The determinants of the dynamic correlation between foreign exchange and equity markets: Cross-Country comparisons

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ABSTRACT

This paper investigates the factors driving the exchange rate-stock return nexus and compares developed and emerging countries. The paper uses a MDCC-GJR-GARCH model to capture the correlation between exchange rate and stock return in 20 randomly selected emerging economies and 23 developed economies for the period 2011-2021. In addition, a dynamic panel model is employed to test the significance of the explanatory variables, that is, VIX, Market Capitalisation to GDP, (RINT), and Global Growth. The empirical results revealed that the level of development matters, developed countries' correlations are mainly influenced by VIX, Global Growth, and Market Capitalisation to GDP variables whereas emerging markets are driven by VIX and RINT. The drivers in both country groups represent both global and local factors. The findings of this research are important to international portfolio investors when diversifying their investment portfolios and to policymakers.

Keywords: Exchange rate, Stock returns, DCC, Dynamic panel model, Emerging economies, Developed economies, VIX, RINT, Market capitalisation to GDP, Global growth.

1. INTRODUCTION

The relationship between exchange rate and stock returns has been widely explored; see, for example, Wu (2000), Desislava (2005), Kumar (2010), and Lin (2012) who concluded that exchange rate and stock returns fluctuations indeed synchronise in that real depreciation of currency corresponds to portfolio inflows and increase in stock returns. Choi (2009) investigated volatility spillovers between stock market returns and exchange rate volatility in New Zealand after the break of the 1997 Asian financial crisis and found that there is a transmission of risk between the two markets. However, some studies show that there is no observed relationship between exchange rate and stock returns. For example, Muhammad et al (2002) assessed the correlation between equity returns and exchange rate in south Asian countries and concluded that the association in both the short and long term is insignificant.

Empirical results revealed a pair of theoretical strands signifying the connection between foreign exchange rates and stock returns; the flow-oriented and stock-oriented models. The flow-oriented models based on exchange rate determination suggest that firms' international competitiveness on global stock markets is subject to the value of currency movement relative to international currencies (Dornbusch and Fisher, 1980). The theory further proposes that the balance of trade of a country is also affected by exchange rate volatility in addition to international competitiveness, and therefore the real output of a country is dictated by exchange rate volatility. Dornbusch and Fischer (1980), who first documented the flow-oriented models, revealed that when the real output of a country is impacted because of exchange rate instabilities, the current and potential cash flows of a firm are affected, and consequently the stock returns as well.

The stock-oriented model, also known as the monetarist model of exchange rate determination, grounded on portfolio balance, suggests that capital account is the driving factor of the exchange rate-stock return nexus. The mechanism follows that when stock returns fluctuate, the firms' international competitiveness, as well as trade balance, is affected, which in turn dictates the value of the local currency relative to foreign currencies. Gavin (1989) explains that equity impacts exchange rate volatility through the demand for currency. Pan et al.'s (2007) analysis confirms the stock-oriented models, asserting that a thriving stock market attracts foreign investors, and cash inflows drive up the demand for a local currency and hence the currency value.

While the above studies' emphasis is on the association between exchange rate and stock returns, very few studies have attempted to uncover the drivers of the correlation between the two variables. For example, Moore and Wang (2014) reinforced the flow-oriented models and show that trade balance is the driving factor of the relationship between stock returns and exchange rates in emerging Asian markets. The authors also identified interest differential as a driving factor in developed nations. Lim and Sek (2014) examined the inter-relationship between the volatility of stock returns and exchange rate in four Asian emerging markets using GARCH and VAR models and found that a significant bi-directional association exists between exchange rate volatility and stock returns in Korea, Indonesia, and Thailand. The results further indicated that money supply, interest rate, lagged volatility of exchange rate, international reserves, and lagged volatility of stock returns are the drivers of the association between exchange rate and stock returns. Tang and Yao (2018) investigated what links exchange rate and stock returns using multivariate Granger causality tests and cointegration methods for the period 1988-2014. Their results showed that the inner-financial structure, that is the direct and indirect financing, drives the relationship between exchange rate and stock prices. The financial structure significantly impacts the correlation between the exchange rate and stock returns of eleven out of the twelve countries contained in the study, and the channel is through both the flow channel and the stock channel for different countries.

While examining the correlation between exchange rate and stock return, studies focused mainly on factors driving this relationship without distinguishing how they differ according to the level of development of the different countries or regions. Such a distinction is important following Bonga-Bonga (2013) who showed that contrary to developed economies, developing economies are often better off when their currency depreciates rather than when it appreciates given the lack of capacity and competitiveness for exports.

However, to the best of our knowledge, no study has attempted to assess the factors driving the dynamic correlation between exchange rate and stock returns in distinguishing between developed and emerging economies and differentiating between local and global factors. In doing so, this paper will use a two-step estimation to this end. In the first step, the MGARCH-DCC models are utilised to capture the dynamic correlation between exchange rate and stock return. The second step employs a dynamic panel data model to assess the determinants of the correlation.

This paper observes the time series of dynamic correlation between the change in the exchange rate and stock returns in developed and emerging economies, and attempts to reveal the drivers of the dynamic correlation, distinguishing between developed and emerging economies. Furthermore, the paper investigates the key factors, between global and domestic factors, that mostly drive this correlation in developed and emerging economies.

The paper utilises a two-step estimation in modelling the dynamic correlation between the change in the exchange rate and stock returns and determining its drivers. In the first step, the MGARCH-DCC models are employed to capture the dynamic correlation between exchange rate and stock return. The second step employs a dynamic panel data model proposed by Bond and Arellano (1995) to assess the determinants of this correlation.

Investors and asset managers are interested in holding portfolios consisting of positions in the foreign exchange and stock markets. The direction of the two markets' correlation signals investors when to hold or rebalance this portfolio. These signals are provided by the drivers of the correlation between the two markets. For example, a factor or driver that causes a negative relationship between exchange rate and stock markets signals the timing for asset managers to hold positions in the two markets while a driver that leads to a positive relationship shows the timing for asset managers to rebalance and unbundle positions in the two markets.

The paper is divided into five chapters. Section 2 presents the literature review. Section 3 discusses the methodology of the paper. Section 4 presents the data used, shows how the model used was estimated, and discusses the results of the paper. The conclusion of the paper is presented in Section 5.

2. LITERATURE REVIEW

Studies abound on the connection between foreign exchange and stock markets. For instance, Beer and Hebein (2008) assessed the exchange rate and stock market dynamics for both developed and emerging economies. The authors employed the Exponential General Autoregressive Conditional Heteroskedasticity (EGARCH) method and showed that there is no persistence of volatility among the exchange rate markets and stock markets in developed countries and the opposite for emerging markets. These findings also indicated a price volatility spillover from the foreign exchange market to the stock market in the USA, Canada, India, and Japan.

Aloui (2007) studied the volatility, mean, and causality transmission mechanism that exists between the foreign exchange and stock markets in the major European countries and the United States. The analysis uses the extended Multivariate Exponential Generalised Autoregressive Conditionally Heteroskedastic model (MGARCH). The results revealed an asymmetric volatility transmission between the foreign exchange market and the stock market for the pre-and post-euro periods with a long-range persistent spillover effect of the volatility and a significant interconnection in the mean and variance between the two price markets for both periods. The authors hypothesised different results in the two periods, such as different persistence ranges post-euro period, but the empirical evidence proved otherwise.

Choi (2009) assessed the volatility spillovers between stock market returns and exchange rate volatility in New Zealand for the trial period 1990 to 2004, which includes a structural break caused by the 1997 Asian financial crisis. The analysis is therefore separated into pre-and post-Asian financial crisis. Choi (2009) employed the EGARCH model to investigate the spillover between exchange rate and stock returns. The evidence suggested that there is a transmission of risk between the NZ stock market and all three exchange rates considered in the study, that is the NZ/AUD, NZ/USD, and TWII index in the overall sample. The flow is observed to be only from the stock market to the NZ/AUD and not vice versa in each subperiod. Furthermore, the pre-Asian Financial crisis period experienced a flow from exchange rate to stock returns and vice versa before the structural break with the NZ/USD and TWII index. On the contrary, post the financial crisis, the spillover is only from the NZ stock market to NZ/USD and TWII index and not vice versa.

He et al (2021) investigated the relationship between exchange rates and stock returns in emerging economies. The authors used a quantile-on-quantile approach to assess how this relationship fares according to the different distributions of the stock markets. The results of the empirical analysis show that stock markets can only be influenced by exchange rates depending on whether the markets are bullish or bearish. Additional factors that were found to influence the exchange rate-stock market nexus were the economy's openness to trade, the relevance of international trade in other countries, and the stock market efficiency.

