLS, but issues arise when the variables under study are stationary at different levels. In our data, some variables are stationary at level and others at the 1st difference.

ARDL model can help derive the dynamic error correction model (ECM) (Banerjee et al., 1993), where ECM integrates the short-run relationship with the long-run equilibrium relationship where integration would not cause any long-run information to be lost. The following model is selected per AIC criteria for the bound testing approach.

$$\begin{aligned}\Delta SMC_{ij,t} = a_0 &+ \sum_{i=1}^{n1} b_i \Delta SMC_{ij,t-i} + \sum_{i=0}^{n2} c_i \Delta EPU_{i,t-i} + \sum_{i=1}^{n1} d_i \Delta USAEPU_{ij,t-i} + \sum_{i=0}^{n3} f_i \Delta GDP_{i,t-i} + \sum_{i=0}^{n4} g_i \Delta InterestSpread_{i,t-i} \\ &+ \sum_{i=0}^{n5} h_i \Delta FDI_{i,t-i} \sum_{i=0}^{n5} k \Delta GFC_{i,t-i} + \alpha_1 SMC_{ij,t-1} + \alpha_2 EPU_{i,t-1} + \alpha_3 USAEPU_{i,t-1} + \alpha_4 GDP_{i,t-1} \\ &+ \alpha_5 InterestSpread_{i,t-1} + \alpha_6 FDI_{i,t-1} + \alpha_7 GFC_{i,t-1} + e_t\end{aligned}$$

$\Delta SMC_{ij,t}$ is a change of stock market correlation calculated by the DCC-GARCH method between country i and j. $\Delta EPU_{i,t-i}$, $\Delta GDP_{i,t-i}$, $\Delta InterestSpread_{i,t-i}$ and $\Delta FDI_{i,t-i}$ change of EPU, GDP growth, Interest Spread, and FDI of i country. We have also included EPU of the USA while measuring the impact of BRIC countries on their correlation with the World MSCI.

After estimating the lag length using AIC criteria, this paper calculates the long-run relationship using the ARDL bounds test. In our given model, the null hypothesis for the bound test is H_0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0$, to negate the long-run relationship against the alternative hypothesis, which states a long-run relationship.

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RESULT AND DISCUSSIONS

The results of the study are discussed in this section. Table 1 provides summary statistics of the macroeconomic variables, and Table 2 provides summary statistics of the correlation between BRIC, USA, and the World MSCI index using the DCC-GARCH model.

Table 1. Summary Statistics for Key Variables

Variable	Mean	Median	S.D.	Min	Max	Obs.
EPU Brazil	137.97	115.27	90.38	12.69	676.96	344
EPU Russia	128.62	110.80	64.20	44.78	503.96	316
EPU India	91.41	78.72	49.67	23.35	283.69	228
EPU China	207.45	117.58	214.79	9.07	970.83	324
FDI Brazil (Mln)	-34400	-27700	26300	-94500	12300	344
FDI Russia (Mln)	3210	-188	12500	-21700	45300	316
FDI India (Mln)	-22300	-23300	14100	-55100	-2330	228
FDI China (Mln)	-89400	-69600	67800	-272000	50200	324
GDP Brazil	2.42	2.45	2.98	-4.55	12.50	344
GDP Russia	2.85	3.05	4.53	-8.84	11.89	316
GDP India	6.26	7.25	3.95	-7.79	23.65	228
GDP China	8.75	8.59	2.37	1.78	14.67	324
INTSPRD Brazil	36.54	35.90	9.40	18.61	58.71	300
INTSPRD Russia	8.25	6.19	6.37	2.98	27.04	300
INTSPRD China	3.01	3.01	0.49	0.51	3.76	324

Table 1 reports summary statistics for the key variable from a sample of 4 countries over 1993M5-2021M12. EPU used in this study is obtained as in Baker et al. (2016). Financial openness is measured as the foreign direct investment (FDI) ratio to GDP (in %). ΔGDP is the GDP growth rate (in %), computed as the first difference in the natural logarithm of real GDP in millions of US dollars (at constant 2005 prices). INTSPRD is computed as the difference between the deposits interests rate for country i and the US money market rate. Interest Spread in India is unavailable, so this variable is not used in relevant Models. China has the highest volatility in the EPU index, with a standard deviation of 214.79, while India has the lowest variation of EPU i.e., 49.67. In the same way, EPU of China has highest mean of 207.45 and India has the lowest which is 91.41. Russia has the highest FDI mean of $3,210 million during the study period while China has the lowest which is $894,00 million. GDP growth average is highest in case of 8.75% being the fast-growing economy while Brazil is the slow growing economy with GDP growth of 2.42% per year.

