Cross-border capital flows and information spillovers across the equity and currency markets in emerging economies

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Abstract

This paper presents a novel perspective on the interaction between equity and currency markets in emerging market economies (EMEs) by (i) examining the nonlinear effects of capital flows on return spillovers between the stock and currency markets in a sample of twelve EMEs via quantile causality tests that capture the quantile specific interactions, and (ii) providing a comparative analysis of the influence of debt versus equity flows over the spillover patterns. We show that the causal effects of international debt and equity flow on return spillovers across the equity and FX markets are largely concentrated at lower quantiles, suggesting that the arrival of information via capital flows tends to ease shock transmissions across these markets. At the same time, international flows are found to facilitate the propagation of shocks in the direction of the currency market from the equity market, in line with the portfolio rebalancing hypothesis wherein equity market fluctuations lead to a subsequent correction in the currency market. The findings have important implications for investors and policymakers regarding the role of international capital flows as a facilitator of informational spillovers in emerging equity and currency markets.

Keywords: Capital flows, Emerging markets, Connectedness, Quantile causality.
JEL Codes: C22, F30, G15.

1. Introduction

Emerging market economies (EMEs) have undergone an enormous process of liberalization and integration over the last three decades that has entailed, among other outcomes, an increase in foreign capital flows accompanied by an increase in average annual real economic growth by circa 1% (e.g. Bekaert et al. 2002b; Bekaert et al. 2005).[1] While capital flows to EMEs bring in potential investment and growth benefits, on the flip side, they expose EMEs to costs associated with financial instability and risks associated with capital reversals (e.g. Prasad et al. 2003; Henry, 2006). As the EMEs opened their markets to cross-border portfolio flows and steadily shifted from a pegged to a more flexible exchange rate regime, foreign exchange (hereafter FX) fluctuations have become more prevalent due to the increased activity of foreign investors who are often considered to influence the prices of financial assets in the EMEs (e.g. Froot et al. 2001; Bekaert et al. 2002b; Bathia et al. 2020).

Given the significance of international capital flows to EMEs due to their extensive financing needs to sustain economic growth, large and abrupt movements in cross-border capital flows can create major turbulence both in the FX and stock markets of these countries, either via the propagation of uncertainty shocks facilitated by credit markets (e.g. Christiano et al. 2014; Caldara et al. 2016) or the theoretical underpinnings linking the stock and currency markets (Liu et al., 2020). Therefore, it becomes imperative to assess the role played by the cross-border capital flows on the interactions between the stock and FX markets, as instability in these markets could have important repercussions on the effectiveness of monetary policy and growth stability in developing nations. The main contribution of this paper is to provide a novel perspective on the role of capital flows in information spillovers between the stock and FX markets from a set of twelve major EMEs via a quantile-based model that accounts for nonlinearities in the causal relationships.[2] By

[1] In this respect, Bekaert et al. (2002a) argue that financial market integration is associated with a lower cost of capital, improved credit rating and real exchange rate appreciation.

[2] Valseth and Jorgensen (2011) define information spillovers as: "… when market specific information, defined as information that directly affects the returns or volatility in one market only, indirectly affects returns or volatility in other markets through some channels of transmission". Fleming et al. (1998) argue that return and volatility spillovers

doing so, we aim to enlarge our understanding of the role of cross-border capital flows as a possible facilitator of possible shocks across the stock and FX markets which is an important consideration from both an investment and policymaking perspective.

Previous studies highlight the role of capital flows in the exchange rate-stock returns nexus via their effect on macroeconomic factors that affect investment and real economic activity (e.g. Wong, 2017; Dahir et al. 2018). In a recent study, Salisu and Vo (2021) show that stock returns respond differently to exchange rates in high and low-interest rate market settings, opening a possible channel that links credit conditions to the stock-currency market nexus. In our application, as a proxy for capital flows, we study the relative roles of equity and bond flows as this approach is supported by Ananchotikul and Zhang (2014) who highlight the differences in the dynamics of equity and bond flows as a result of market conditions (e.g. the great financial crisis of 2007-09).[3] The motivation to study the two components of international flows was also derived from Chuhan et al. (1998) who distinguish between different types of capital flows in order to account for the variation in the determinants of these flows.[4] Further supporting these findings, more recently, Bathia et al. (2020) find that both equity and debt flows in the EMEs possess incremental information over stock market returns and volatility that is not captured by the aggregate capital market risk factors.