Although the above studies fixated on the possible link between foreign exchange and stock markets, several other studies have focused rather on factors that drive the correlation between foreign exchange and stock markets.

For instance, Huang et al (2021) studied the drivers of the correlation between the foreign exchange and stock markets in BRICS countries. The authors use the TVP-VAR (time-varying parameters-vector autoregressive) method to account for the asymmetric effects of the drivers of this correlation. The findings of the empirical analysis show that the financial account is the driving factor of the effect of exchange rate variations on the stock market in Brazil and Russia. However, the current account is found to drive this correlation in South Africa, China, and India.

Nguyen and Yuan (2019) investigated whether the global financial crisis that occurred from 2007 to 2009 influenced the link between exchange rate and stock returns in BRICS and further examined the impact of the USD (US dollar) exert on BRICS countries. Different methodologies are used to this end, like cointegration and multivariate Granger causality tests. The authors found that the global crisis that occurred in 2007-2009 was the driving factor in the connection concerning stock return and exchange rate volatility. Dahir (2018) also reached the same conclusion as Nguyen and Yuang (2019) that financial crises have a substantial impact on the link between exchange rates and stock returns.

Several studies use the Granger Causality test to identify the determinants of the synchronisation of exchange rates and stock return in different countries. The findings of these studies point to the role of the exchange rate regime as the main driver of this synchronisation. For instance, Murinde and Poshakwale (2004) studied price relations between foreign exchange markets and stock markets of the European emerging financial markets before and after the adoption of the Euro to decipher the impact of the exchange rate regime or the influence of introducing the euro on the exchange rate–stock returns nexus in EU countries.

The authors estimated a bivariate vector autoregressive model to test granger causality between the stock return index and nominal exchange rate for most of the EU countries. The correlation and causality amid foreign exchange rates and stock returns were found to be higher positive in the Euro period than in the pre-Euro period. Murinde and Poshakwale (2004) suggested that their findings are coherent with the dynamic nature of the modification process which advocates that when markets integrate, correlations and causality are easily detectable.

Using the Granger Causality test as Murinde and Poshakwale (2004) did, Horobet and Ilie (2007) studied the driving factors of the dynamic link between exchange rates and stock prices in Romanian countries. The empirical results showed that inflation targeting, and exchange rate regimes are the driving factors of the linkage between the stock market and the exchange rate.

Adjasi et al (2008) also concluded similar variables (trade deficit, treasury bills, and inflation rate) as the determinants of the linkage of exchange rate and stock returns in the Ghanaian markets. The authors reached this conclusion under the research topic: "Effect of exchange rate volatility on the Ghana stock exchange. The research used the Ghanaian stock exchange historical data and analysed using the EGARCH model.

Using EGARCH methodology in different Latin American countries, Morales (2008) investigated how volatility spillovers were transferred among foreign exchange and stock markets. The outcomes suggested that a unidirectional flow exists in stock returns volatility and is transferred through exchange rate volatility, and it was also found that the driving factor is different in all included Latin American countries.

Lim and Sek (2014) investigated the effect of different exchange rate regimes on the relationship between exchange rates and stock returns. The authors used GARCH and Vector Autoregression (VAR) models when exploring the interrelation between exchange rate and stock returns in four Asian emerging markets that have switched their exchange rate regimes due to the fiscal crisis period in 1997. The analysis observed the impact of three macroeconomic variables on the changes in volatility during the pre-inflation targeting and post-inflation targeting periods. The empirical outcomes indicated that in both inflation targeting periods, lagged volatility of exchange rate, interest rate, international reserves, lagged volatility of stock returns, and money supply significantly influences the exchange rate volatility and stock market volatility in Thailand, Indonesia, and Korea.

Using a Dynamic Conditional Correlation (DCC) methodology, Moore and Wang (2014) studied the determinants of the dynamic correlation amid the stock return differentials relating to the US stock market and the real exchange rate in both emerging Asian markets and developed markets. The authors used a two-step methodology consisting of the (DCC) and the Ordinary Least Squares (OLS) regression. The first step derived the DCC between the real exchange rate and the stock returns, and the second step used the DCC derived as a dependent variable. The regressors chosen to explain the variations in the DCC were interest rate differentials, trade balance, and capital mobility. The results found that the main driver of the dynamic linkage between stock returns and exchange rates in Asian markets is the increasing trade balance. Some emerging economies as well as Canada in the empirical analysis revealed that exchange rate and stock returns are tied by the increased capital mobility and international trade, whereas interest rate differentials foster the correlation in the UK and Australia.

The correlations between capital flows, equity market returns, and currency value are jointly examined using daily, monthly, and quarterly data by Hau and Rey (2006) in seventeen OECD countries. Hau and Rey (2006) developed an equilibrium model and the empirical results found that the connections between equity markets and currency markets are strongest after the year 1990 in all the sample countries. Additionally, the results observed comparably stronger correlations when equity market capitalisation relative to GDP was higher. The empirical evidence suggested that the negative correlation observed is due to the risk-rebalancing theory which asserts international equity portfolio investors deport their domestic currency after selling their outperforming stocks to ensure the currency weights of the portfolio remain at the same optimal level.

Ulku et al (2016) reassessed Hau and Rey’s (2006) empirical work and argued the empirical evidence that the risk-rebalancing theory explains that the destructive relationship between currency value and equity market return differentials was not sufficient. The authors developed a model that includes extrapolative expectations as well as home wealth to assess further what Hau and Rey (2006) documented. Ulku et al (2016) panel regression revealed that the economy’s source status, that is, if the economy is a source of international capital or a receiver, is the main determinant of the association between equity market returns and currency value in addition to the equity market capitalisation relative to GDP.

In the study of the conduits through which exogenous shocks influence the dynamic connection between exchange rates and stock prices, Tang and Yao (2018) employed multivariate Granger Causality tests as well as the cointegration methodology to analyse eleven emerging markets for the period 1988 to 2014. The empirical evidence indicated that the correlation between the exchange rate and stock returns is stronger when the degree of marketisation increases, and evident under an open economy environment.

Moore and Wang (2014), Lim and Sek (2014), Tang and Yao (2018), and all the other authors included in this literature did not consider the impact of the country's level of development, including other emerging countries not limited to the Asian region and developing countries. The literature indicates that studies determined the driving factors of the association concerning exchange rates and stock returns.

However, other similar variables may influence the association between exchange rate and stock returns but are not included in the existing literature. Generalising the factors will allow policymakers and investors to identify other factors of the paper. The studies did not classify the factors into local and global segments as we intend. The segments are meant to assist policymakers and international investors in monitoring the co-movement and its direction when local or global variables deviate from the equilibrium. For this reason, this paper will determine which factors influence the dynamic connection between exchange rate volatility and stock return in developed and emerging economies, and segment them into local and global variables using a DCC-GARCH model to extract the dynamic correlation series and the dynamic panel model to test the significance of the factors.

3. METHODOLOGY

This section describes the research methodology employed in this paper. To investigate the different macroeconomic factors influencing the dynamic linkage between exchange rates and stock returns in developed and emerging economies, a two-step process is used. Firstly, the dynamic correlation amongst exchange rate and stock returns is obtained from the DCC GARCH (Dynamic Conditional Correlation – Generalised Auto-Regressive Conditional Heteroskedasticity) model. In the second step, the dynamic panel model is utilised to assess the determinants of the dynamic correlation obtained in the first step. The important contribution of this paper is in differentiating the determinants of the dynamic correlation between exchange rate and stock returns in terms of local and global factors.

The next sections will present the MGARCH models, the DCC GARCH model as well as the dynamic panel model respectively.

3.1 The Multivariate GARCH model

Contrary to univariate models, the MGARCH model offers a genuine but parsimonious specification of the variance matrix with the covariance, representing the off-diagonal elements. The MGARCH models are mostly applied in studies that assess the relations between the volatilities and co-volatilities of several markets. The models attempt to answer questions such as: Is unpredictability of a market leading to the instability of other markets? Also, the models are applied to research questions related to cross-transmission of volatilities or returns (see Bonga-Bonga, 2013). A DCC GARCH model is part of the MGARCH model.

3.1.1 DCC GARCH Model

To examine the correlation between exchange rates and stock returns in developed and emerging markets, a Vector Autoregressive Dynamic Conditional Correlation GARCH (VAR DCC GARCH) model is used. There are three phases to be estimated in a VAR DCC GARCH model. The first stage estimates the VAR model as the mean equation which examines the collaboration between exchange rates and stock returns and shows any spillovers that may be present between the exchange rates and stock returns. The second stage involves the estimation of the GARCH equations. GARCH (1,1) is estimated following the assumption by Engle and Patton (2001) that the model is suitable for stock returns. The third model estimates the time-varying correlation matrix using the covariance matrix obtained from the second phase.