Table 2. Summary statistics for correlations coefficients

Correlation Coefficients	Mean	Median	S.D.	Min	Max	Obs.
USA and BRZ	0.53	0.57	0.14	0.11	0.76	343
USA and RSS	0.47	0.46	0.15	0.08	0.74	315
USA and IND	0.56	0.57	0.07	0.33	0.77	227
USA and CHN	0.26	0.25	0.10	0.06	0.45	323
World and BRZ	0.60	0.66	0.14	0.24	0.80	343
World and RSS	0.54	0.54	0.16	0.17	0.83	315
World and IND	0.61	0.62	0.06	0.40	0.78	227
World and CHN	0.29	0.29	0.10	0.07	0.48	323

Table 2 shows the summary statistics for dynamic conditional correlations of BRIC countries with USA and World, which the DCC-GARCH Model calculates. These include the period from 1993M5 to 2021M12 and are calculated monthly. All the BRIC countries positively correlate with the USA and World, ranging from 0.26 to 0.60. Brazil has the highest mean correlation (0.60) with World, while India has the highest mean correlation (0.56) with the USA. China has the lowest stock market correlation with the USA (0.26) and World (0.29). The minimum correlation between China and the USA and the World may be due to its unique international policies and governance.

Figure 1. The DCC- GARCH-based Correlations of the USA Stock Market with the Member Countries of the BRIC Block

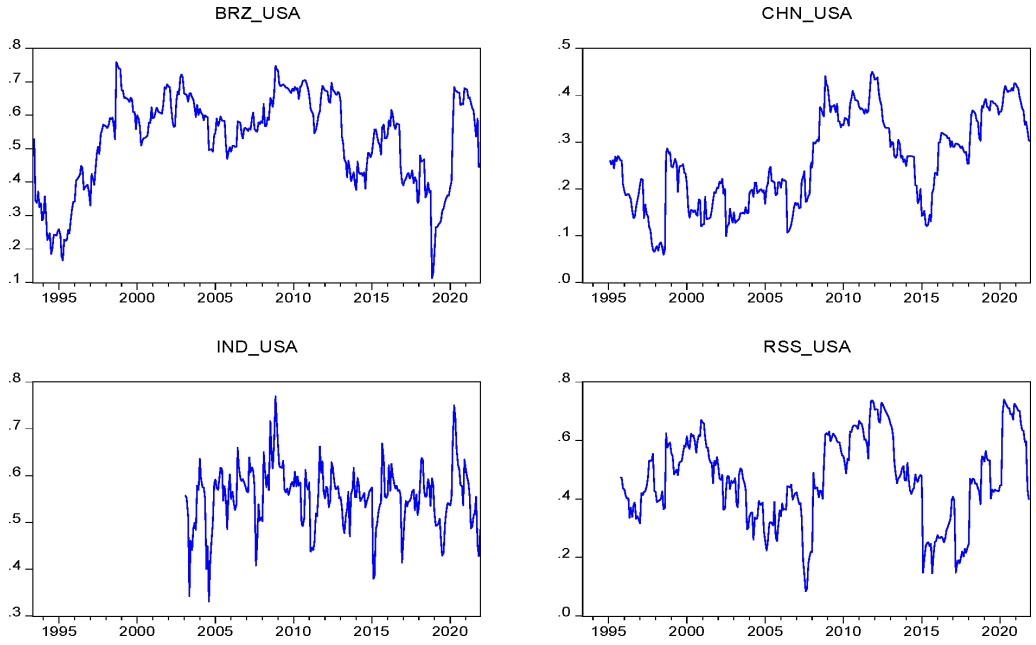

Figure 1 and Figure 2 present the dynamic conditional correlation graphs of individual countries with the USA and the World. Figure 3 exhibits the plots of EPU

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of each country. It can be seen that the EPU spiked during the global financial crisis period in 2008, due to which the Global Financial Crises (GFC) dummy was used. The same spikes can be observed during Covid-19.