In the context of EMEs, the literature documents that both equity and debt flows bring substantial benefits to the recipient economies which in turn can create a channel that facilitates spillover effects across the FX and stock markets. For instance, capital flows in the foreign sovereign debt market are shown to enhance investments (Williams, 2018) as well as economic

are the two main types of information spillovers where changes in return in one market trigger changes in return in other markets, while volatility spillovers refer to the transmission of volatility across markets.

[3] The authors point out that equity flows to EMEs declined sharply prior to the Bear Sterns collapse in mid-March 2008, while bond flows remained unaffected. However, after the Lehman Brothers' collapse in September 2008, equity flows remained relatively stable, though, bond flows reversed sharply. With the initiation of the QE tapering in May 2013, investors retrenched from both emerging bond and equity markets to similar degrees.

[4] Chuhan et al. (1998) assess the importance of global factors as well as country-specific factors in explaining equity and debt flows. Specifically, they find that equity flows are generally more sensitive to global factors whereas bond flows are more sensitive to a country's credit rating and secondary market debt price.

growth (Igan et al. 2020). Specifically, Williams (2018) notes that the entrance of foreign institutional investors into the domestic sovereign debt market aids domestic financial institutions to sell excess debt and use the proceeds to extend credit. This, in turn, facilitates firm-level investments through improved funding conditions, opening a possible channel to stock returns. In fact, Igan et al. (2020) find that capital inflows are likely to increase credit availability and reduce interest rates, thereby contributing to disproportionately faster growth of external finance dependent industries. Similarly, Calomiris et al. (2021) demonstrate the importance of equity inflows for real economic activity as they find that equity inflows into EMEs are associated with higher values of country-level equity issuance proceeds, subsequently leading larger firms to increase corporate investment.

The empirical literature including Brooks et al. (2004) and Hau and Rey (2006), among others, establishes a link between portfolio flows and exchange rate fluctuations, while Combes et al. (2012) find that inflows of capital are associated with an appreciation of the real effective exchange rate. In a study that is more related to our focus, Jongwanich and Kohpaiboon (2013) further highlight that the composition of capital inflows matters in determining the impact of flows on real exchange rates. Therefore, against this background and considering the evidence in Davis (2014) that an exogenous increase in debt inflows leads to a significant increase in GDP, inflation and stock prices, in addition to equity flows, we also test for a relationship between bond flows and equity-currency market interactions to determine the extent of information spillovers between these two markets.

Motivated by the evidence in Cerutti et al. (2019) that sensitivity to capital flows differs across EMEs and for different types of flows, the central goal of this paper is to provide a new perspective on the impact of cross-border portfolio flows on information spillovers between financial markets in EMEs by (i) examining the nonlinear causal effects of cross-border capital flows on return connectedness of the stock and FX markets in a set of twelve major EMEs via the causality-in-

quantiles technique of Balcilar et al. (2016); and (ii) providing a comparative analysis of the explanatory role of debt versus equity flows over the connectedness patterns between equity and FX markets. Market connectedness in our application is measured by the magnitude of return spillovers between the stock and FX markets in each EME, a widely used indicator of cross-market interdependence based on the connectedness framework of Diebold and Yilmaz (2012). In essence, this approach allows us to explore whether the effect of international investment flows is the same under various market states that describe the strength and direction of informational transmissions across the stock and FX markets. Hence, this analysis presents a more nuanced picture of the nexus between foreign capital flows and interconnectedness between stock and FX markets. To the best of our knowledge, this is the first study to investigate the linkage between the stock and FX markets in the context of cross-border debt and equity flows and to combine the causality-in-quantiles test of Balcilar et al. (2016) and the Diebold-Yilmaz connectedness approach, which have been widely employed in different settings in the recent literature.

Our findings show that the causal effects of international debt and equity flows on return spillovers across the equity and FX markets of EMEs are predominantly concentrated at lower quantiles of connectedness. We argue that the arrival of information via capital flows tends to ease shock transmissions across these markets as it helps to dissipate informational asymmetries and/or market uncertainty. In contrast, we observe largely insignificant causality running from capital flows at higher connectedness quantiles. At the same time, international flows are found to facilitate the propagation of shocks from the stock to the currency market in most EMEs, in line with the portfolio rebalancing hypothesis according to which equity market fluctuations lead to a subsequent correction in the FX market. The results imply that investors and policymakers in EMEs should pay special attention to the dynamics of cross-border debt and equity flows as a facilitator of shock transmissions from the stock to the currency markets in EMEs. This casts serious doubts as to the effectiveness of hedging strategies against exchange rate risks in these

markets as the spillover effects facilitated by international flows can pose a double challenge for both domestic and global investors.