The mathematical expression for the mean equation in the first stage is represented as an Autoregressive (AR (1)) model such as

$$Y_t = \theta Y_{t-1} + \varepsilon_t \qquad \text{with} \quad \varepsilon_t = \sigma_t \epsilon_i \tag{1}$$

Y_t represents countries' exchange rates or stock returns[1] and θ is an autoregressive coefficient. The error term ε_t is the product of heteroscedastic component σ_t and a white noise process ϵ_i.

The second stage estimates the univariate conditional-variance model fit for the exchange rate returns or stock returns using the error term obtained in the previous stage. The Glosten, Jagannathan, and Runkle (1993) (GJR) GARCH model is employed to account for possible asymmetric effects in the foreign exchange and stock returns. The expression of the GJR GARCH (1,1) model is as follows:

$$\sigma_t^2 = \omega + \alpha\sigma_{t-1}^2 + \beta\varepsilon_{t-1}^2 + d\varepsilon_{t-1}^2 I(\varepsilon_{t-1} < 0) \tag{2}$$

Where ω is a long-term conditional variance parameter, the lag coefficient is presented as in the equation. If the lagged error term ε_{t-1} is less than zero, the indicator $I(\varepsilon_{t-1} < 0)$ takes the value 1 and zero otherwise.

The third stage determines the time-variant conditional correlation matrix presented as follows:

$$H_t = D_t R_t D_t \tag{3}$$

D_t is a diagonal matrix made of conditional variances and R_t is a conditional correlation matrix expressed as:

$$R_t = (1 - a - b)\bar{R} + a\Psi_{t-1} + bR_{t-1} \tag{4}$$

[1] The lag is determined by AIC criteria.

These conditions are met if the parameters a and b are both positive and the inequality $a + b < 1$ holds. If a and b in the equation are equal to zero, the scalar R̄ equates to R_t. The equation below gives the value of Ψ_{t-1}, the conditional correlation:

$$\Psi_{ij,t-1} = \frac{\Sigma_{m=1}^{M} u_{1,t-m} u_{j,t-m}}{\sqrt{\left(\Sigma_{m=1}^{M} u_{i,t-m}^{2}\right)\left(\Sigma_{h=1}^{M} u_{j,t-h}^{2}\right)}} \quad (5)$$

Ψ_{t-1} is a square matrix of sample correlations compiled using shocks or the error term from the equation t = t – M, t – M +1, …, t – 1 for a detailed M. In this case M must be at least greater than N. R_t is a weighted average correlation matrix. The coefficients are acquired by exploiting the following likelihood function:

$$ln\, ln\, L = -\frac{T}{2} ln\, ln\, (2\pi) - \frac{1}{2}\Sigma_{t-1}^{T}(ln\, ln\, |D_t R_t D_t| + \varepsilon_t'(R_t)^{-1}\varepsilon_t) \quad (6)$$

3.2 Dynamic Panel Model

We utilise the Generalized Method of Moments (GMM) on the panel data with 20 countries in emerging economies and 23 in developed economies. This method of estimation fits the data with the period T (11 years) being less than the number of countries (20 and 23 countries). The GMM estimator is preferable as it is a robust estimator that considers endogeneity in the lagged variable in the case where there is a connection between the error term and the explanatory variables. The GMM estimator was improved to a two-step GMM estimator which ensures that the measurement errors, the unchecked biases in variables as well as the unobserved panel heterogeneity are eliminated.

The two-step GMM model estimator includes a lagged dependent variable, that is the lagged DCC variable, to ensure that in the static regression model, the autocorrelation factor is considered. The two-step GMM is expressed in a functional form as follows:

$$Y_{it} = aY_{i,t-1} + \beta X_{it} + \varepsilon_i + \mu_{it} \quad (7)$$

$$\Delta Y_{it} = a\Delta Y_{i,t-1} + \beta \Delta X_{it} + \varepsilon_i + \mu_{it} \quad (8)$$

where Y_{it} and X_{it} are dependent variables and independent variables, respectively. The error term $\varepsilon_{it}$is composed of the fixed term μ_i and idiosyncratic shocks ϑ_{it}. Arellano and

Bover (1995) and Blundell and Bond (1998) suggest that the estimation of Equation 8 must be differenced to get Equation 9 where Δ presents a difference operator.

An acceptable estimation output should have a significant AR1 (first-order Autoregressive model) at a 5% level of significance, and an AR2 (second-order Autoregressive model) value insignificant at 5%. Furthermore, Hansen's p-value is expected to be more than 10% but less than 30%. If these requirements are not met, the results would be unreliable. GMM uses the Hansen and Sargan test to assess if the instrument used in the analysis is dependable. In the case where the model experiences overidentifying restrictions, Hansen and Sargan regulate the restrictions to improve the results.

Our dynamic model is expressed as:

$$DCC_{it} = \alpha_i + \beta_1(DCC)_{i,t-1} + \beta_2(RINT)_{i,t} + \beta_3(MCGDP)_{i,t} + \beta_4(VIX)_{i,t} + \beta_5(GlobalGrowth)_{i,t} + \mu_i + \varepsilon_{it} \quad (9)$$

Where DCC is the dynamic conditional correlation concerning exchange rate and stock returns, RINT represents the real interest rate, Market Capitalisation to GDP ratio (MCGDP) is the Market Cap as a percentage of GDP (depth of the financial system), VIX is the global Volatility index and Global Growth is the global growth measured as the percentage change in global GDP. Furthermore, α_i is a cross-section effect and the β_i is the coefficient. ε_{it} is the idiosyncratic shock whereas μ_i represents the error term.

4. DATA, ESTIMATION, AND DISCUSSION OF RESULTS

4.1 Data

This paper assesses the determinants of the dynamic correlation concerning returns in foreign exchange and equity markets in emerging and developed economies The sample period for the variables used is monthly data from 2011-2021 for exchange rate and stock returns. The sample is chosen due to data availability. Given that GARCH models are applied to data with high frequency, the monthly data of exchange rate and stock returns are used in the first step to estimate the DCC model and obtain the dynamic correlation series. These series are converted into yearly frequency by averaging the monthly series. Such conversion is important given that the regressors used in the second step to determine the drivers of the dynamic correlation between exchange rate and stock returns have a yearly frequency.

These regressors or drivers used in the second step are divided into domestic factors and global factors. Domestic factors are those that are only specific to a country but can be influenced by external factors such as economic shocks. In this paper, the selected domestic factors are the *RINTs* and the *depth of the financial system (Market Cap as a percentage of GDP)*. It is expected that changes in domestic interest rates can affect both exchange rates and stock returns, thus their correlation. We expect the local currency to depreciate with high-interest rates and lower stock returns, hence a negative impact on the dynamic correlation between exchange rate and stock returns.

Moreover, a positive change in stock market capitalisation is expected to increase stock prices and therefore result in higher stock returns. Furthermore, the change would attract investors and cause a currency to appreciate[2], hence a negative effect on the correlation between exchange rate and stock returns.

To capture the global factors, we use two variables including global growth and VIX. Global factors are forces outside a country's control that affect each country but at different magnitudes. The volatility index as computed by the Chicago Board Options Exchange measures global risk. It is calculated to capture the overall economic uncertainty using a range of options prices from the S&P500 index. The higher the VIX the greater

[2] Given the direct quote used, positive (negative) change in local currency denotes depreciation (appreciation) of the currency.

the global risk, which can affect stock returns negatively, the consequence of the change of VIX on the exchange rate can be ambiguous given the global imbalances principle, causing appreciation to countries that receive capital flowing from riskier countries and depreciating their currency. Table A1 in the appendix presents the variables used and their sources.

4.2 Estimation and results interpretation

4.2.1 Dynamic conditional correlation between exchange rate and stock returns

In the first step of our empirical analysis, we estimated the dynamic correlation between the foreign exchange and equity markets in developed and emerging economies based on Equations 1 to 6.

The graphs displayed in Figure 1 and Figure 2 show the trend of the DCC between exchange rate and stock returns over time in developed and emerging economies respectively. The negative correlation happens when the exchange rate depreciates (appreciates) while equity returns are negative (positive).

Figure 1 shows a decline in the volatility of the dynamic correlation series in most of the countries during global and idiosyncratic crisis periods. For instance, the decrease of the correlation throughout the 2009-2012 European debt crisis may denote the co-occurrence of depreciation of currencies and negative returns in several advanced European countries triggered by the crisis. The negative of this correlation is common in advanced European countries like France, Germany, Italy, and Sweden. The same decrease is detected throughout the COVID-19 pandemic crisis.