Figure 2. The DCC- GARCH-based Correlations of the MSCI World Index with the Member Countries of the BRIC Block

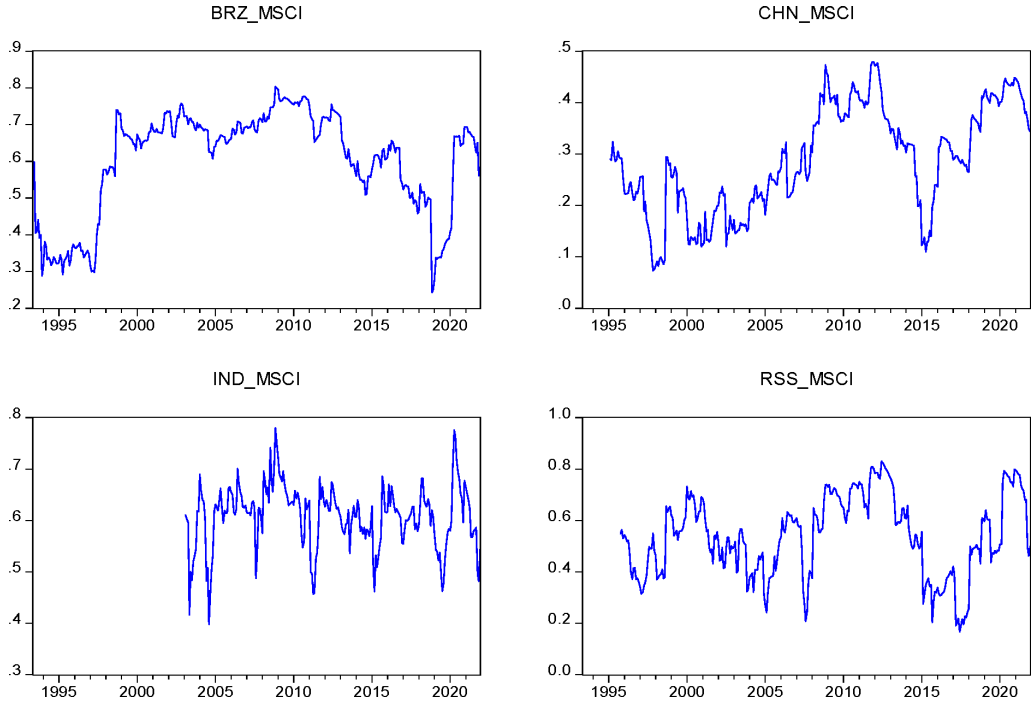

Figure 3. The Economic Policy Uncertainty (EPU) Data Series

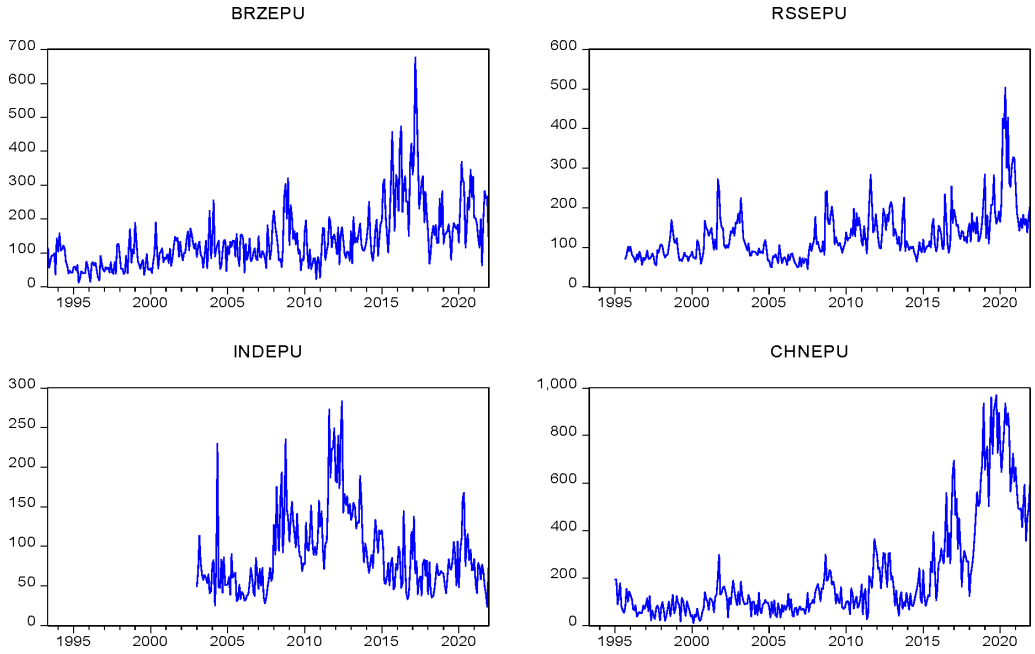

Table 3. The long-run Relationship Among SMC of BRIC Countries with the USA.

