“Impact of Brexit on bond yields and volatility spillover across France, Germany, UK, USA, and India’s debt markets”

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IMPACT OF BREXIT ON BOND YIELDS AND VOLATILITY SPILLOVER ACROSS FRANCE, GERMANY, UK, USA, AND INDIA'S DEBT MARKETS

Abstract

Britain's decision to exit the EU lead to disruptions in global markets. This study investigates the change in the return and volatility spillover pattern due to the repercussions of the Brexit vote between the US, France, the UK, Germany, and India's 10-year government bond yields by applying the VAR and GARCH-BEKK models. The findings demonstrate a substantial rise in the return spillover to India and USA 10-year government bond yields following the Brexit vote compared to the pre-Brexit vote era. In addition, the results showed evidence of unidirectional volatility spillover from India to France, bidirectional volatility spillover between the USA and India, and unidirectional volatility spillover from the UK to India 10-year government bond market post-Brexit vote. However, there was no interconnection between these markets before the Brexit vote. Therefore, the Brexit vote did affect and significantly increased the linkage between the US, France, the UK, and India's 10-year government bond market. The increase in correlation in India-US, India-UK, and India-France's 10-year government bond markets will help predict and have an important implication for hedgers, decision-makers, and portfolio managers if similar political events occur in the future.

Keywords return spillover, 10-year government bond market, Brexit vote, volatility transmission, GARCH-BEKK, VAR

JEL Classification G11, G15

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INTRODUCTION

Britain voted to leave the EU on June 23, 2016. The word "Britain" and "exit" are joined together to refer to "Brexit." The decision of the UK to quit the European Union is one of the most important economic and political events. After the Brexit vote results, on June 24, 2016, the global stock market lost around two trillion dollars. It was an enormous loss incurred on a single day that global markets have never seen. Following the Brexit vote, UK FTSE 100 dropped by 10%, German DAX by 8.4%, French CAC by 9.6%, USA S&P500 by 5.5%, and Indian Nifty50 dropped by 181.85 points. The British pound lost its value by 7.6% against the US dollar (Hui & Chan, 2021; Burdekin et al., 2018). The Brexit vote pushed the international EPU (Economic Policy Uncertainty) index to new highs. Brexit created turbulence in the 10-year government bond market. 10-year UK gilt yields dropped by 35 bps, and yields of 10-year USA notes fell by 28 bps (Gu & Hibbert, 2021). As per the Yes Bank Report, India's 10-year government bond yields dropped by 28 bps (Dugal & Sonavane, 2016). The 10-year bond yield of Germany fell by more than 20 bps, concerned with Brexit worries (Geddie, 2016). The 10-year French government bonds declined between 7 to 12 bps (Ranasinghe, 2019). Political uncertainty asso-

ciated with Brexit affected several businesses and the global equity market. Additionally, the political risk affected the government bonds, forex, and commodity markets (Guedes et al., 2019). The shocking Brexit results brought about severe fluctuations in the global market (Gu & Hibbert, 2021).

Due to Brexit, UK's financial stability is under threat, which may have long-term effects. There are several uncertainties associated with Brexit. Firstly, it is unclear what the UK's future investment decisions, fiscal policy, and product regulations will be after the Brexit vote (Kara et al., 2021). Secondly, the Brexit vote has increased the investors' concern about the United Kingdom's future involvement in the European Single Market (Stoupos & Kiohos, 2021). Furthermore, Brexit could adversely affect the availability of migrant labor and the trade relation of the UK with that of the EU (Driffield & Karoglou, 2019). Thirdly, several UK banks are shifting their headquarters to the EU, which might negatively affect the UK's banking sector (Kara et al., 2021). Fourthly, Indian firms operating in the UK might relocate their manufacturing unit to the European Union countries to reap the tariff benefits (Tripathi, 2021).

Brexit has a long-term economic impact. Major political events like Brexit had the ability to tumble the stock market and foreign exchange market of well-developed nations (Stoupos & Kiohos, 2021). In the future, if such a similar event occurs, the findings of this study can be of material use to investors and policymakers to understand through what channels volatility spillover took place. Moreover, the findings help understand what preventive measures they can take to avoid such shocks and to protect their wealth. Though the Indian market remained solid and unaffected during the subprime crisis, this study investigates whether Brexit impacted the Indian 10-year government bond markets. Moreover, it analyzes whether there have been any changes in the volatility transmission channels. Therefore, with this context, this study aims to examine the potential impact of the Brexit vote on the return and volatility spillover of 10-year government bond markets of the UK, France, USA, Germany, and India using VAR and BEKK-GARCH models.

1. LITERATURE REVIEW

In the 1980s, the world witnessed substantial development in the global financial markets due to globalization. Developing nations took specific measures by opening the markets, removing barriers, and liberalizing the economy, which increased market integration (Vo, 2009). Following various political and economic events and crises, diverse finance literature investigated the concept of shock transmission between international markets. During these investigations, a new term was invented – "volatility spillover" (BenSaïda et al., 2018; Bekaert et al., 2014). Engle et al. (1990) first presented the concept of volatility spillover. Volatility spillover may be attributed to the "Heatwave hypothesis," which is its own spillover, or the "Meteor shower hypothesis," a cross-market spillover. Volatility spillover describes the causes of variance between financial markets (Engle et al., 1990). It estimates interdependence. Volatility spillover occurs when a shock from one country is propagated to another (Rigobon, 2016). There has been an increase in the financial literature related to the interdependence of the global markets, concerning returns and volatility, particularly after the "Asian contagion" in the late 1990s (Forbes & Rigobon, 2002).

The main reason for the 1997 "Asian Contagion" was due to the high dependence on banking funds, while stock and especially bond markets remained underdeveloped (Bhattacharyay, 2013; Park & Lee, 2011). The financial systems at that time were largely bank-centric. It indicated that most risks were mainly focused on the banking system, and no alternate finance sources were available. In addition, the banking sector faced the severity of the Asian crisis and had lending issues. Following the Asian crisis, ASEAN members tried to avoid future financial shocks by diversification by developing their bond markets (Plummer & Click, 2005; Kim & Lee, 2012; Tsang et al., 2021; Rughoo & You, 2016). Bond markets are essential in funding major investment projects with high investment requirements in emerging markets. However, such investments are generally risky and take longer to earn profits (Felman et al., 2014).

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Additionally, unlike bank loans, bonds have added advantages. They are authorized to be traded. The bondholders can shift the default risk to others by trading bonds even before completing the task. The ability of the bond markets to share and shed risk helps it replace banks (Felman et al., 2014). Following the 2007–2008 financial crisis, the bond markets in emerging economies have grown tremendously (Agur et al., 2019).