The dynamic correlation between exchange rates and stock returns for emerging economies is erratic and depends on specific countries and regions. For example, the correlation decreases during the period 2015-2016 in several Asian emerging economies, like the Philippines, China, Malaysia, and Singapore. This period corresponds to the burst of the stock market bubble that started in June 2015 and ended in February 2016. The dynamic correlation between exchange rate and stock returns in emerging economies with stable stock exchange markets, like India and South Africa displays the same trend as most developed economies, i.e., decreasing during major global crises. In emerging economies with a weaker stock market, like Botswana and Mauritius, the correlation seems to be stable and abruptly becomes volatile during crisis periods such as COVID-19. This may be evidence that this correlation is dictated by the exchange rate that depreciates to a greater extent during global crisis periods

FIGURE 1. Dynamic correlation between exchange rate and stock returns in Developed economies

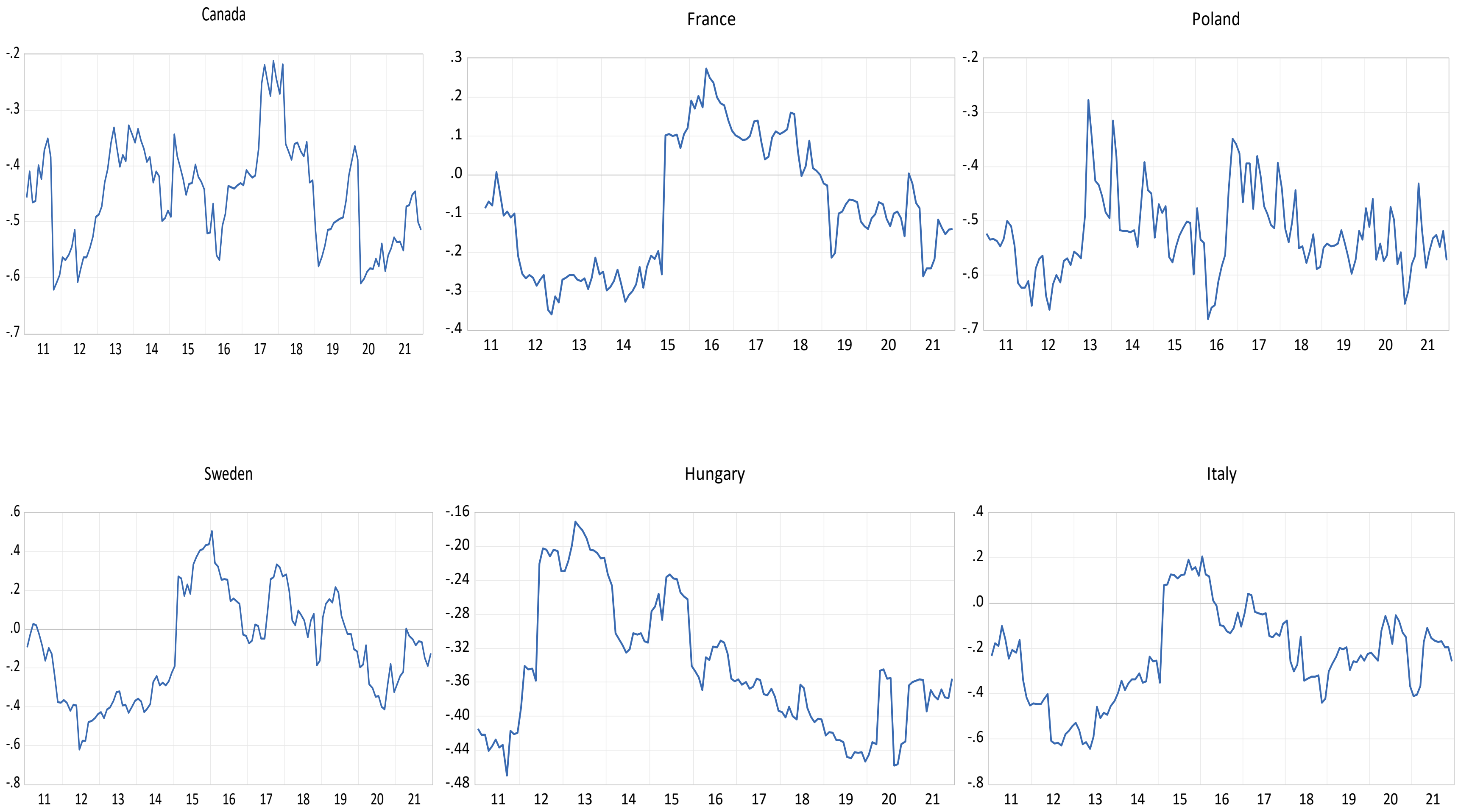


Figure 1. continued

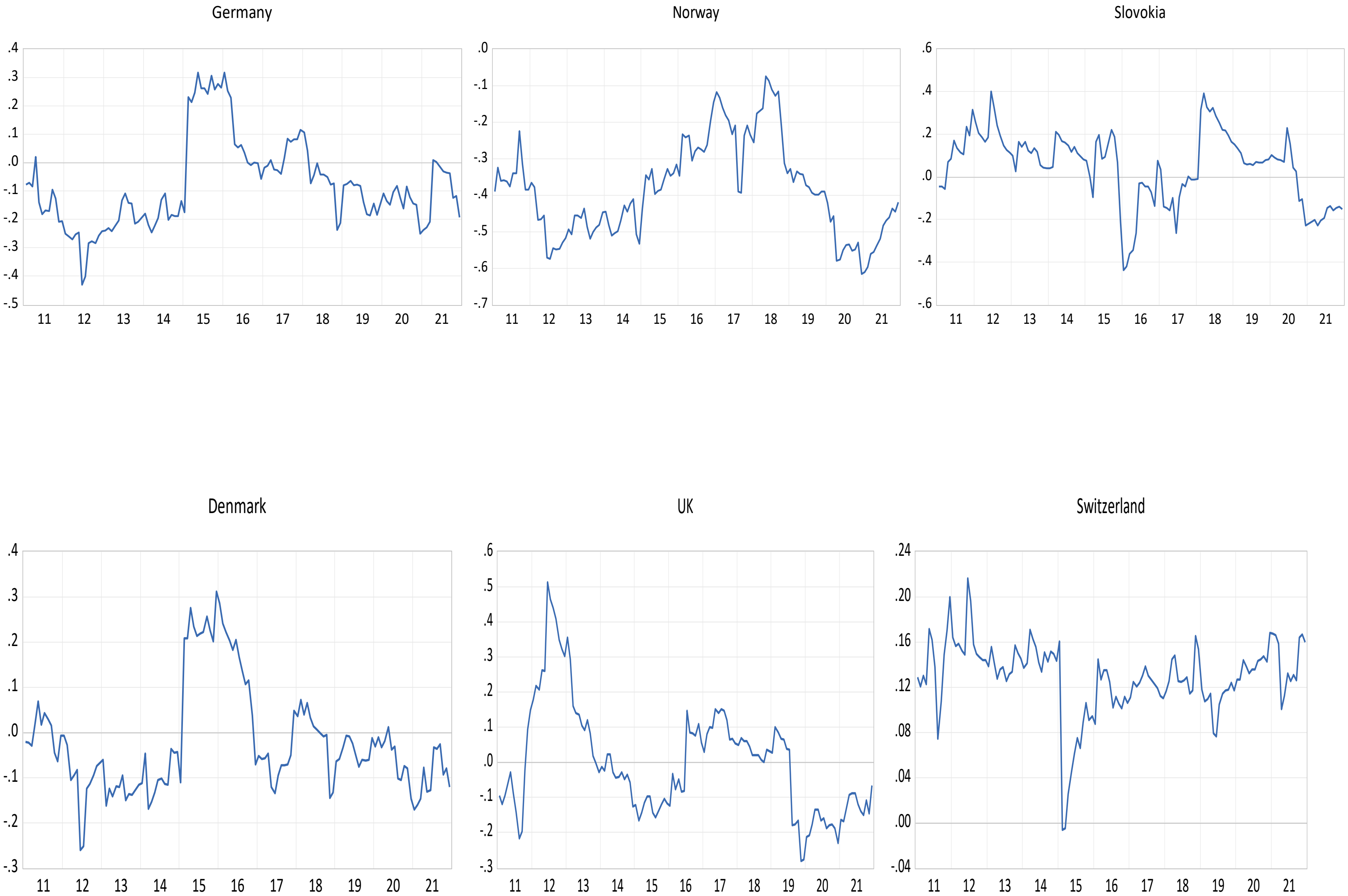


Figure 1. continued

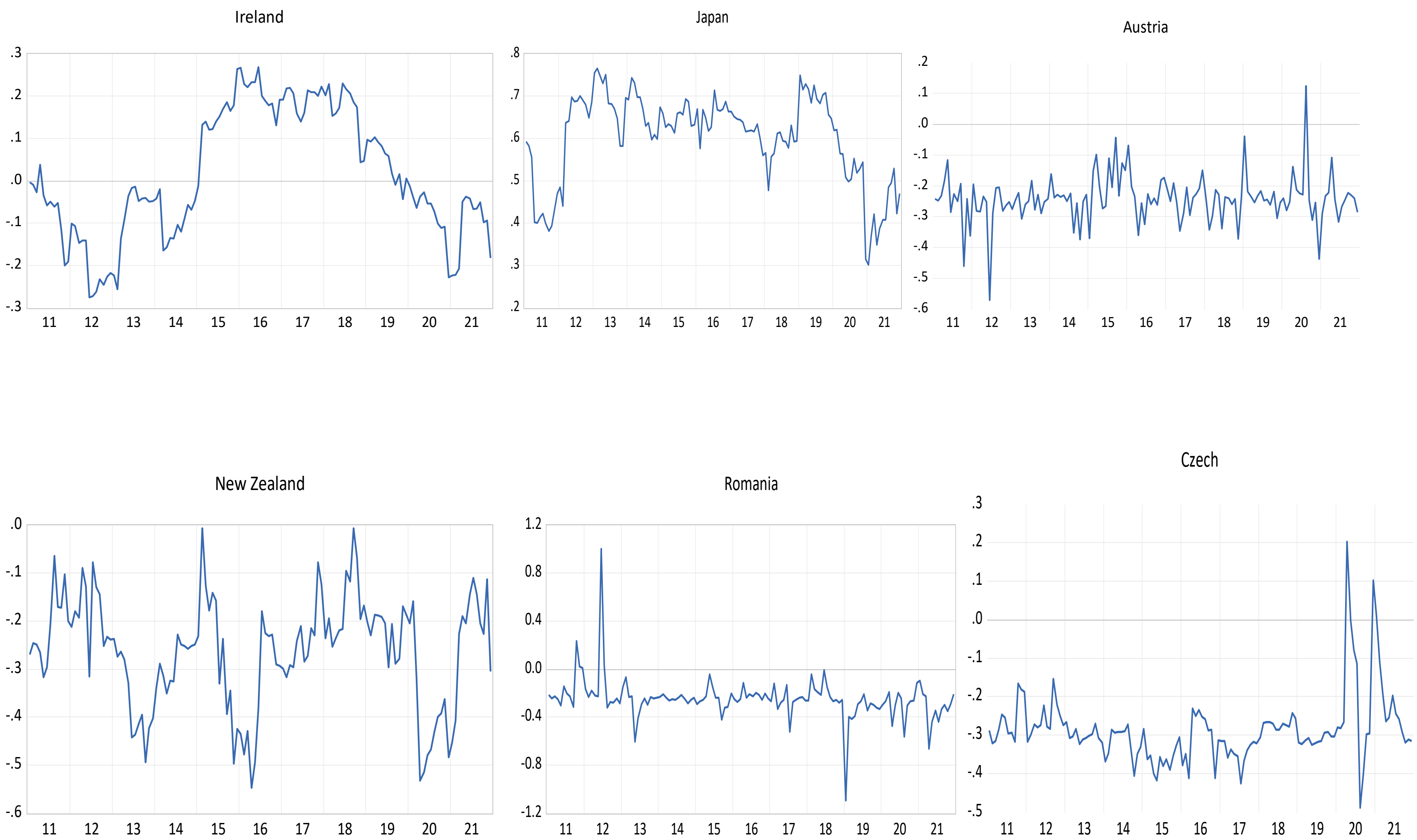


Figure 1. Continued

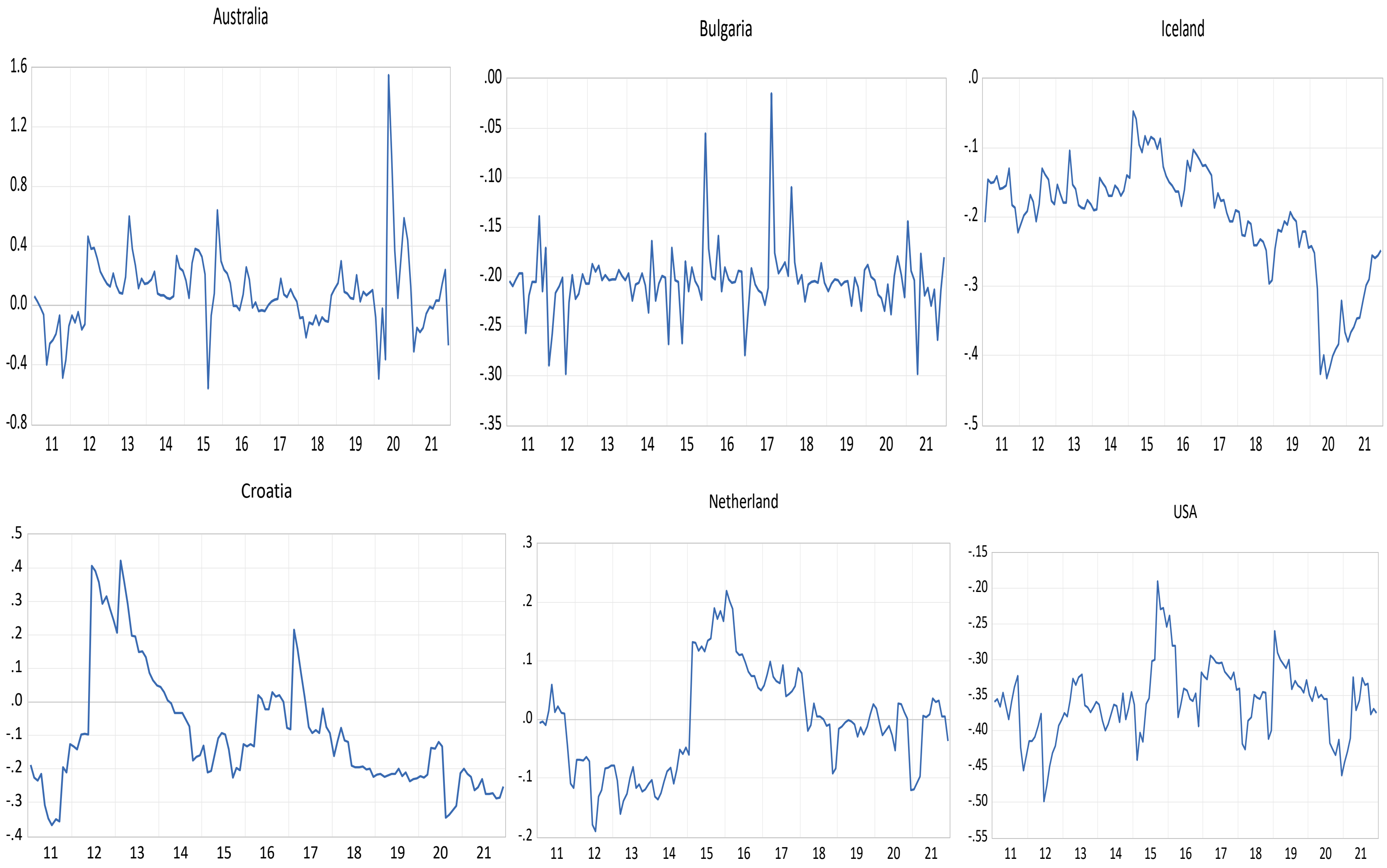


FIGURE 2. Dynamic correlation between exchange rate and stock returns in Emerging economies