Stock Market Correlation	Model AIC Criterion	F Statistics	Lower bounds I(0)	Upper bounds I(1)	Level of Significance
USA and BRZ	(1,0,2,4,2,3,0)	2.85**	2.56	4.05	<1%
USA and IND	(1,0,4,0,2,1)	9.495***	3.06	4.15	<1%
USA and RSS	(1,1,0,0,0,0,1)	4.24**	2.66	4.05	<1%
USA and CHN	(1,0,1,2,0,0,1)	3.08***	2.66	4.05	<1%

Table 3 and Table 4 represent the results of ARDL models where Stock Market Correlation is the dependent variable, and a set of independent variables is used. We examine the hypothesis "Economic policy uncertainty of the USA and home country affects stock market correlation of BRICS with USA and World stock markets." We expect each country's EPU to impact its correlation with the USA and World stock markets. In Table 3, the results for the ARDL model are given. The dependent variable is a stock market correlation (SMC) of each country with the USA, computed for each country using the DCC-GARCH model. The bound tests and F-statistics show that via the DCC-GARCH approach EPU of Brazil, India, Russia, and China has a long-run relationship with the USA.

Table 4. The long-run Relationship among SMC of BRIC Countries with the World

Stock Market Correlation	Model AIC Criterion	F Statistics	Lower bounds I(0)	Upper bounds I(1)	Level of Significance
World and BRZ	(1,0,4,0,2,0,0)	2.03*	1.75	2.87	<10%
World and IND	(1,4,4,3,2,1)	5.85***	3.06	4.15	<1%
USA and RSS	(1,2,1,0,0,2,1)	2.46**	2.32	3.59	<2.5%
World and CHN	(1,0,1,2,0,0,1)	2.72**	2.66	4.05	<1%

Table 4 presents the results of the ARDL bounds testing approach for a sample of 4 countries over maximum periods for each country. The dependent variable is a stock market correlation (SMC) of each country with World, computed for each country and each month using the DCC-GARCH model. At the same time, in Table 4, we show that via the DCC-GARCH approach EPU of Brazil, India, Russia, and China has a long-run relationship with the World MSCI index. There is hardly any study where EPU is used as a predictor of stock market correlation, so we rely on the other studies where correlation is explored and confirmed. The results of our study confirm the findings of the researcher where the association between developed and developing countries is explored (An & Brown, 2010; Bracker et al., 1999; Chiang & Zheng, 2010; Dimitriou et al., 2013; Hiang Liow, 2012; Vithessonthi & Kumarasinghe, 2016). We are contributing to the literature by providing an additional determinant of this cointegration: EPU. This study confirmed the impacts of EPU of USA and BRIC countries on their correlation

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with the USA and World stock market. It means that whenever USA/BRIC countries change their economic policies, the correlation between BRIC, USA, and the World Stock Market increases.

Table 5. The Long-run and Short-run Coefficient of SMC of BRICs with the USA

Dependent Variables	Brazil	Russia	India	China
Short Run Coefficients				
SMC (-1)	-0.070***	-0.102***	-0.390***	-0.078***
EPU	0.0001	-	0.000	0.000
EPU(-1)	-	0.0001***	-	-
USAEPU	-	0.0001	-	-
USAEPU(-1)	0.0001***	-	0.000**	0.0001***
GDPG	-	0.001	-	-
GDPG(-1)	0.001		-0.004***	0.001
GDPG	-	0.001	-	-
FDI	-	0.0001	-	-
FDI(-1)	0.0001		0.000	0.000
INTSPRD	-	0.002***	-	-
INTSPRD(-1)	0.001**	-	-0.016	-0.001
GFC**	0.001	-	0.281	-
GFC(-1)	-	-0.007		-0.005
D(GFC)	-	0.052	0.103***	0.037**
D(EPU)	-	0.0001	-	-
D(EPU(-1))	-	-	-	-
D(USAEPU)	0.0001	-	0.0001	0.0001
D(USAEPU(-1))	0.0001	-	0.0001***	
D(GDPG)	0.002	-	-	-0.002
D(GDPG(-1))	0.006	-	-	-0.011*
D(GDPG(-2))	-0.012**	-	-	-
D(GDPG(-3))	-0.008*	-	-	-
D(FDI)	0.0001	-	0.0001	-
D(FDI(-1))	0.0001***	-	0.0001***	-
D(INTSPRD)	-0.002	-	-	-
D(INTSPRD(-1))	0.012**	-	-	-
D(INTSPRD(-2))	-0.008*	-	-	-
CointEq(-1)	-0.070***	-0.101***	-0.390***	-0.078***
Long Run Coefficients				
Country's EPU	0.0001	0.003***	0.0001	0.0001
USAEPU	0.002***	0.0001	-0.001**	0.001***
GDP	0.012	0.009	-0.011***	0.014
FDI	0.0001	0.0001	0.0001	0.0001
INTSSPRD	0.009***	0.015***	-	-0.008
GFC	0.018	-0.065	-0.041	-0.067