The 10-year government bond yields are an economic indicator. It serves as a benchmark as it indicates the overall interest rate scenario in a country. It is used as a substitute for mortgage rates and is considered a safe investment. The 10-year US Treasury yield represents investor sentiments about the economy. A decrease in the 10-year US Treasury yields indicates instability in the market and the future of the global economy. The increasing 10-year US Treasury yield suggests decreasing demand for government bonds. It shows that investors are seeking high-risk and high-return investments. The decrease in yield suggests increasing demand for government bonds. It shows that investors play safe, avoid risk, and seek safe haven investments (McCormick & Regan, 2021). Any international political tensions can have a significant influence on US Treasury yields. US Treasury notes are considered safe-haven investments even during market turbulence since the US government backs them. Europe's benchmark government bonds, such as the 10-year German and 10-year French government bonds, protect investors when there is uncertainty in the market (Reuters, 2016). The 10-year UK gilt yields are a benchmark indicator of long-term interest rates (Whitehouse, 2016). India's 10-year G-sec bonds are considered benchmark bonds in emerging markets (Rebello, 2020).

Interest rates play a crucial role in the country's economy, indicating profit or cost of capital. It significantly influences lending, money supply, monetary policies, the real economy, and the stock market. Any increase or decrease in interest rate indicates the nation's restrictive or accommodative monetary policies (Wang et al., 2017). The formation of the European Economic Monetary Union and the introduction of the euro currency minimized cross-border currency risk. They led to increased integration among government bond markets across the Eurozone (Ribeiro et al., 2017; Wagenvoort et al., 2011; Christiansen, 2014). Volatility in the US debt market considerably influenced the individual debt markets of Europe, the UK, and Asian markets (Tsukuda et al., 2017; Christiansen, 2007). It is commonly known that when there is a high degree of integration between a country's financial market with international markets, there is a high probability that the global factors will influence the prices of these financial assets (Tsukuda et al., 2017; Šimović et al., 2016; Inaba, 2021).

The referendum in which Britain, constituting England, Whales, Scotland, and Northern Ireland, voted to exit the EU is called Brexit. Brexit is not a mere event of voting. However, it is considered the twenty-first century's major transactional change where two economies are getting separated for better prospects (Jawad & Naz, 2019). This transactional change has created a new wave in the research field. The outcome of Brexit is keenly observed by investors, politicians, and economists to design their future strategies accordingly. The Brexit vote created potential turbulence and uncertainty in the global financial market (Hui & Chan, 2021). It could have extensive macroeconomic repercussions on the growth opportunities of developing and emerging markets. In the long run, Brexit will influence financial sectors to relocate their business from the UK to European Union or other countries. Brexit triggered substantial economic and policy uncertainty. This created financial instability, which in turn led to the rise in volatility in the equity market (Forbes & Rigobon, 2002; Diebold & Yilmaz, 2009, 2012; Bloom, 2009; Belke et al., 2018; Hosoe, 2018; Samitas et al., 2018). Brexit adversely affected international stock markets, travel, and banking sectors, too (Ramiah et al., 2017; Burdekin et al., 2018). Subsequent to the Brexit vote, persistence in volatility sharpened in equity markets and reduced in currency markets (Adesina, 2017). The shock of the Brexit vote led to continued volatility spillover among the European stock markets (Aristeidis & Elias, 2018; Li, 2020). Political risk increases the uncertainty in the economy as well as volatility in the stock market.

Along with this currency, government bonds and commodity markets were also influenced by Brexit uncertainty (Breinlich et al., 2018). Crude oil and gold offered hedging opportunities to UK stocks during the Brexit referendum period (Abuzayed et al., 2022). Following the Brexit vote, the yields of the 10-year UK bonds had no impact on the US dollar and euro

against sterling because different kinds of investors invest in these different markets (Stoupos & Kiohos, 2021). After the Brexit vote, volatility transmission among the safe-haven currencies like the Japanese yen and the Swiss franc increased. However, after the Brexit vote, the volatility transmission reduced between euro and British sterling due to a decrease in market integration between these markets (Dao et al., 2019). Brexit has an adverse effect on the inward FDI of the UK. This loss will affect the growth and investments of the UK. This, in turn, will lead to the further devaluation of the UK currency in the forex market (Srovnalikova & Razinskaite, 2017). As the devaluation of the pound continued, the impact was more severe. Due to this, there was a loss in UK aid to developing countries. The devalued British pound affected the world economy (Cumming & Zahra, 2016). Any uncertainty in the largest economies like the UK, USA, France, and Germany will influence its own market before it influences the market of others. Brexit has affected remittance globally. A weak pound leads to a decline in remittances. The Brexit vote negatively affected the economies of both the European Union and the United Kingdom.

EU and India are strong trade partners with a substantial economic connection. Likewise, India and United Kingdom have historical connections. As a result of Brexit, tariff and non-tariff restrictions on goods, exports, and imports were imposed. It will increase bilateral trade costs and hamper trade flows between the UK and the EU, which will affect their trading partners like India and others (Roy & Mathur, 2016). The UK is expected to face internal political disruptions soon as Scotland is against Brexit (Tripathi, 2021). The United Kingdom is a significant export market and investment destination for India within the European Union (Chaudhuri, 2020).

Indian companies have made considerable investments in the United Kingdom. Those companies using the UK as a gateway to the EU market are concerned about the future trade relationship between the EU and UK due to Brexit. India has invested considerably in the UK's finance, information technology (IT), pharmaceutical, and automotive industries. Following Brexit, the Indian auto sector operating in the United Kingdom incurred losses (Tripathi, 2021). Brexit is likely to increase the export cost and paperwork, especially for automobile industries exporting their products from the UK to the EU. In addition, the UK is facing a huge labor shortage due to Brexit. These are the reasons to worry for Indian companies operating in the UK. As the UK is the key economic partner of India in the EU, both India, and the EU would have benefitted more from the Free Trade Agreement if Britain had continued to be a member of the EU (Roy & Mathur, 2016).

The overall effect of the sub-prime meltdown on the Indian economy was very trivial (Gopinath, 2008). Consequent to the sub-prime mortgage meltdown, the spillover of volatility from the US stock market did not affect the Indian equity markets (Chiang et al., 2013). When compared to the rest of the market, Indian markets were proven highly efficient. The Indian markets had the lowest market risk, which provided investors with diversification opportunities. Even the South Asian crisis had a minimal impact on Indian markets (Bhar & Nikolova, 2009). However, during the post-Brexit vote, the bidirectional volatility spillover has increased between the UK, USA, France, and India's stock market indices. This study would like to investigate if Brexit uncertainty has influenced the return and volatility spillover between the 10-year government bond market of the USA, France, Germany, the UK, and India before and after the Brexit vote.