The rest of the paper is organized as follows. Section 2 provides a brief review of the relevant related literature. Section 3 presents the empirical methodology, while Section 4 describes the dataset. Section 5 discusses the main empirical findings. Finally, Section 6 offers some concluding remarks and practical implications for economic agents.

2. Literature review

This paper is related to the strands of the literature that deal with (i) the linkage between the stock and FX markets and (ii) the impact of cross-border capital flows on emerging markets. As regards the first strand, there is an extensive body of research on the nexus between the stock and currency markets in both developed and emerging countries based on a wide variety of empirical approaches. Earlier studies in this literature utilized standard correlation and regression analysis (Aggarwal, 1981; Solnik, 1987; Jorion, 1990) as well as traditional linear cointegration and Granger causality tests (Bahmani-Oskooee and Sohrabian, 1992; Abdalla and Murinde, 1997; Granger et al. 2000; Phylaktis and Ravazzolo, 2005). The increased market turbulence associated with the global financial crisis of 2008-2009 bolstered a renewed interest in detecting possible nonlinearities in the relationship between stock and currency markets. More sophisticated techniques, such as the nonlinear autoregressive distributed lag (NARDL) approach (Bahmani-Oskooee and Saha, 2016; Cuestas and Tang, 2017), nonlinear Granger causality tests (Kumar, 2009; Xie et al. 2020), quantile regression (Tsai, 2012; Yang et al. 2014), wavelet analysis (Andrie et al. 2014; Afshan et al. 2018), copula functions (Ning, 2010; Wang et al. 2013; Reboredo et al. 2016) and regime-switching models (Chkili et al. 2011; Chkili and Nguyen, 2014) have also been employed in this context.

More strongly tied to our empirical methodology, Qin et al. (2018) and Fernández-Rodríguez and Sosvilla-Rivero (2020) have applied the Diebold and Yilmaz (2012) connectedness measure to quantify information spillovers between the FX and stock markets of a number of major

economies. Despite their considerable heterogeneity, a common feature in all the above-mentioned works is that they address the link between equity and FX markets without considering the possible impact of credit conditions, captured by cross-border capital flows, that are shown to facilitate the propagation of shocks (e.g. Christiano et al. 2014; Caldara et al. 2016).

The economic perspective that motivates our study is provided by Hau and Rey (2006), who develop an equilibrium model that induces a systematic negative relationship between equity and currency returns via portfolio rebalancing caused by the inability of investors to fully hedge exchange rate risk present in their portfolios. Accordingly, investors reduce their foreign equity positions following a gain in value to mitigate exchange rate risk by diverting funds towards domestic equities. This leads to capital outflows and the consequent depreciation of the foreign currency. However, a weakness of this approach is that it ignores the high positive correlation typically observed across global equity markets. In this regard, Cho et al. (2016) provide an explanation of the degree of correlation between stock and currency markets of developed and emerging countries based on cross-border capital movements driven by the flight-to-quality phenomenon. In this setting, capital tends to move out of emerging into developed countries during global downturns, leading to a depreciation of emerging currencies and an appreciation of developed currencies. This mechanism results in a positive correlation between equity and FX markets in emerging nations and a negative correlation in the case of developed economies, which are amplified by the magnitude of capital flows.

A strand of research more directly linked to the main focus of this paper investigates the influence of movements in portfolio capital flows on the degree of connectedness across stock and FX markets. For instance, Akyüz (1993) argues that the entry of cross-border capital flows into domestic financial markets can give rise to a stronger association between stock and currency markets, thus increasing the likelihood of the emergence of FX and/or stock market crises in emerging countries. Along the same line, Singh and Weisse (1998) contend that, among other factors, the destabilizing interactions between the FX and stock markets due to economic shocks

caused by foreign capital flows may lead to greater instability, damaging industrialization and long-term economic growth of less developed countries. More recent applications that are tangentially related to our study include Bathia et al. (2020) and Ordu-Akkaya and Soytas (2020) who examine the effect of capital flows in different contexts. Distinguishing between equity and debt flows, Bathia et al. (2020) show that both debt and equity flows possess incremental information over stock returns and volatility even after controlling for the aggregate capital market risk factors. Separately, Ordu-Akkaya and Soytas (2020) find that cross-border capital flows significantly strengthen the connectedness across stock and commodity markets for most countries in their sample which includes G7 and the top ten emerging economies. We extend these studies to a novel context by analyzing the causal links running from foreign capital flows to the degree of stock-FX market connectedness in a group of major emerging countries via a quantile-based causality method and by distinguishing between equity and debt flows.