*, **, and *** indicates significance at 10%, 5%, and 1% respectively.

Table 5 presents the results of a long-run as well as the short-run impact on the correlation between the USA and BRIC countries. Earlier studies on the stock markets confirm the integration of stock markets due to some macroeconomic variables, financial developments, and herding behavior (An & Brown, 2010; Bracker et al., 1999; Chiang & Zheng, 2010; Dimitriou et al., 2013; Hiang Liow, 2012; Vithessonthi & Kumarasinghe, 2016). But this study confirmed that EPU is also a significant variable impacting the integration levels of the stock markets. EPU of the USA is found to significantly impact the integration of BRIC countries with the USA Stock Market except for India in the long run. However, individual EPU of the country is found to be impacting insignificantly for BRIC except for Russia in the long run. The EPU of Russia impacts more on its correlation with the USA than the EPU of the USA. The USA is one of the biggest economies that dominate the impact of individual countries' EPU, but this is not true for Russia. Whenever the Economic policies of the USA are changed, this impacts its correlation with BRIC increases. So, the uncertainty spillover impact of the USA is observed among the BRIC countries except for Russia. Similar findings are observed in the short-run relationship. So in the period of higher uncertainties, stock markets are correlated higher, as seen during GFC and Covid-19. Diversification becomes useless in global crisis periods.

Table 6 presents the results of a long-run as well as the short-run impact of USA EPU on the correlation (SMC) of BRIC countries with the World MSCI Index. We find that the EPU of Brazil, India, and China are insignificant predictors of their stock market correlations with the World MSCI Index, while this is not true for Russia. However, the EPU of Russia impacts its correlation with the World MSCI Index instead of the USA EPU. In the short run, it is also evident that EPU of the USA impacts significantly and positively the correlation between Brazil, China, and India only. The association is positive, i.e., as the economic policy of the USA increases, the BRIC countries get closer to the USA market to avoid losses. Moreover, the investors follow the trends, i.e., changes in USA policy uncertainty may change the outcomes in BRIC markets, and so integration among the markets increases.

The Russian stock market is independent of the policy uncertainties in the USA. The investors in Russia possibly behave differently compared to China, India, and Brazil as this is a novel study where correlation among the stock markets is considered, but the same results are found in the case of the correlation between oil and stock markets in the USA (Fang et al., 2018). These findings are also consistent with the crisis period, where stock markets tend to perform closer in times of financial crisis (Liu & Zhang, 2015). Similar findings are confirmed by Xiong et al. (2018) in the context of Chinese stock exchanges. They also used the DCC-GARCH model for correlations. In the same way, Asgharian et al. (2016) studied the impact of EPU on UK-USA stock markets correlation and confirmed the association. The findings of this study extended the literature by providing a research gap in the context of BRIC countries.