The government bond market is of particular interest because of its recent rising trend and the absence of related empirical studies on the bond market. There is no empirical study investigating the influence of the Brexit vote on the financial integration of the 10-year government bond market of the USA, France, the UK, Germany, and India. This study contributes to the literature in two ways. Firstly, this paper investigates the influence of the Brexit vote on the 10-year government bond markets. It is essential because it allows portfolio diversification for investors over a wide range of alternative assets to achieve the required risk level. Secondly, this study adds to the body of literature by presenting new findings on how an unexpected political event like Brexit can change the linkage among the 10-year government bond markets and what are the new different channels through which financial markets were affected. Hedgers, policymakers, and portfolio managers need to understand the market volatility, particularly after the financial crises.

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2. METHODS

The daily closing yield of 10-year government bonds of the UK, USA, India, France, and Germany are used in this study. The data were collected from The Wall Street Journal database. The Brexit voting occurred on June 23, 2016. This study is divided into two groups. The first part covers the time before the Brexit vote, which begins on January 1, 2011, and ends on June 22, 2016. From June 23, 2016, to December 31, 2021, is the second part after the Brexit vote. The vector autoregression (VAR) model examines the relationship among different markets that varies with time. It assesses the magnitude and direction of cross-correlation between multiple variables (Hung, 2019). This study used the VAR model with one lag to analyze the interconnection among the yields of 10-year government bonds of the UK, US, India, France, and Germany.

This study uses Engle and Kroner's (1995) GARCH-BEKK model to explore the volatility spillover among India, France, Germany, the UK, and the USA 10-year government bond yields. While building the model, the conditional covariance matrix is designed to be positive. It is one of the critical characteristics of this model. Moreover, it systematically explains the cause-and-effect relationship between covariances and variances (Majdoub & Mansour, 2014; Hung, 2019).

The bivariate GARCH-BEKK model is expressed by:

$$H_t = C'C + A'\varepsilon\varepsilon' A_{11} + B'H_{t-1}B, \quad (1)$$

$$\begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix} = \begin{bmatrix} c_{11,t} & c_{12,t} \\ c_{21,t} & c_{22,t} \end{bmatrix}' \cdot \begin{bmatrix} c_{11,t} & c_{12,t} \\ c_{21,t} & c_{22,t} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix}' \cdot \begin{bmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1.t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon^2_{2,t-1} \end{bmatrix} \cdot \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix} + \begin{bmatrix} \beta_{11,t} & \beta_{12,t} \\ \beta_{21,t} & \beta_{22,t} \end{bmatrix}' \cdot \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix} \cdot \begin{bmatrix} \beta_{11,t} & \beta_{12,t} \\ \beta_{21,t} & \beta_{22,t} \end{bmatrix}, \quad (2)$$

Here upper triangular matrices are denoted by C. The ARCH term is represented by matrix A, while the GARCH term is reflected by matrix B. α_{xy} refers to the influence of volatility of market x on the volatility of market y. β_{xy} indicates between market x and market y, volatility spillover persists. The Quasi Maximum Likelihood function is used to estimate the parameters of the GARCH BEKK model. It was proposed by Bollerslev and Wooldridge (1992). To investigate the nature of volatility spillover between the 10-year government bond market yields, "α" and "β" are the prime focus.

3. RESULTS AND DISCUSSION

Table 1 presents test results of unit root, descriptive statistics, and auto regressive conditional heteroscedasticity results of bond yields of all the chosen countries' 10-year government bond markets before and after the Brexit vote. By looking at the mean and median values, it can be said that the daily bond yields have decreased following the Brexit vote. Standard deviation estimates show how far the observations are from their sample mean value. As per the standard deviation estimates, the volatility increased in India 10-year government bond yields following the Brexit vote. However, volatility in the US, UK, France, and Germany's 10-year government bond market decreased comparatively following the Brexit vote. All five countries' 10-year government bond markets are positively skewed during both periods except India, which is negatively skewed during the pre-Brexit vote period, and the US, which is negatively skewed during the post-Brexit vote period. All the five nations' 10-year government bond markets are leptokurtic during both sub-periods. The null hypothesis of the Jarque-Bera test is that the distribution is normal. The probability value is significant at a 1 percent significance level for all countries during the two sub-periods. Therefore, it leads to the rejection of the null hypothesis, and the dataset is found to have non-normal distribution. The bond yields of all countries are stationary at the first difference at a 1 percent significance level for both the sub-periods as per PP and ADF tests. The ARCH test statistic is significant for all nations for both periods, confirming the ARCH effect's existence. It indicates that BEKK-GARCH model could be applied to measure the volatility spillover among the 10-year government bond market.

Figures 1 and 2 present the daily yield value series graph of the 10-year government bond market of

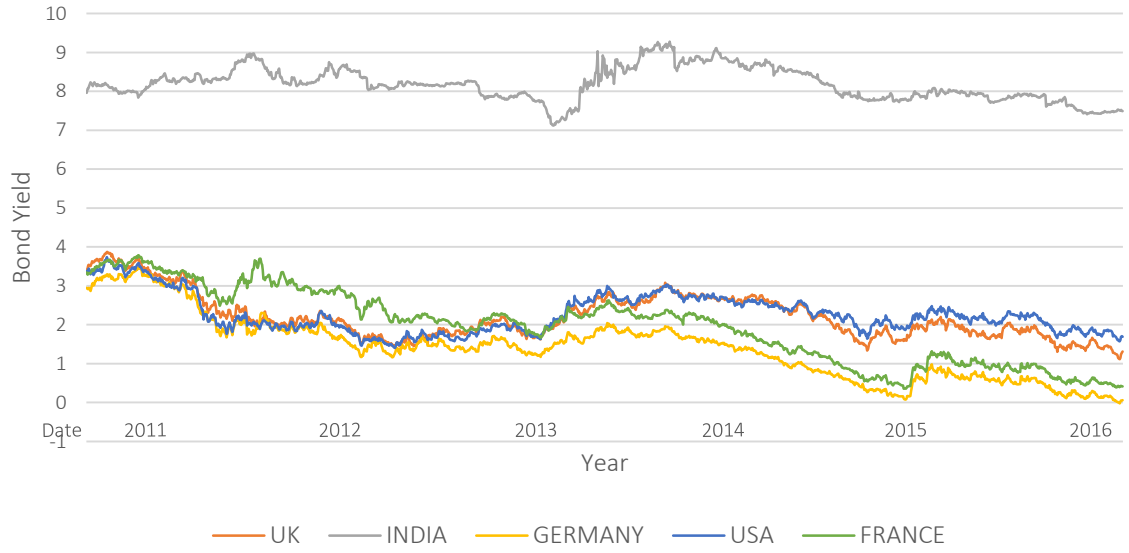

Figure 1. Pre-Brexit vote era bond yield

Table 1. Descriptive statistics of 10-year government bond yields at first difference