3. Econometric framework

The econometric framework adopted in this study consists of two parts. First, the spillover index approach developed by Diebold and Yilmaz (2012) is utilized to quantify return spillovers across the stock and foreign exchange markets of each EME. Second, the causality-in-quantiles test of Balcilar et al. (2016) is used to assess whether debt and equity flows in each economy have a significant causal effect on the return spillovers across the stock and currency markets at different quantiles representing the strength and direction of connectedness.

3.1 Diebold-Yilmaz connectedness method

The spillover index approach of Diebold and Yilmaz (2012) is built on the generalized version of the variance decomposition of forecast errors of a VAR system proposed by Koop et al. (1996) and Pesaran and Shin (1998). This method provides a useful framework to measure the magnitude and direction of spillovers between various assets and markets. The key advantage of the Diebold-

Yilmaz model is that its results are insensitive to the ordering of the variables in the VAR process.[5] As it is broadly accepted in the financial econometrics literature, the variance decomposition tools enable us to efficiently measure the impact of shocks in one variable on the other variables in the system. In particular, the Diebold-Yilmaz methodology is founded on the *H*-step ahead forecast error variance decomposition. The proportion of the forecast error variance of the *i*th variable that is due to shocks to the *j*th variable for a given forecast horizon *H*, with $i \neq j$, is formulated as:

$$\theta_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i' \Psi_h \Sigma e_j)^2}{\sum_{h=0}^{H-1} (e_i' \Psi_h \Sigma \Psi_h' e_j)} \quad (1)$$

where Σ denotes the covariance matrix of the error vector ε_t, $\sigma_{jj} = (\Sigma)_{jj}$, e_i is a $n\ x\ 1$ selection vector that has one as the *i*th element and zero otherwise, and Ψ_h is a matrix of coefficients corresponding to lag *h*. Thus, $\theta_{ij}(H)$ quantifies the importance of the *j*th variable in predicting the *i*th variable and offers an intuitive measure of spillovers between the two variables.

The Diebold-Yilmaz framework provides measures of total spillovers (or connectedness in the whole system) as well as of directional and pairwise spillovers that allow the assessment of the level of connectedness across a system of variables (stock and currency markets in our case) from different perspectives. This approach has been extensively used to assess the degree of connectedness across various assets and markets due to its appealing and intuitive features. It also makes it possible to capture the time-varying nature of spillovers, in line with the evidence that spillover effects between stock and currency markets vary over time and tend to be stronger during crisis periods (e.g. Qin et al. 2018; Fernández-Rodríguez and Sosvilla-Rivero, 2020). It must be noted that the return spillover series in our analysis are estimated using daily returns of stock and FX markets and these spillovers are then matched with the monthly capital flow series by averaging the daily spillover values for each month.

3.2 Causality-in-quantiles test

[5] The complete description of the spillover index approach can be found in Diebold and Yilmaz (2012).

As mentioned earlier, the second step in our empirical analysis involves studying the causal effects of capital flows on return spillovers across the equity and currency markets via the causality-in-quantiles test of Balcilar et al. (2016). This is a nonparametric method built on the models of Nishiyama et al. (2011) and Jeong et al. (2012) and allows us to detect nonlinear causality in a set of quantiles covering the entire conditional distribution of return spillovers. Our focus is on the causal effects running from equity and debt flows (x_t) to stock-FX market spillovers (y_t) measured by the Diebold-Yilmaz connectedness estimates.[6] Intuitively, the existence of causality from x_t to y_t in the θ-th quantile implies that the past realizations of x_t, i.e., $x_{t-1}, \ldots, x_{t-p}$, can be used to predict the value of y_t in the θ-th quantile, but not in other quantiles.