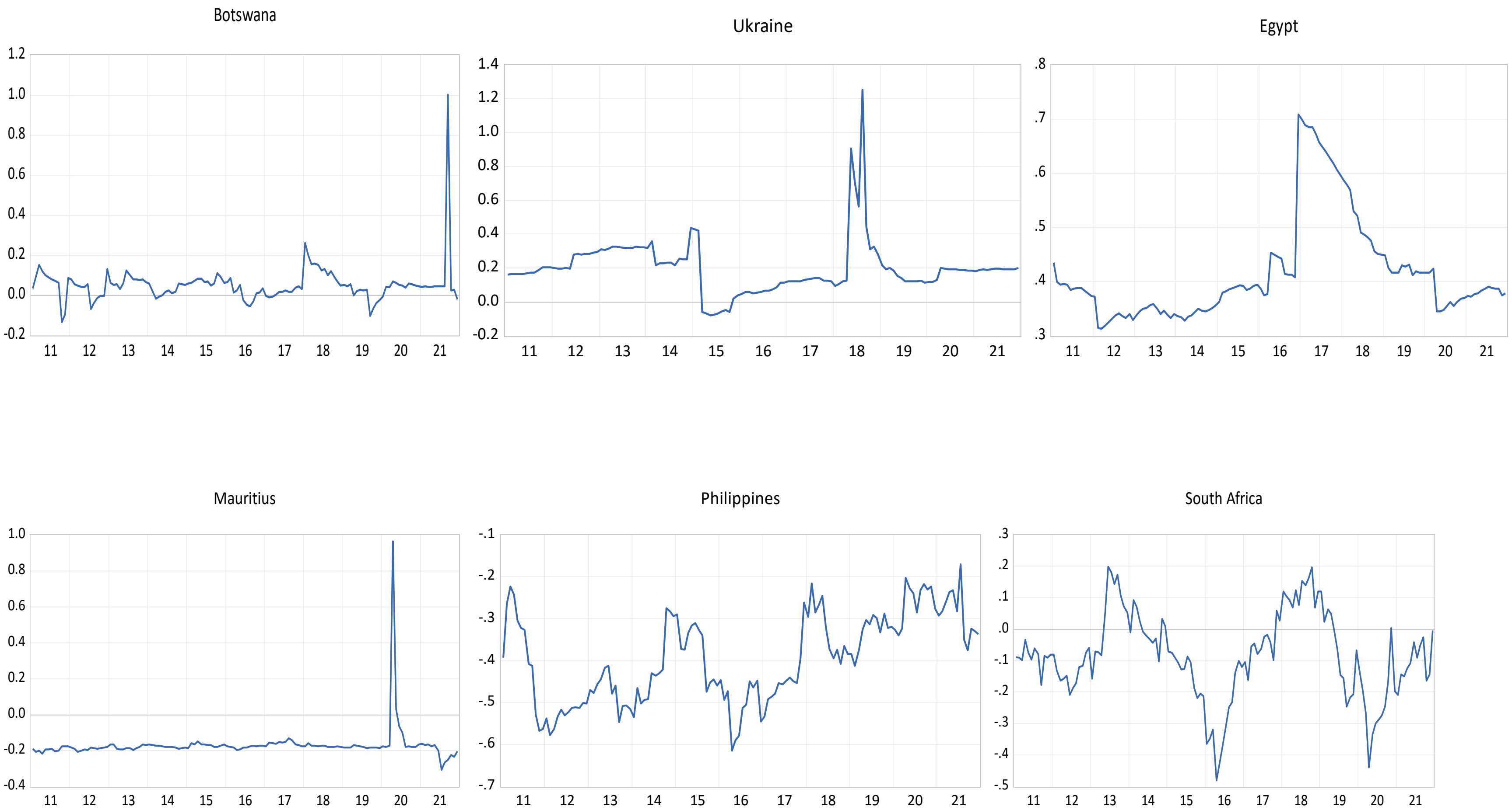


Figure 2. continued

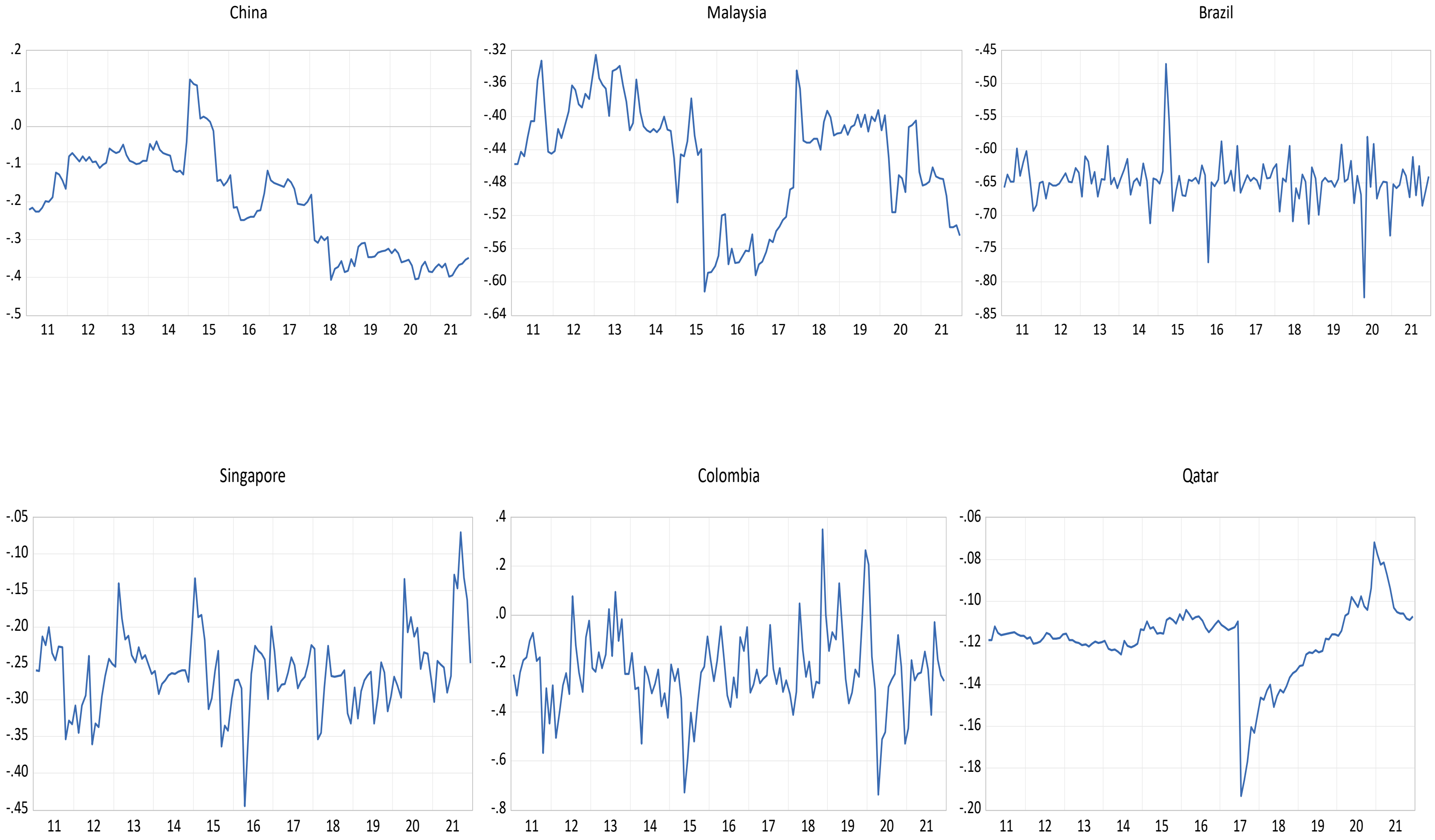


Figure 2. continued

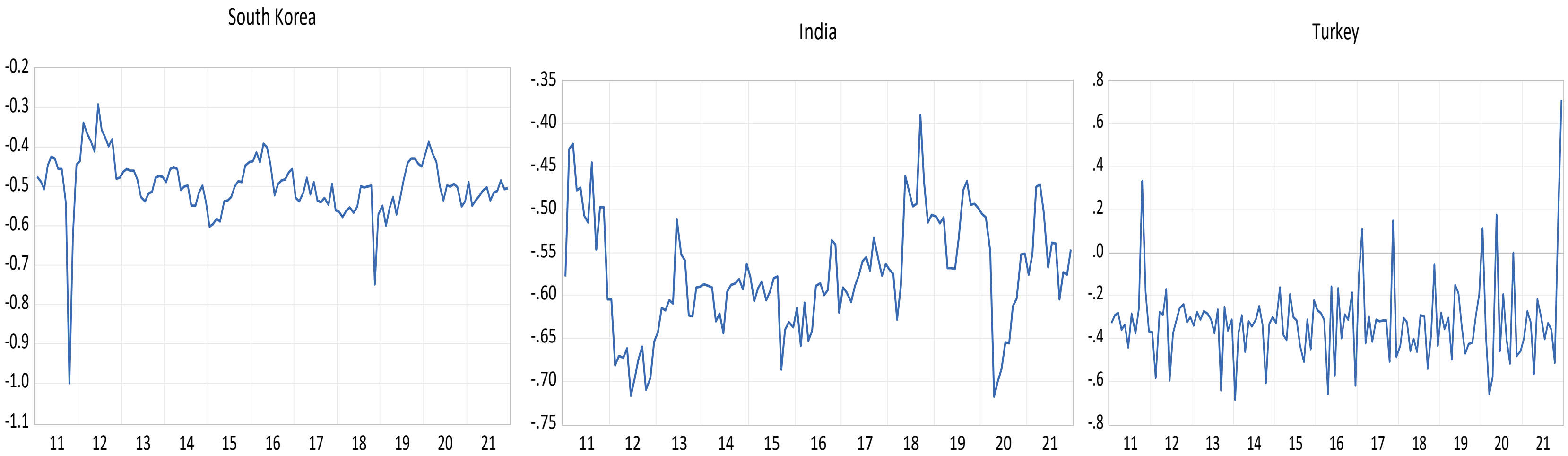
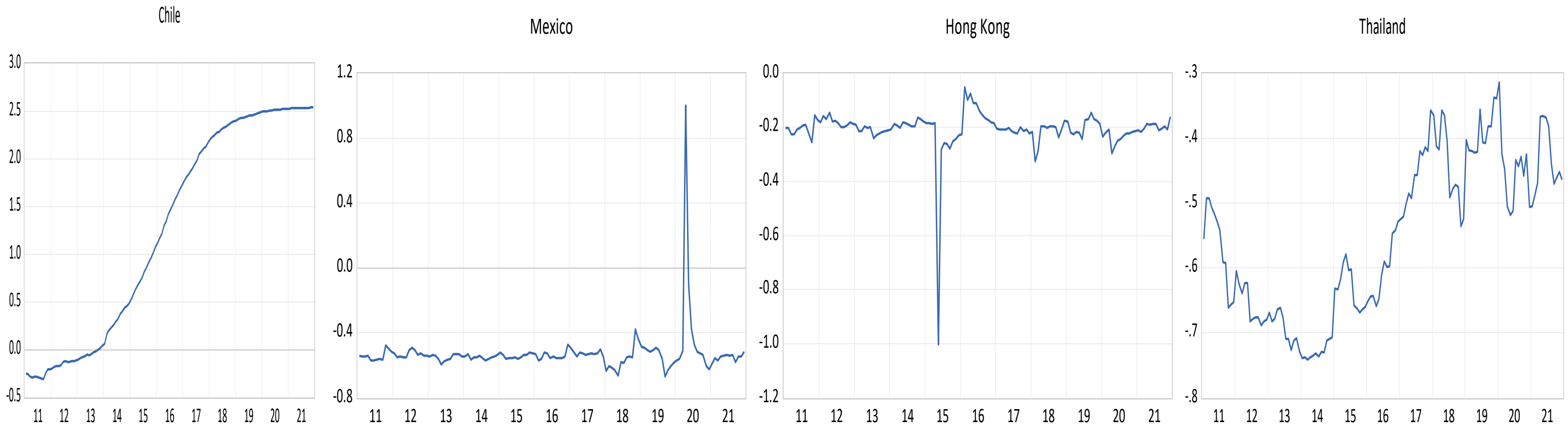


Figure 2. continued



4.2.2 Stationarity test

Before estimating the dynamic panel model represented in Equation 10, we need to ensure that all the variables do not have unit root. Unit root tests based on LLC (Levin, Lin, and Chu t*), ADF-Fisher (Augmented Dickey-Fuller,) and PP-Fisher (Phillips-Perron) tests are conducted and presented in Table 1.

Table 1. Unit root for Developed economies

Variables	**LLC test**	**ADF-Fisher**	**PP-Fisher**
DCC	-6.5720	88.0988	78.0593
	(0.00)***	(0.00)***	(0.00)***
RINT	-19.5588	149.726	176.481
	(0.00)***	(0.00)***	(0.00)***
VIX	-9.5719	201.205	201.205
	(0.00)***	(0.00)***	(0.00)***
LDCC	-6.3167	84.8197	69.0611
	(0.00)***	(0.00)***	(0.02)**
D (Market Cap To GDP)	-14.4108	153.927	201.144
	(0.00)***	(0.00)***	(0.00)***
Global GDP Growth	-9.0958	137.274	179.115
	(0.00)***	(0.00)***	(0.00)***

Note: p-values are written in parentheses, and lag periods are automatically determined by the Newey-West automatic bandwidth selection and Bartlett Kernel. *** Represents a rejection of the null hypothesis of the presence of panel unit root at a 1% significance level. All variables are tested at t level I(0).

Table 2. Unit root test for Emerging economies

Variables	LLC test	ADF-Fisher	PP-Fisher
DCC	-3.5558	85.4307	124.635
	(0.00)***	(0.00)***	(0.00)***
RINT	-3.93393	71.4850	101.135
	(0.00)***	(0.00)***	(0.00)***
VIX	-9.5719	201.205	201.205
	(0.00)***	(0.00)***	(0.00)***
LDCC	-3.36882	76.8031	114.069
	(0.00)***	(0.00)***	(0.00)***
D (Market Cap To GDP)	-8.45973	106.782	256.932
	(0.00)***	(0.00)***	(0.00)***
Global GDP Growth	-2.64911	81.1557	155.752
	(0.00)***	(0.00)***	(0.00)***

Note: p-values are written in parentheses, and lag periods are automatically determined by the Newey-West automatic bandwidth selection and Bartlett Kernel. *** Represents a rejection of the null hypothesis of the presence of panel unit root at a 1% significance level. All variables are tested at the level I(0).

From the results depicted in Tables 1 and 2, we can rule out the absence of a unit root across the panel in the MCGDPs variable after the first difference at a 1% level of significance in both emerging and developed countries. In fact, all the unit root tests described in Tables 1 and 2 reject the null hypothesis of unit root and confirm that all the series are stationary.

To preliminarily assess the link between all the variables, dependents and independents in Equation 11, we conduct the Pearson correlation test. The findings reported in Table 3 show a negative connection between DCC and MCGDPs, VIX, and global growth. Furthermore, VIX is negatively correlated with all the other variables, while RINT has a negative relationship with Lagged DCC (LDCC), market capitalisation to GDP, VIX, and global growth. Table 4 reports that both DCC and LDCC exhibit a negative connection between RINTs and market capitalisation to GDP.

4.2.3 Correlation Matrix

Table 3. The Pearson correlation test for Developed countries.