Descriptive Statistics	USA	Germany	UK	France	India
Pre-Brexit vote era					
Mean	–0.001211	–0.002067	–0.001490	–0.002101	–0.000336
Median	–0.003000	–0.001000	–0.001000	–0.001000	0.000000
Maximum	0.238000	0.201000	0.234000	0.234000	0.492000
Minimum	–0.257000	–0.300000	–0.271000	–0.223000	–0.897000
Std. Deviation	0.049252	0.046430	0.050854	0.045686	0.060130
Skewness	0.126004	0.117322	0.124189	0.326976	–2.185342
Kurtosis	4.428456	5.620527	4.738252	6.297109	51.180505
Jarque- Bera	122.29466**	402.35410**	179.21174**	656.73016**	136039.46863**
PP test	–37.90345**	–37.00075**	–37.79439**	–33.92147**	–42.40857**
ADF test	–37.76246**	–36.89659**	–37.62061**	–34.04885**	–41.34069**
ARCH test	3.971116*	54.83429**	9.130489**	17.35900**	51.45650**
Observations	1395	1395	1395	1395	1395
Post-Brexit vote era					
Mean	–0.000164	–0.000195	–0.000287	–0.000180	–0.000728
Median	0.000000	–0.001000	0.000000	0.000000	0.000000
Maximum	0.349000	0.215000	0.243000	0.175000	2.008000
Minimum	–0.304000	–0.146000	–0.288000	–0.173000	–1.938000
Std. Deviation	0.044684	0.032141	0.041202	0.032924	0.089819
Skewness	–0.044318	0.516074	0.034231	0.486959	0.771924
Kurtosis	9.342152	6.622289	6.806177	6.228052	333.645900
Jarque- Bera	2360.20400**	832.26340**	850.17820**	666.97190**	6413974.00**
PP test	–40.10779**	–37.35135**	–38.52704**	–36.81826**	–64.73433*
ADF test	–40.07048**	–37.30393**	–38.44021**	–36.81090**	–29.05808**
ARCH test	150.7773**	4.330521*	32.40357**	85.67567**	244.7156**
Observations	1408	1408	1408	1408	1408

Note: * and ** indicate 5% and 1% statistically significant, respectively. The pre-Brexit vote period is from January 1, 2011, to June 22, 2016. The post-Brexit vote period is from June 23, 2016, to December 31, 2021.

the UK, USA, France, Germany, and India prior to and subsequent to the Brexit vote. The fluctuation in the yield values is slightly high following the Brexit vote compared to the period before the vote. The correlation matrix of the chosen countries' yield values of the 10-year government bond market prior to and subsequent to the Brexit vote are shown in Table 2. Before the Brexit vote pe-

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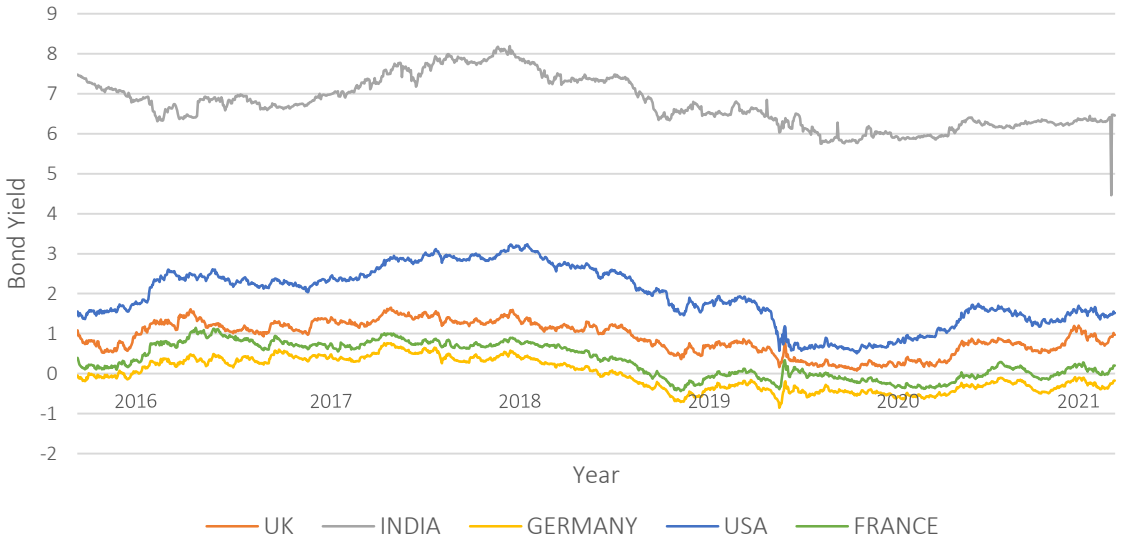

Figure 2. Post-Brexit vote era bond yield

Table 2. Correlation matrix between bond yields at first difference

Countries	USA	Germany	UK	France	India
Pre-Brexit vote era					
USA	1				
Germany	0.659946	1			
UK	0.682258	0.794201	1		
France	0.442268	0.690525	0.566529	1	
India	0.019931	0.042754	0.041158	0.02001	1
Post-Brexit vote era					
USA	1				
Germany	0.613361	1			
UK	0.615395	0.788580	1		
France	0.504139	0.834553	0.700014	1	
India	0.141940	0.126860	0.094914	0.095116	1

Table 3. VAR parameters for the pre-Brexit vote era

Vector Autoregression coefficient estimates					
Bond yield	**US yield**	**Germany yield**	**UK yield**	**France yield**	**India yield**
US yield	–0.072699	0.164496**	0.269665**	0.199480**	0.155270**
Germany yield	–0.006510	–0.144333**	–0.112641*	–0.155642**	0.001707
UK yield	0.056298	–0.064434	–0.162853**	–0.087803	–0.049467
France yield	0.038504	0.117202**	0.067815	0.135339**	–0.011527
India yield	0.000832	–0.004702	–0.021290	0.028393	–0.127598**

Note: * and ** indicate 5% and 1% statistically significant, respectively.

Table 4. VAR parameters for the post-Brexit vote era

Vector Autoregression coefficient estimates					
Bond yield	**US yield**	**Germany yield**	**UK yield**	**France yield**	**India yield**
US yield	–0.062960	0.155223**	0.154488**	0.130624**	0.152156**
Germany yield	–0.159166	–0.231746**	–0.219292**	–0.182166**	–0.218560*
UK yield	0.066853	–0.027238	–0.071716	–0.014477	–0.015181
France yield	0.219819**	0.161826**	0.183887**	0.084977	0.203262**
India yield	–0.013451	0.002153	–0.007981	–0.020009	–0.100066**

Note: * and ** indicate 5% and 1% statistically significant, respectively.

riod, India and USA had the lowest correlation (0.019931). Following the Brexit vote, Germany and France showed the highest correlation (0.834553). The correlation between the countries increased to a greater extent after the Brexit vote.