The causality-in-quantiles approach offers several important advantages over standard linear and nonlinear Granger causality tests. First, it is robust to misspecification errors as it detects the underlying dependence structure among the time series under analysis. This feature is particularly relevant as it is well known that financial returns usually exhibit nonlinear dynamics. Second, this technique enables us to test not only for causality-in-mean but also for any causality that may exist in the tails of the joint distribution of the variables. This aspect is quite important if the dependent variable has fat-tails – again, something very common in financial data. The empirical implementation of the causality-in-quantiles approach involves three key choices: the lag order p of the VAR model, the bandwidth h used in the kernel estimation and the type of kernel function for $L(\cdot)$. In our application, a lag order of one is determined based on the Schwarz Information Criterion (SIC) for a VAR model comprising foreign capital flows and the stock-currency connectedness measure for each emerging country. The bandwidth value h is selected using the leave-one-out least-squares cross-validation technique of Racine and Li (2004). Lastly, Gaussian-type kernels are employed for $L(\cdot)$.

[6] For a more detailed description of the causality-in-quantiles method, please see Balcilar et al., (2016), Nishiyama et al., (2011) and Jeong et al., (2012).

4. Data description and preliminary analysis

The dataset used in our empirical analysis includes monthly portfolio flows for twelve EMEs, including Brazil, Bulgaria, Chile, Czech Republic, India, Lithuania, Poland, Romania, South Africa, South Korea, Slovakia and Turkey, collected from the International Institute of Finance for the period November 2000 to December 2020. The equity (bond) flows for a given country are measured by net non-resident purchases of common stocks (bonds). In line with the literature, we standardize flow data for each country using the nominal GDP to allow for a fair comparison across countries. The start date of monthly equity and debt flow data is not the same for all countries in the sample and depends on the availability of the flow data for each country (see Table 1). The data for national stock market indices and the exchange rate of each emerging currency against the U.S. dollar are obtained from Thomson Reuters Eikon. Following the usual practice, stock and foreign exchange returns are computed as log differences of the respective price series in levels.

Figure 1 plots the monthly equity and debt flow as a percentage of the GDP for each emerging economy. The estimates of the Diebold-Yilmaz total connectedness index (TCI) for the stock and currency returns of each country are also displayed in the secondary axis of this figure. We observe considerable time-variation in the total spillover effects across the stock and FX markets in all EMEs, in line with the evidence by Qin et al. (2018) and Fernández-Rodríguez and Sosvilla-Rivero (2020). Clearly, the global financial crisis (GFC) period in 2007/2008 has resulted in a visible rise in the spillover effects across the currency and stock markets. Further, the European emerging nations, including Bulgaria, Poland, Czechia, Slovenia and Lithuania, have also experienced several notable spikes in spillover values during the aftermath of the GFC, likely driven by the European sovereign debt crisis that started in Greece in the autumn of 2009 and subsequently spread across the whole of the European Union, causing enormous turbulence in Eurozone credit markets.

Table 1 presents the summary statistics for stock and currency returns as well as international portfolio flows for all countries in the sample. As shown in Panel A, stock markets experience

greater return volatility compared to the currency markets in all EMEs. In the case of spillover effects reported in Panel B, Brazil, India, South Korea and Turkey stand out in terms of total spillovers between their stock and currency markets. In the case of net spillovers, calculated as the difference between return spillovers transmitted from the currency to the stock market and return spillovers received by the currency market from the stock market in each emerging country, Brazil and India also stand out with negative mean net spillovers. This suggests that the currency markets in these countries generally serve as a net receiver of shocks from their respective stock market, implying that the stock market informs the currency market on average.

The average debt and equity flows reported in Panel C are mostly positive, indicating that the local bond and stock markets of almost all of the EMEs in the sample have experienced net capital inflows from abroad over the sample period. The average debt flows are higher than average equity flows for most countries implying that sovereign and corporate bond markets have attracted more foreign capital flows than stock markets for the majority of emerging countries. In turn, debt flows exhibit higher variability than equity flows for all countries, except India and South Korea. The high kurtosis values for all stock and currency returns as well as capital flows imply the existence of extreme movements in these series, which can be a sign of non-normality and possible nonlinearity. Hence, this preliminary analysis supports the use of the quantile-based nonlinear causality test, which is robust to extreme values in the data series and allows us to capture nonlinear causal dependencies.