Variables	DCC	LDCC	RINT	D (Market Cap to GDP)	VIX	Global Growth
DCC	**1.000**					
LDCC	**0.8912**	**1.000**				
RINT	**0.0201**	**-0.0043**	**1.000**			
D (Market Cap to GDP)	**-0.0003**	**-0.0142**	**-0.0213**	**1.000**		
VIX	**-0.0772**	**-0.0426**	**-0.0733**	**-0.0396**	**1.000**	
Global Growth	**-0.0693**	**0.0112**	**-0.2190**	**0.0840**	**-0.2721**	**1.000**

Table 4. The Pearson correlation test for Emerging countries

Variables	DCC	LDCC	RINT	D (Market Cap to GDP)	VIX	Global Growth
DCC	**1.000**					
LDCC	**0.9772**	**1.000**				
RINT	**-0.2069**	**-0.2150**	**1.000**			
D (Market Cap to GDP)	**-0.0352**	**-0.0235**	**0.0013**	**1.000**		
VIX	**0.0349**	**0.0630**	**0.0139**	**0.0664**	**1.000**	
Global Growth	**0.0448**	**0.0326**	**-0.1906**	**-0.1112**	**-0.2721**	**1.000**

4.2.4 Estimation of the Dynamic Panel Model

The findings of the estimation of Equation 9 for both the developed countries and emerging countries are reported in Table 5. The Arellano-Bond serial correlation tests presented at the bottom of each table give the diagnostic test at a 5% level of significance and indicate that the serial correlation between the residuals test rejects the null hypothesis of the presence of serial correlation in the error term (AR(1)) with the p-value equal to 0.003 in developed countries and 0.009 in emerging markets and concludes that there is no serial correlation in both groups, but further indicates the presence of serial correlation in the second lag (AR(2)) as expected. The Hansen over-identification tests the instruments used and the lagged variables included in the model at a p-value greater than 10% but less than a 30% level of significance. The Hansen p-value in developed countries equates to 0.212 and 0.298 in emerging markets, which both fall within the range specified.

The LDCC in Table 5 with a coefficient value of 0.3906 in developed countries and 1.0550 in emerging countries is significant with the p-values of 0.033 and 0.001 respectively. This confirms the dynamic nature of the model and the high persistence of the dynamic correlation, especially for emerging economies. Other significant drivers in developed countries are VIX with a coefficient of -0.0039 and a p-value of 0.019, Global Growth with a coefficient of -0.0056 and a p-value of 0.002, and the market capitalisation to GDP with a coefficient of 0.0002 and p-value of 0.032. The rest of the variables do not significantly influence the dynamic conditional correlation between exchange rate and stock returns in the selected sample of developed economies as per our data analysis. The significant variables are from both categories, that is, Global Growth and VIX are the global variables and the MCGDP is a domestic variable. The results suggest that the drivers of the exchange rate–stock returns nexus in developed economies only exclude the RINT. On the other hand, in addition to VIX and LDCC, emerging countries' DCC is significantly influenced by the RINT with a coefficient of 0.0015 and a p-value = 0.090. Therefore, emerging countries' DCC is also driven by both domestic and global factors.