This study uses the Vector Auto-Regressive (VAR) model to measure the spillovers of yield among the 10-year government bond market. This study uses one lag for the two sub-periods, as suggested by the Akaike Information Criterion. The VAR model's estimated results for the two sub-periods are presented in Tables 3 and 4. Before the Brexit vote, India's 10-year government bond yields were affected by the first lag yield of the Indian bond and the first lag yield of the US bonds. However, during the post-Brexit vote era, India's 10-year government bond market was not just affected by the first lag yield of Indian bonds and US bonds but also by the first lag yield of France and Germany's 10-year government bonds.

The first lag yield of the US bond made a significant return spillover to India, the UK, Germany, and France's 10-year government bond yields prior to and following the Brexit vote. US 10-year government bond yields were not affected by any other countries' bond yields prior to the Brexit vote. However, during the post-Brexit vote era, the USA was affected by the first lag yield of France 10-year government bond. UK 10-year government bond market was affected by its own first lag and the first lag of Germany and US bond markets prior to the Brexit vote. Conversely, the first lag yield of France, Germany, and the US 10-year government bond made a considerable return transmission to the UK 10-year government bond yield post-Brexit vote. German government bond markets were affected by its own first lag and the first lag of France and the US government bond markets during the two sub-periods. French bond yields were affected by the return spillover of its own first lag only during the pre-period and the first lag yield of the Germany and US government bond market before and after the Brexit vote.

The volatility spillover between the UK, France, USA, Germany, and India 10-year government bond markets are analyzed using GARCH BEKK (1,1) model. Table 5 illustrates the BEKK model results. The GARCH BEKK model output is presented in the pairs of Indian bond markets and other countries such as the USA, UK, France, and Germany, respectively. In this GARCH-BEKK analysis, A(x, x) indicates ARCH parameters, and B(x, x) indicates GARCH parameters related to market x. For all ARCH A(1,2) and GARCH B(1,2) parameters, India is always denoted by 1 all through the analysis, whereas the UK, USA, France, and Germany are denoted by 2. The ARCH specification's diagonal component, such as A(x, x), indicates that the volatility in market x depends on its earlier fluctuations. The diagonal components of ARCH parameters, A(1,1) and A(2, 2), are significant for all countries. The ARCH specification's off-diagonal components, such as A(x,y), which include A(1,2) and A(2,1), indicate the past cross shocks, i.e., the previous cross volatility is transferred from market x to market y. The ARCH parameter A(y,x) demonstrates the same but in the opposite direction. Here the past cross shocks of market y are transmitted to market x. The ARCH specification's off-diagonal component A(1,2) results demonstrate that the past cross shocks of Indian bond markets were transmitted to the USA, Germany, and France before and after the Brexit vote but, on the contrary, to the UK only prior to the Brexit vote. However, the past cross shocks of the US and UK bond markets were transmitted to the Indian bond market only during the post-Brexit vote era. It shows whenever shocks affect the US and UK bond markets, it is being captured by India's bond markets.

The GARCH effect explains three criteria. Firstly, B(1,1) and B(2,2) diagonal GARCH parameter represents conditional variance. B(x,x) points out that the volatility in market x depends on its own history (Hung, 2020). The UK and Indian bond markets show statistically significant conditional variance clustering during both periods. Therefore, they are affected by their own spillovers. However, France and Germany's 10-year government bond market seem to be affected by their own spillovers prior to the Brexit vote. The US bond market is affected only by its own spillover after the Brexit vote. The second criterion explained by the GARCH effect is B(x,y), which measures the spillover of volatility from market x to market y, and the third criterion explained by the GARCH effect is B(y, x), which measures the volatility spillover from market y to market x (Hung, 2020; Mohammadi & Tan, 2015;

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Table 5. Estimation of bivariate GARCH-BEKK model parameters

Parameter	India Bond yield & US Bond yield		India Bond yield & UK Bond yield		India Bond yield & France Bond yield		India Bond yield & Germany Bond yield	
	Pre-Brexit vote era	Post-Brexit vote era	Pre-Brexit vote era	Post-Brexit vote era	Pre-Brexit vote era	Post-Brexit vote era	Pre-Brexit vote era	Post-Brexit vote era
Conditional Mean								
mu1	–0.001104972	0.000835945	–0.000506882	–0.002259640	–0.001105038	–0.000185687	–0.000456166	–0.000281766
mu2	–0.000561866	0.001159780	–0.001497138	0.000828815	–0.002799150**	–0.000698198	–0.002555925**	–0.000219481
Conditional Variance								
A011	0.012374977 **	0.015256261**	0.012413193**	0.014968002	0.024017657**	0.010440417	0.019575819	0.010417985
A021	0.000148784	0.000765500	0.000310153	0.002929826	0.000208504	0.003914333**	0.000329603	0.004779641
A022	0.010035849	0.009184790 **	0.010387366 **	0.008420607**	0.009375664**	0.006716810	0.009533946	0.006548954
A11	0.540308895**	0.000001000	0.518847647 **	0.018168825	0.815080840 **	0.199543269**	0.752287490	0.197985576
A21	–0.001970132	0.022355953**	–0.022850155	–0.021424240*	–0.023558584	–0.005908135	–0.005156251	–0.006184378
A12	–0.140918928**	–0.134185680**	0.095536077**	0.226022276	0.166705708 **	0.082346918**	0.093819624**	0.108248503**
A22	0.198347490	0.380559831**	0.155557930 **	0.342256544 **	0.237701036**	0.273016363**	0.227633447**	0.249726102 **
B11	0.846275365 **	0.950770110**	0.853372432**	0.967935648	0.582981210**	0.960114585	0.699448440	0.959667463
B21	–0.001980377	–0.045631910**	0.014345109	0.024746385 **	0.022811533	–0.001522508	0.008550288	–0.003549440
B12	0.026032145	0.189267232**	–0.017638007	–0.172304533	–0.036432074	–0.048826228**	–0.019560989	–0.057285304
B22	0.959459107	0.916734384**	0.966586449 **	0.919221567**	0.949272779 **	0.934386239	0.952586549 **	0.936077571

Note: * and ** indicate 5% and 1% statistically significant, respectively.