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Table 6. The Long-run and Short-run Coefficient of SMC of BRICs with the World

Dependent Variables	Brazil	Russia	India	China
Short Run Coefficients				
SMC (-1)	-0.032***	-0.067***	-0.273***	-0.075***
EPU	0.000	-	0.000	0.000
EPU(-1)	-	0.0001***	-	-
USAEPU(-1)	0.000**	0.0001	0.000	0.000**
GDPG	-0.001	0.001	-0.002**	0.002**
GDPG(-1)	0.001	-	-	-
FDI	0.001	0.0001	-	-
FDI(-1)	0.000**	-	0.0001	0.000
INTSPRD**	0.0001*	-	-	-0.002
GFC**	0.002	-	-	-
GFC(-1)	-	-0.010	-0.018**	-0.004
D(EPU)	0.0001	0.0001	0.0001	-
D(EPU(-1))	0.0001**	0.0001	0.0001	-
D(EPU(-2))	-	-	0.0001	-
D(EPU(-3))	-	-	0.0001**	-
D(USAEPU)	0.000	0.0001*	0.0001	0.0001
D(USAEPU(-1))	0.000***	-	0.0001**	-
D(USAEPU(-2))	0.000*	-	0.0001**	-
D(USAEPU(-3))	0.000	-	0.0002**	-
D(FDI)	0.000		0.0001	
D(FDI(-1))	0.000	-	0.0001***	
D(GDPG)	0.001	-	0.007	0.000
D(GDPG(-1))	0.000	-	-0.010*	-0.012*
D(GDPG(-2))	-0.005	-	-0.006	-
D(GDPG(-3))	-0.006*	-	-	-
D(GFC)	-	0.050	0.094***	0.032*
D(INTSPRD)	-	-0.027*	-	-
D(INTSPRD(-1))	-	0.032**	-	-
Coint. Eq(-1)	-0.032***	-0.098***	-0.273***	-0.075***
Long Run Coefficients				
EPU	0.0001	0.003***	0.0001	0.0001
USAEPU	0.002**	0.0001	0.0001	0.001**
GDP	0.017	0.019	-0.009**	0.021**
FDI	0.0001	0.0001	0.0001	0.0001
INTSPRD	0.010**	0.016**	-	-0.023
GFC	0.053	-0.155	-0.066**	-0.059

*, **, and *** indicates significance at 10%, 5%, and 1% respectively.

Based on the ARDL model, our findings suggest that the Economic Policy Uncertainty of Brazil, India, and China are positively correlated with the stock market of the USA and the World, while the EPU of Russia is uncorrelated. Further. The

only exception is the Russia and USA SMC that has no relation with any independent variables. On average, results imply that economic policy uncertainty would increase the stock market correlation of BRIC countries with the USA and the World.

To check the model goodness of fit of the ARDL model, we have applied Q statistics that is used for serial correlation and the cumulative sum of recursive residuals (CUSUM) along with the cumulative sum of squared recursive residuals (CUSUMSQ) for model stability tests. Figure 4 to Figure 11 shows the results of CUSUM and CUSUM of Square test results for only those models where F statistics are significant, i.e., long run, and the short-run relationship among variables is significant. We found no serial correlation issue in this data except partial effects in the case of Brazil and India. Further, stability test results show that the model is stable, and there are no structural breaks except in 2008 due to global financial crises. We incorporated the GFC era as a dummy variable and found it only significant in the short run.