Furthermore, the interest rate recommends that the correlation is robust to financial integration in emerging countries. This further reflects the unrestricted capital mobility in emerging markets. The negative interest rate coefficient implies that with a high-interest rate, stock returns decline, hence the exchange rate depreciates. This supports the allegations of the portfolio approach to exchange rate determination, that the exchange rate is affected by stock prices through the demand for money (Phylaktis and Ravazzolo, 2005).

In emerging economies, explanations are provided for the latter by the degree of capital market integration with other countries including the US market. This emphasises how sensitive emerging financial markets are to the volatility of interest rates and the volatility index. The volatility index is also known as the fear index or the uncertainty index. A positive change in the volatility index would cause a reduction in the stock demand, hence a decline in the stock returns. The currency demand would also decrease due to less investment and further result in currency depreciation, hence exchange rate appreciation. For this reason, VIX has a negative influence on the correlation between exchange rates and stock returns in both emerging and developed countries. Policymakers are advised to watch the RINTs in emerging countries. Any changes in the RINT will have an inverse impact on the correlation between the exchange rate and stock returns.

Global Growth suggests higher future investment returns to portfolio investors. Consequently, when the global economy improves, portfolio investors would demand more stocks and other products, and hence the stock returns increase. Furthermore, investors would demand more currency to acquire more stocks which will result in currency appreciation, and therefore exchange rate depreciation. The impact of global growth on the dynamic correlation between exchange rate and stock return is therefore negative.

The depth of the financial market increases with an increase in market capitalisation. A rise in market capitalisation would result in more stocks and demand for stocks, hence higher stock returns. In addition, the ratio has GDP as a denominator, and if the market capitalisation to GDP ratio increases, the GDP would have relatively declined or increased slower than the market capitalisation. Slower GDP growth or a decline in GDP relates to currency depreciation, hence exchange rate appreciation. In this case, the market capitalisation to GDP ratio has a positive influence on the dynamic correlation between exchange rate and stock returns.

The global growth economic indicator is calculated using the world aggregate GDP including all the developed, emerging, and developing countries. Considering that developed countries have higher GDPs, the global growth value would be high, and the emerging economies would barely be affected by this value, hence there would be no effect on the emerging countries' dynamic correlation between exchange rate and stock returns.

Table 5. Results of the estimation of the drivers of the correlation between exchange rate and stock returns using the Two-step system GMM

	Developed Countries	Emerging Countries
Variable	Coefficient (P-value)	Coefficient (P-value)
DCC L1	0.3906 (0.000) ***	1.0550 (0.000) ***
VIX	-0.0039 (0.019) **	-0.0021 (0.011) **
Global Growth	-0.0056 (0.002) ***	0.0018 (0.281)
MCGDP	0.0002 (0.032) **	-0.00004 (0.455)
Interest Rate	-0.0023 (0.537)	0.0015 (0.090) *
CONS	0.0631 (0.030) **	0.0466 (0.020) **
AR (1) Pr > z	0.003 ***	0.009 ***
AR (2) Pr > z	0.749	0.876
Hansen test Prob > chi2	0.212	0.298

Table 6 estimates the same data using a One-step Difference GMM model as a robustness test. The empirical results also show a significant lagged DCC with coefficients equal to 0.1407 and 0.4374, and p-values of 0.033 and 0.040 in developed and emerging countries respectively. VIX is also ruled significant with a p-value of 0.000 in developed countries and 0.059 in emerging countries. An additional significant driver in emerging economies is the RINT with a coefficient of 0.022693 and a p-value of 0.098. Developed countries' other correlation drivers include market capitalisation to GDP and global growth. The robustness test gives the same conclusion as our model; hence our model is reliable.

4.2.5 Robustness Test

Table 6. Results of the estimation of the drivers of the correlation between exchange rate and stock returns using the One-step difference GMM

	Developed Countries	Emerging Countries
Variable	Coefficient (P-value)	Coefficient (P-value)
DCC L1	0.1407 (0.033) **	0.4374 (0.040) **
VIX	-0.0037 (0.000) ***	-0.0036 (0.059) *
Global Growth	-0.0034 (0.000) ***	0.0036 (0.901)
MCGDP	-0.0003 (0.034) **	0.00002 (0.906)
Interest Rate	-0.0020 (0.428)	0.00014 (0.084) *
CONS	0.0588 (0.021) **	0.0218 (0.014) **
AR (1) Pr > z	0.007 ***	0.018***
AR (2) Pr > z	0.171	0.330
Hansen test Prob > chi2	0.192	0.214

Emerging economies' correlation concerning exchange rate and stock returns is determined by VIX but not the global growth as opposed to developed economies. The results suggest that emerging economies' correlation is influenced by only negative contagion from the global economy.

5. CONCLUSION

This paper assesses the dynamic correlation between exchange rates and stock returns in emerging and developed economies. Moreover, the paper attempts to determine the drivers of this correlation by distinguishing between domestic and global drivers of this correlation. The paper makes use of a two-step estimation to this end. In the first phase, the MGARCH-DCC models are utilised to capture the dynamic correlation between exchange rate and stock return. The second step employs a dynamic panel data model to assess the determinants of the correlation.

The paper finds that the dynamic correlation between exchange rates and stock returns for emerging economies is erratic and depends on specific countries and regions. For example, the correlation decreases during the period 2015-2016 in several Asian emerging economies like the Philippines, China, Malaysia, and Singapore. This period corresponds to the burst of the stock market bubble that started in June 2015 and ended in February 2016. The dynamic correlation between exchange rate and stock returns in emerging economies with stable stock exchange markets, like India and South Africa, displays the same pattern as in developed economies. Regarding developed economies, the paper finds a decline in the volatility of the dynamic correlation series in most of the countries during global and idiosyncratic crisis periods. For example, the decrease of the correlation during the 2009-2012 European debt crisis may denote the co-occurrence of depreciation of currencies and negative returns in several advanced European countries triggered by the crisis. The negative of this correlation is common in advanced European countries like France, Germany, Italy, and Sweden. The same decrease is observed in the COVID-19 pandemic crisis.

On the determinants of the correlation between exchange rate and stock returns, the paper finds that dynamic conditional correlations are determined by domestic and global variables in developed economies. For example, global volatility negatively affects the correlation between exchange rate and stock returns. This is because global volatility increases stock returns (negative sign) and depreciates exchange rates (positive sign) in developed economies. However, only very few global variables, like global volatility, affect the correlation in emerging economies.

The findings of this paper provide useful insights for investors and portfolio managers who intend to select the two assets, currency and stocks, in their portfolio. The sign of the correlation between the two assets provides investors and portfolio managers with the knowledge on when to use the two assets to diversify their portfolio. Moreover, knowing how domestic and global variables affect this correlation, investors and portfolio managers can anticipate the movement of the two assets for possible rebalancing of their portfolio.

The negative interest rate coefficient implies that with a high-interest rate, stock returns decline, hence the exchange rate depreciates. This implies that when interest rate increases, portfolio managers in emerging markets should invest more in the foreign exchange market rather than the stock market as currency will appreciate. In the case of VIX, investors that are not risk-averse in both developed and emerging countries should focus on investing in equity. Investors would demand more currency to acquire more stocks which will result in currency appreciation when there is global growth in developed countries and stock returns will increase, hence they should consider balancing between the two assets. Additionally, slower GDP growth or a decline in GDP relates to currency depreciation, hence exchange rate appreciation in developed countries corresponds to increased depth of financial markets, portfolio investors should reduce finds allocated to equity investment.

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APPENDIX

Table A1

VARIABLE	DESCRIPTION	SOURCES
Exchange rate	The price of a local currency relative to the US Dollar	International Financial Statistics (IFS)
Stock returns	The percentage return from an investment is measured as the percentage change in a stock price and mathematically expressed as: $$SR_t = \frac{SP_t - SP_{t-1}}{SP_{t-1}}$$ Where SR is the stock return and SP is the stock price.	Yahoo Finance and Investing.com
Dynamic conditional correlation	A conditional correlation between exchange rate and stock returns	International Financial Statistics (IFS), Yahoo Finance, and Investing.com. Student-generated using STATA 14.2 software
Market Capitalisation	The total value of a company's stock shares is calculated as the number of outstanding shares multiplied by their share price.	The Global Economy

RINT	1-Month RINT, Percent, Annual, Not Seasonally Adjusted. RINT measures the lending interest rate or cost of borrowing adjusted for inflation and calculated using the GDP deflator.	Federal Reserve Economic Data from the economic research division at the Federal reserve bank of St. Louis
Volatility Index (VIX)	Measures the volatility of the stock market or the perceived riskiness of investing in the stock market.	The Global Economy
Global economic growth	Measured as the annual percentage growth rate of the gross domestic product at the global level at market prices anchored by the constant 2010 US Dollar.	World development indicators from IMF