Vo & Ellis, 2018). There was no volatility spillover between the Indian government bond markets and German government bond markets for the two sub-periods. The GARCH specifications B(1, 2) and B(2,1) between India and German government bond markets for pre-and post-period are not statistically significant. The Brexit vote did not affect the linkage between Indian and German government bond markets. There was no linkage before, and there was no linkage later as well. There was no significant volatility spillover from France bond market to the Indian government bond market before and after the Brexit vote. The GARCH parameters B(2,1) from France to India for both pre and post-period are not statistically significant. The GARCH specification B(1, 2) from India to France prior to the Brexit vote era is also not statistically significant. There was no spillover of volatility from the Indian bond market to France bond market prior to the Brexit vote. However, the coefficient B(1,2) from India to France equals 0.048 for the post period and is statistically significant. Indian government bond market made significant volatility spillover to France bond market following the Brexit vote.

The Indian government bond market did not make any volatility spillover to the UK government bond market before and after the Brexit vote. The GARCH specification B(1,2) from India to the UK for the two sub-periods are not statistically significant. The UK government bond market did not make a considerable spillover of volatility to Indian markets prior to the Brexit vote. The GARCH parameter B(2,1) for the pre-period is also not statistically significant. However, the UK bond market made a considerable volatility spillover to the Indian government bond market post-Brexit vote. The Coefficient B(2,1) from the UK to India is estimated to be 0.024 for the post-period and is statistically significant. The US government bond market made a considerable volatility spillover to the India bond market post-Brexit vote. Before the Brexit vote, the US government bond had no considerable spillover of volatility on the Indian bond market. Prior to the Brexit vote, the GARCH specifications B(2,1) and B(1,2) between the USA and India are not statistically significant. The Coefficient B(1,2) from India to the USA, which is equal to 0.18, and the coefficient B(2,1) from the USA to India, equal to 0.04 for the post period, are statistically significant. Indian government bond market also made a considerable volatility spillover to the US government bond market post-Brexit vote era. However, prior to the Brexit vote, the India government bond market had no considerable spillover of volatility on the US government bond market.

Compared to all other countries Indian government bond market made the highest volatility spillover to the US government bond market post-Brexit vote. The coefficient B(1,2) from India to the USA equals 0.18, which is statistically significant at one percent. This indicates that the volatility spillover from India to the USA was highest at 18% post-Brexit vote. It suggests that if the Indian bond market returns increase by 1%, then the Indian bond market will spill over the volatility to the US government bond market by 18%. The result suggests there was no integration between India 10-year government bond market and the UK, USA, France, and Germany's 10-year government bond markets prior to the Brexit vote. Following the Brexit vote, integration between India and UK, France, and US 10-year government bond market strengthened to a large extent. It implies integration among the 10-year government bond market considerably increased except for Germany subsequent to the Brexit vote. It is useful for individual and institutional investors, portfolio managers, and policymakers to identify the different channels through which India got affected by the Brexit vote.

CONCLUSION

The aim of this paper is to examine the correlation among the 10-year government bond market of the USA, Germany, UK, France, and India by analyzing their return and volatility spillover prior to and subsequent to the Brexit vote. This study has used the bivariate GARCH BEKK model to analyze the volatility spillover and the VAR model to investigate the return spillover. The VAR results reveal that India's own lag and the USA made a substantial yield spillover to Indian government bond markets be-

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fore the Brexit vote. However, following the Brexit vote, India's own lag, US, German, and French government bonds had a substantial spillover of yield to the India 10-year government bond market. Before the Brexit vote, there was no volatility spillover between the USA, UK, France, and India's 10-year government bond market. In contrast, following the Brexit vote, there was a substantial rise in the spillover of volatility between India and the USA, from India to France, and from the UK to India's 10-year government bond market. The Brexit vote significantly affected the USA, UK, France, and India's 10-year government bond market.

The results imply that the increase in volatility spillover in the 10-year government bond market is mainly due to the uncertainty of Brexit and the rise in risk factors. All the risk-averse investors have migrated their investments from risky investments such as stocks to safe-haven assets like government bonds. Safe-haven assets offer protection against political risk. Analyzing volatility spillovers would be very useful to investors, traders, policymakers, and risk managers for planning optimal portfolios and devising strategies to minimize the transmission of adverse shocks in the future. In addition, it will be helpful in international trading and investment strategies. This increased linkage between the India government bond market and other government bond markets will help in forecasting the Indian government bond market behavior by capturing the information from the other markets. It is mainly because Indian government bond markets are getting more integrated with international bond markets post-Brexit vote. A political event like Brexit can affect the government bond markets of developed nations like the USA, the UK, France, and India. It can be anticipated that any future political events can similarly impact the government bond markets.

AUTHOR CONTRIBUTIONS

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REFERENCES

1. Abuzayed, B., Al-Fayoumi, N., & Bouri, E. (2022). Hedging UK stock portfolios with gold and oil: The impact of Brexit. *Resources Policy, 75*, 102434. https://doi.org/10.1016/j.resourpol.2021.102434
2. Adesina, T. (2017). Estimating volatility persistence under a Brexit-vote structural break. *Finance Research Letters, 23,* 65-68. https://doi.org/10.1016/j.frl.2017.03.004
3. Agur, I., Chan, M., Goswami, M., & Sharma, S. (2019). On international integration of emerging sovereign bond markets. *Emerging Markets Review, 38*, 347-363. https://doi.org/10.1016/j.ememar.2018.11.006
4. Aristeidis, S., & Elias, K. (2018). Empirical analysis of market reactions to the UK's referendum results – How strong will Brexit be? *Journal of International Financial Markets, Institutions and Money, 53,* 263-286. https://doi.org/10.1016/j.intfin.2017.12.003
5. Bekaert, G., Ehrmann, M., Fratzscher, M., & Mehl, A. (2014). The Global Crisis and Equity Market Contagion. *Journal of Finance, 69*(6), 2597-2649. https://doi.org/10.1111/jofi.12203
6. Belke, A., Dubova, I., & Osowski, T. (2018). Policy uncertainty and international financial markets:

the case of Brexit. *Applied Economics, 50*(34-35), 3752-3770. https://doi.org/10.1080/00036846.2018.1436152

7. BenSaïda, A., Litimi, H., & Abdallah, O. (2018). Volatility spillover shifts in global financial markets. *Economic Modelling, 73*, 343-353. https://doi.org/10.1016/j.econmod.2018.04.011

8. Bhar, R., & Nikolova, B. (2009). Return, volatility spillovers and dynamic correlation in the BRIC equity markets: An analysis using a bivariate EGARCH framework. *Global Finance Journal, 19*(3), 203-218. https://doi.org/10.1016/j.gfj.2008.09.005

9. Bhattacharyay, B. N. (2013). Determinants of bond market development in Asia. *Journal of Asian Economics, 24,* 124-137. https://doi.org/10.1016/j.asieco.2012.11.002