Figure 4. CUSUM and CUSUM of Squares of ARDL models for Brazil and the USA

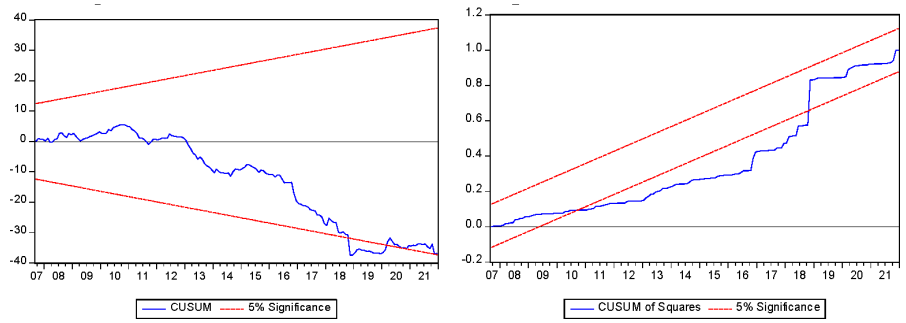

Figure 5. CUSUM and CUSUM of Squares of ARDL models for Brazil and the World

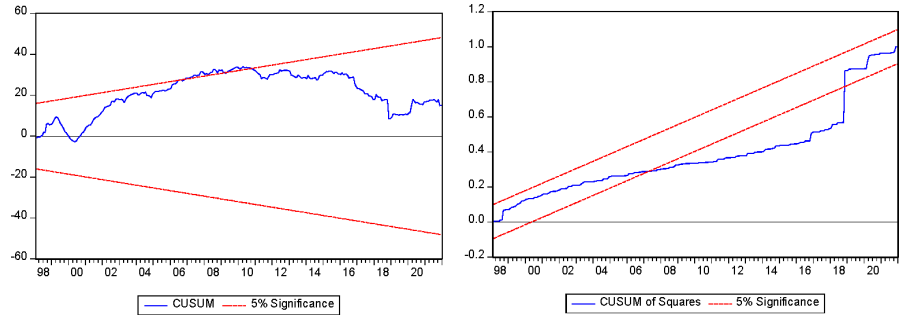

Figure 6. CUSUM and CUSUM of Squares of ARDL models for India and the World

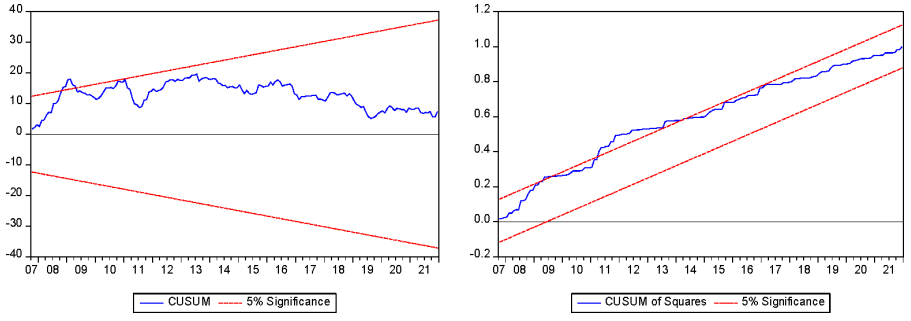

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Figure 7. CUSUM and CUSUM of Squares of ARDL models for India and the USA