Insert Table 1 about here

5. Empirical Findings

5.1. Testing for linear causality

Before starting the analysis of quantile-based causality, we first examine whether the standard linear Granger causality test is able to pick up any causal effects from capital flows to return

spillovers. Table 2 reports the results of the traditional linear Granger causality test associated with the causality running from each type of capital flow to the total connectedness index (TCI) between the currency and stock markets (Panels A1 and A2) and net spillovers from the currency to the stock market (Panels B1 and B2). Clearly, the linear causality test cannot detect any causal effects in the vast majority of cases with the exception of India and Turkey where capital flows are found to cause return spillovers. Therefore, on a larger scale, the findings from the standard linear causality tests suggest that capital flows do not exert a remarkable linear causal influence on the degree of connectedness between stock and FX markets for most emerging countries. However, it should be noted that, in the presence of potential nonlinearity and high kurtosis (as shown in Table 1), the linear Granger causality test is misspecified and, hence, may lead to misleading and inaccurate results. Accordingly, based on Table 2, one cannot argue that the relationship between flows and stock-FX market connectedness is significant for Turkey and India only and nowhere else as this would not be a correct assessment based on the mis-specified linear model.

Insert Table 2 about here

Given the limitations of the conventional linear Granger causality test, especially when nonlinearities are present in the data, next, we formally analyze the existence of nonlinearity in the relationship between capital flows and the connectedness series. To that end, the BDS nonlinearity test of Broock et al. (1996) is applied to the residuals of the equations of the VAR model used in the standard linear Granger causality test for each emerging economy. The results of the BDS test are shown in Table 3. Panel A employs the total return spillover index as a measure of stock-currency market connectedness, while Panel B uses net pairwise spillovers as the connectedness indicator. The BDS test statistics reject the null hypothesis of i.i.d. residuals for all emerging countries at the 1% significance level, which suggests the presence of nonlinearity in the relationship between capital flows and both connectedness estimates. Accordingly, linear Granger causality tests do not seem appropriate to explore the causal linkages between capital flows and

stock-FX market connectedness and nonlinear Granger causality approaches should be instead applied. Therefore, this strong evidence of nonlinearity justifies the use of the nonlinear causality-in-quantiles test which is a nonparametric data-driven model that is robust to misspecification.

Insert Table 3 about here

5.2. Results of the causality-in-quantiles test

Table 4 reports the results of the quantile causality tests between foreign debt and equity flows and the total connectedness index between equity and currency markets for each of the twelve EMEs in the sample. The findings in general support the evidence in Cerutti et al. (2019) that the effect of capital flows differs across EMEs and for different types of flows. As can be seen, the observed causality patterns are rather heterogeneous across the EMEs in the sample and exhibit quantile-based features for most countries. More precisely, we find that the causal effects of capital flows are largely concentrated in the quantiles of total return connectedness below and around the median, although significant causal effects are more numerous at lower quantiles associated with a lower connectedness between the stock and currency markets. This result means that the cross-border capital flows capture predictive information regarding the subsequent realizations of market states characterized by a more limited transmission of shocks between the equity and currency markets. In contrast, there are only very weak causal effects from portfolio capital flows to total market connectedness at higher connectedness quantiles above the median for all EMEs, implying that debt and equity flows do not have a significant effect on stock-currency market connectedness in times of high transmission of information between the two markets.

Comparing the results across the different markets and for different types of flows, we observe that equity flows generally play a more dominant causal role in the spillover effects, implied by significant test statistics for equity flows at lower quantiles for all EMEs. At the same time, debt flows are also found to cause stock-FX return spillovers for Brazil, Bulgaria, Czech Republic,

Poland and South Africa. Clearly, the stock and FX markets in these emerging economies are sensitive to both debt and equity flows, which poses a particular challenge for policy authorities as bond flows in and out of these economies can generate FX market fluctuations that cannot be explained by stock market fluctuations. Further comparing the magnitude of the test statistics, we observe that Bulgaria exhibits relatively greater sensitivity to both types of flows, while equity flows seem to be the dominant factor for South Korea, as evidenced by significant causality at a wide range of connectedness quantiles.

Insert Table 4 about here

A key implication of the findings from Table 4 is that the arrival of information via capital flows tends to ease shock transmissions across the equity and currency markets, implied by the significant causality test statistics found at low quantiles of total connectedness and insignificant causality at the high quantiles.[7] Therefore, the empirical evidence here represents a nuance of the commonly held view in previous related research (Akyüz, 1993; Singh and Weisse, 1998; Cho et al. 2016) that cross-border portfolio capital flows can substantially influence the linkage between stock and currency markets. Specifically, our results suggest that the dynamics of equity and FX markets in emerging nations and, hence, their level of connectedness are significantly affected by international portfolio investment flows. However, these capital flows are associated with subsequent spillovers that are smaller in magnitude. It can thus be argued that cross-border portfolio flows bring information to the local markets, easing informational asymmetries or uncertainty regarding market signals and/or economic fundamentals, whether this is good or bad news, reflected by the direction of flows. The easing of informational asymmetries through the information brought about by foreign flows, in turn, predicts smaller information spillover effects across the equity and currency market participants.