10. Bloom, N. (2009). The Impact of Uncertainty Shocks. *Econometrica, 77*(3), 623-685. https://doi.org/10.3982/ecta6248

11. Bollerslev, T., & Wooldridge, J. (1992). Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances. *Econometric Reviews, 11*(2), 143-172. https://doi.org/10.1080/07474939208800229

12. Breinlich, H., Leromain, E., Novy, D., Sampson, T., & Usman, A. (2018). The Economic Effects of Brexit: Evidence from the Stock Market. *Fiscal Studies, 39*(4), 581-623. https://doi.org/10.1111/1475-5890.12175

13. Burdekin, R. C. K., Hughson, E., & Gu, J. (2018). A first look at Brexit and global equity markets. *Applied Economics Letters, 25*(2), 136-140. https://doi.org/10.1080/13504851.2017.1302057

14. Chaudhuri, P. P. (2020). Brexit and India-UK Relations. In R. A. Jain (Ed.), *India and the European Union in a Turbulent World* (pp. 91-107). Singapore: Palgrave Macmillan. https://doi.org/10.1007/978-981-15-3917-6

15. Chiang, S.-M., Chen, H.-F., & Lin, C.-T. (2013). The spillover effects of the sub-prime mortgage crisis and optimum asset allocation in the BRICV stock markets. *Global Finance Journal, 24*(1), 30-43. https://doi.org/10.1016/j.gfj.2013.03.001

16. Christiansen, C. (2007). Volatility-spillover effects in European bond markets. *European Financial Management, 13*(5), 923-948. https://doi.org/10.1111/j.1468-036X.2007.00403.x

17. Christiansen, C. (2014). Integration of European bond markets. *Journal of Banking & Finance, 42*(1), 191-198. https://doi.org/10.1016/j.jbankfin.2014.01.022

18. Cumming, D. J., & Zahra, S. A. (2016). International Business and Entrepreneurship Implications of Brexit. *British Journal of Management, 27*(4), 687-692. https://doi.org/10.1111/1467-8551.12192

19. Dao, T. M., McGroarty, F., & Urquhart, A. (2019). The Brexit vote and currency markets. *Journal of International Financial Markets, Institutions and Money, 59,* 153-164. https://doi.org/10.1016/j.intfin.2018.11.004

20. Diebold, F. X., & Yilmaz, K. (2009). Measuring financial asset return and volatility spillovers, with application to global equity markets. *The Economic Journal, 119*(534), 158-171. https://doi.org/10.1111/j.1468-0297.2008.02208.x

21. Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting, 28*(1), 57-66. https://doi.org/10.1016/j.ijforecast.2011.02.006

22. Driffield, N., & Karoglou, M. (2019). Brexit and foreign investment in the UK. *Journal of the Royal Statistical Society. Series A: Statistics in Society, 182*(2), 559-582. https://doi.org/10.1111/rssa.12417

23. Dugal, I., & Sonavane, R. (2016, July 28). *India's 10-year bond yield nears 2009 lows*. Mint Delhi. https://www.livemint.com/Money/8FnhfxJqDeaGBSzd1tyN3H/Indias-10year-bond-yield-nears-2009-lows.html

24. Engle, R. F., & Kroner, K. F. (1995). Multivariate Simultaneous Generalized ARCH. *Econometric Theory, 11*(1), 122-150. Retrieved from https://www.jstor.org/stable/3532933

25. Engle, R. F., Ito, T., & Lin, W.-L. (1990). Meteor Showers or Heat Waves ? Heteroskedastic Intra-Daily Volatility in the Foreign Exchange Market. *Econometrica, 58*(3), 525-542. https://doi.org/10.2307/2938189

26. Felman, J., Gray, S., Goswami, M., Jobst, A. A., Pradhan, M., Peiris, S., & Seneviratne, D. (2014). ASEAN-5 bond market development: Where does it stand? Where is it going? *Asian-Pacific Economic Literature, 28*(1), 60-75. https://doi.org/10.1111/apel.12051

27. Forbes, K. J., & Rigobon, R. (2002). No contagion, only interdependence: Measuring stock market comovements. *The Journal of Finance, 57*(5), 2223-2261. https://doi.org/10.1111/0022-1082.00494

28. Geddie, J. (2016, June 17). *UPDATE 3-Euro zone bond markets steady as Brexit chances seen receding*. Reuters. https://www.reuters.com/article/euro-zone-bonds-idINL8N1990OD

29. Gopinath, T. (2008). Does Subprime Mortgage Crisis in the US Impact India?: An Exploration. *The Indian Economic Journal, 56*(3), 159-180. https://doi.org/10.1177/0019466220080311

30. Gu, C., & Hibbert, A. M. (2021). Expectations and financial markets: Lessons from Brexit. *The Financial Review, 56*(2), 279-299. https://doi.org/10.1111/fire.12248

31. Guedes, E. F., Ferreira, P., Dionísio, A., & Zebende, G. F. (2019). An econophysics approach to study the effect of BREXIT referendum on European Union stock markets.

http://dx.doi.org/10.21511/imfi.19(3).2022.16

Physica A: Statistical Mechanics and Its Applications, 523, 1175-1182. https://doi.org/10.1016/j.physa.2019.04.132

32. Hosoe, N. (2018). Impact of border barriers, returning migrants, and trade diversion in Brexit: Firm exit and loss of variety. *Economic Modelling, 69,* 193-204. https://doi.org/10.1016/j.econmod.2017.09.018

33. Hui, E. C. M., & Chan, K. K. K. (2021). New test of contagion with application on the Brexit referendum. *Physica A: Statistical Mechanics and Its Applications, 564,* 125474. https://doi.org/10.1016/j.physa.2020.125474

34. Hung, N. T. (2019). Return and volatility spillover across equity markets between China and Southeast Asian countries. *Journal of Economics, Finance and Administrative Science, 24*(47), 66-81. https://doi.org/10.1108/JEFAS-10-2018-0106

35. Hung, N. T. (2020). An analysis of CEE equity market integration and their volatility spillover effects. *European Journal of Management and Business Economics, 29*(1), 23-40. https://doi.org/10.1108/EJMBE-01-2019-0007

36. Inaba, K. I. (2021). An empirical illustration of the integration of sovereign bond markets. *Journal of Multinational Financial Management, 61,* 100674. https://doi.org/10.1016/j.mulfin.2020.100674

37. Jawad, M., & Naz, M. (2019). Pre and post effects of Brexit polling on United Kingdom economy: an econometrics analysis of transactional change. *Quality & Quantity, 53*(1), 247-267. https://doi.org/10.1007/s11135-018-0746-1