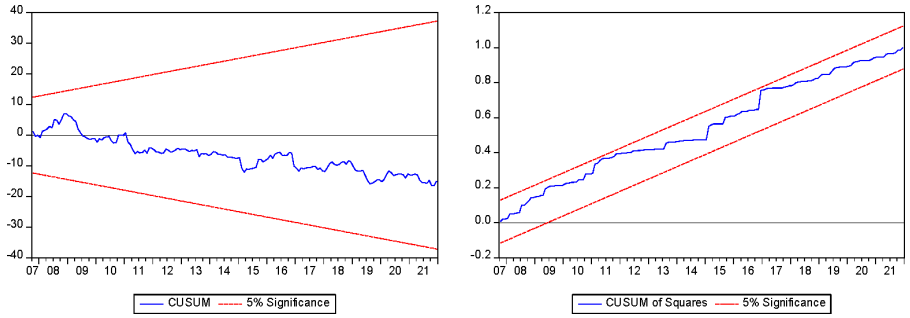


Figure 8. CUSUM and CUSUM of Squares of ARDL models for Russia and the World

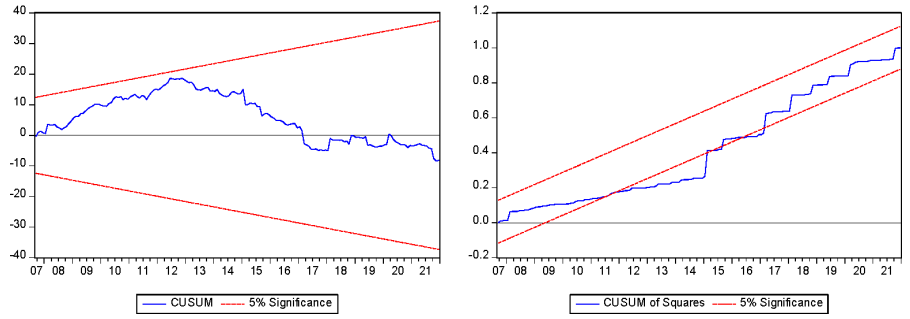


Figure 9. CUSUM and CUSUM of Squares of ARDL models for Russia and the USA

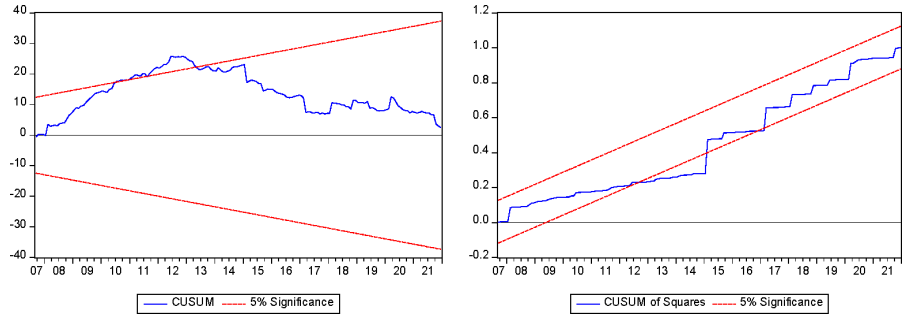


Figure 10. CUSUM and CUSUM of Squares of ARDL models for China and the USA

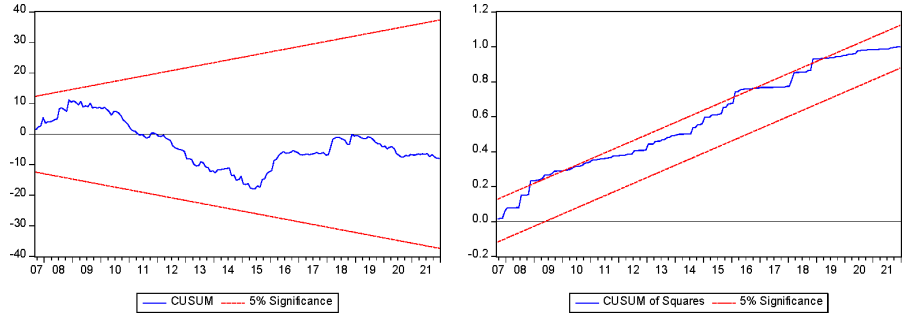
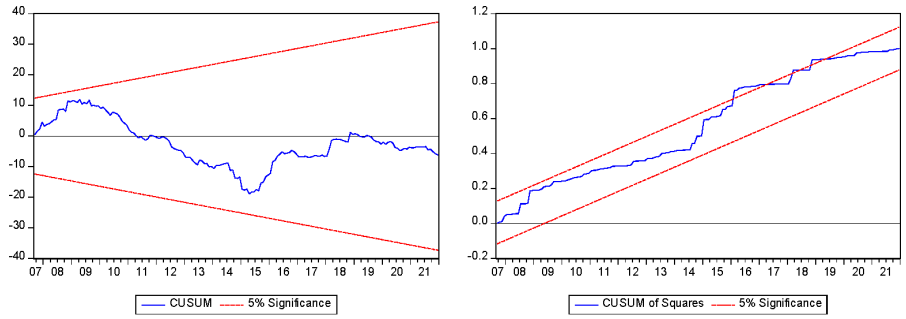


Figure 11. CUSUM and CUSUM of Squares of ARDL models for China and the World



The study has contributed to the existing literature in many ways. Firstly, we have contributed to the literature by providing a new direction to investors using the EPU Index to measure the impact on correlations of developed and BRIC countries' stock exchanges. This is important for the investor to diversify their portfolio formation across borders to gain maximum returns. This is also important for policymakers to avoid negative impacts on developing stock markets due to the fast switching of economic policy-related decisions in developed countries. Secondly, this study has used the EPU Index very first time to the best of our knowledge on said correlation, especially in the BRIC context. Thirdly, we have employed the DCC-GARCH model and Auto-Regressive Distributed Lag (ARDL) by incorporating maximum lags as per Akaike Information Criterion (AIC), which was developed by Akaike (1998) and found that EPU impacted significantly on this correlation.

CONCLUSION

This study tests whether the EPUs and World MSCI impact BRIC stock markets' correlation with the USA by using the DCC-GARCH approach, while ARDL bound testing approaches were utilized to measure the association of BRIC with the USA and World MSCI Index. The need for this investigation is ingrained in increasing economic and financial dependence among countries, which results in contagion effects, as evidenced in the global financial crisis. These crises result from policy disputes and fiscal and monetary policy uncertainties arising from political regime changes.

The findings suggest that EPU of the USA has a significant long-run and short-run relationship with BRIC, except for Russia. The stock market of Russia is found to behave differently than the rest of the BRIC countries. These results have important implications for policymakers and portfolio managers as any change in the policy of the USA can influence not only the domestic stock but also the BRIC stock markets. This study can be extended in the future by analyzing the policy spillovers across developed and emerging markets.

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