38. Kara, A., Karimov, N., & Nguyen, A. P. (2021). Brexit referendum and the UK securitization market. *Applied Economics Letters, 28*(13), 1092-1097. https://doi.org/10.1080/13504851.2020.1798340

39. Kim, S., & Lee, J. W. (2012). Real and Financial Integration in East Asia. *Review of International Economics, 20*(2), 332-349. https://doi.org/10.1111/j.1467-9396.2012.01025.x

40. Li, H. (2020). Volatility spillovers across European stock markets under the uncertainty of Brexit. *Economic Modelling, 84,* 1-12. https://doi.org/10.1016/j.econmod.2019.03.001

41. Majdoub, J., & Mansour, W. (2014). Islamic equity market integration and volatility spillover between emerging and US stock markets. *North American Journal of Economics and Finance, 29,* 452-470. https://doi.org/10.1016/j.najef.2014.06.011

42. McCormick, L., & Regan, M. P. (2021, March 17). *Why 10-Year Treasury Yields Get All the Attention*. Bloomberg. https://www.bqprime.com/quicktakes/why-10-year-treasury-yields-get-all-the-attention-quicktake

43. Mohammadi, H., & Tan, Y. (2015). Return and volatility spillovers across equity markets in Mainland China, Hong Kong and the United States. *Econometrics, 3*(2), 215-232. https://doi.org/10.3390/econometrics3020215

44. Park, C. Y., & Lee, J. W. (2011). Financial integration in emerging Asia: Challenges and prospects. *Asian Economic Policy Review, 6*(2), 176-198. https://doi.org/10.1111/j.1748-3131.2011.01193.x

45. Plummer, M. G., & Click, R. W. (2005). Bond market development and integration in ASEAN. *International Journal of Finance and Economics, 10*(2), 133-142. https://doi.org/10.1002/ijfe.268

46. Ramiah, V., Pham, H. N. A., & Moosa, I. (2017). The sectoral effects of Brexit on the British economy: early evidence from the reaction of the stock market. *Applied Economics, 49*(26), 2508-2514. https://doi.org/10.1080/00036846.2016.1240352

47. Ranasinghe, D. (2019, September 27). *French, Spanish 10-year bond yields set for biggest weekly fall in six weeks*. Reuters. https://www.reuters.com/article/eurozone-bonds-idUSL5N26I0XU

48. Rebello, J. (2020, March 4). *Why India's 10-year bond yield stays high*. The Economic Times. https://economictimes.indiatimes.com/markets/bonds/why-indias-10-year-bond-yield-stays-high/articleshow/74470055.cms

49. Reuters. (2016, June 14). *Germany's 10-year government bond yield falls to 0% for first time as Brexit worries mount*. Financial Express. https://www.financialexpress.com/market/germanys-10-year-government-bond-yield-falls-to-0-for-first-time-as-brexit-worries-mount/284451/

50. Ribeiro, P. P., Cermeño, R., & Curto, J. D. (2017). Sovereign bond markets and financial volatility dynamics: Panel-GARCH evidence for six euro area countries. *Finance Research Letters, 21,* 107-114. https://doi.org/10.1016/j.frl.2016.11.011

51. Rigobon, R. (2016). *Contagion, spillover and interdependence* (Working Paper No. 1975). European Central Bank. Retrieved from https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1975.en.pdf

52. Roy, A., & Mathur, S. K. (2016). Brexit and India–EU Free Trade Agreement. *Journal of Economic Integration, 31*(4), 740-773. Retrieved from https://www.e-jei.org/upload/JEI_31_4_740_773_2013600112.pdf

53. Rughoo, A., & You, K. (2016). Asian financial integration: Global or regional? Evidence from money and bond markets. *International Review of Financial Analysis, 48,* 419-434. https://doi.org/10.1016/j.irfa.2015.03.007

54. Samitas, A., Polyzos, S., & Siriopoulos, C. (2018). Brexit and financial stability: An agent-based simulation. *Economic Modelling, 69,* 181-192. https://doi.org/10.1016/j.econmod.2017.09.019

55. Šimović, P. P., Tkalec, M., Vizek, M., & Lee, J. (2016). Time-varying integration of the sovereign bond markets in European post-transition economies. *Journal of Empirical Finance, 36,* 30-40. https://doi.org/10.1016/j.jempfin.2015.12.005

56. Srovnalikova, P., & Razinskaite, J. (2017). The Eurozone Crisis and the Effect of Brexit. *Vadyba Journal of Management, 30*(1), 95-102. Retrieved from https://www.ltvk.lt/file/zurnalai/12_Srovnalikova.pdf

57. Stoupos, N., & Kiohos, A. (2021). BREXIT referendum's impact on the financial markets in the UK. *Review of World Economics, 157*(1), 1-19. https://doi.org/10.1007/s10290-020-00393-z

58. Tripathi, D. (2021). Evaluating Brexit Implications for India's Relations with the EU and the UK. *International Studies, 58*(2), 234-247. https://doi.org/10.1177/00208817211011361

59. Tsang, A., Yiu, M. S., & Nguyen, H. T. (2021). Spillover across sovereign bond markets between the US and ASEAN4 economies. *Journal of Asian Economics, 76*, 101343. https://doi.org/10.1016/j.asieco.2021.101343

60. Tsukuda, Y., Shimada, J., & Miyakoshi, T. (2017). Bond market integration in East Asia: Multivariate GARCH with dynamic conditional correlations approach. *International Review of Economics and Finance, 51*, 193-213. https://doi.org/10.1016/j.iref.2017.05.013

61. Vo, X. V. (2009). International financial integration in Asian bond markets. *Research in International Business and Finance, 23*(1), 90-106. https://doi.org/10.1016/j.ribaf.2008.07.001

62. Vo, X. V., & Ellis, C. (2018). International Financial Integration: Stock Return Linkage and Volatility Transmission between Vietnam and Other Advanced Countries. *Emerging Markets Review, 36,* 19-27. https://doi.org/10.1016/j.ememar.2018.03.007

63. Wagenvoort, R. J. L. M., Ebner, A., & Borys, M. M. (2011). A factor analysis approach to measuring European loan and bond market integration. *Journal of Banking & Finance, 35*(4), 1011-1025. https://doi.org/10.1016/j.jbankfin.2010.09.016

64. Wang, Z., Yan, Y., & Chen, X. (2017). Long-range correlation and market segmentation in bond market. *Physica A: Statistical Mechanics and Its Applications, 482,* 477-485. https://doi.org/10.1016/j.physa.2017.04.066

65. Whitehouse, M. (2016). *The Bond Market Still Thinks Brexit Is Bad.* Bloomberg. https://www.bqprime.com/opinion/the-bond-market-still-thinks-brexit-is-bad

http://dx.doi.org/10.21511/imfi.19(3).2022.16