[7] This inference is further supported by the negative effects of flows in multivariate regressions discussed later.

Table 5 presents the results for the causality-in-quantiles running from capital flows to net spillovers. As stated earlier, net spillovers are calculated as the difference between return spillovers transmitted from the currency to the stock market and return spillovers received by the currency market from the stock market. This means that negative values of the net connectedness series indicate that the stock market serves as a net transmitter and the FX market acts as a net receiver of return spillovers. We observe in Table 5 significant causal effects from international capital flows to the net connectedness estimates almost exclusively at lower quantiles of net spillover values. In contrast with the evidence for total spillovers, however, we observe that debt flows play an equally significant role as equity flows when it comes to the directional spillover effects. While both types of flows are found to drive net spillovers from the stock to the FX markets in Poland, Romania, S. Africa and S. Korea, the rest of the EMEs exhibit a more heterogeneous pattern in the type of flow as a driver of directional spillovers.

Considering that the lower quantiles of the net connectedness series correspond to negative values for net connectedness and, hence, reflect net spillovers from the equity to the FX market, significant causality at lower quantiles observed in Table 5 suggests that cross-border debt and equity flows exert a significant causal influence on the propagation of information from the stock to the currency market, consistently across the EMEs in the sample. Accordingly, although the causality tests do not directly provide a sign for the relationship between flows and connectedness patterns, the findings for the total and net connectedness series combined imply that capital flows indeed play a significant role in the lead-lag relationship between the stock and FX markets and how one market informs the other. Meanwhile, the lack of significant Granger causality at the upper quantiles of net return spillovers suggests that there are no causal effects from debt and equity flows to net spillovers in the opposite direction, i.e., from the FX to the equity market. Therefore, it seems that foreign portfolio investment emerges as a meaningful driver of the transmission of information from the equity to the FX market in emerging economies.

These findings are indeed consistent with the recent evidence that suggests the presence of predictive relationships from the stock to the FX markets. For example, in a forecasting application, examining daily FX rates for the seven most traded currencies, Chen and Hsu (2019) show that stock returns capture predictive information to forecast FX rate returns. Similarly, utilizing panel Granger causality tests for advanced and emerging market currencies, Xie et al. (2020) find that there is causation from stock prices to exchange rates. Our results, thus, provide a new perspective to the literature that supports the flow of information from the stock to the FX market (Aloui, 2007; Yang and Doong, 2004; Chen and Hsu, 2019; Xie et al. 2020) by showing that capital flows contribute to the transmission of shocks from the equity to the currency market and not the other way around.

Insert Table 5 about here

Overall, the empirical evidence presented here is consistent with Bathia et al. (2020) in that cross-border capital flows significantly drive the dynamics of financial markets in emerging countries. Our results are also in line with those of Akyüz (1993), Singh and Weisse (1998) and Cho et al. (2016), who show that international portfolio flows substantially affect the interactions between the stock and FX markets in emerging countries. However, it should be noted that all the above-mentioned contributions do not contemplate a variety of scenarios that characterize the strength and direction of the linkage between the two markets, as does the present study. In addition, our empirical findings have notable similarities with those of Ordu-Akkaya and Soytas (2020). These authors document the critical role of foreign investment flows on the degree of connectedness across various markets under diverse states of connectedness in a large group of developed and emerging nations. Nevertheless, it should be underlined that, unlike our paper, Ordu-Akkaya and Soytas (2020) focus on the link between stock and commodity markets and apply standard quantile regression techniques.

From an economic perspective, our findings are in accordance with the portfolio rebalancing model of Hau and Rey (2006) wherein investors, who are unable to fully hedge the exchange rate risk of their portfolios, reduce their foreign equity exposures, thus leading to the depreciation of the foreign currency. Based on these results, one can argue that capital flows could be a driving factor for the transmission of shocks from the equity to the currency market as investors respond to fluctuations in their equity market positions due to capital flow effects. In any case, our evidence shows that EMEs exhibit a heterogeneous pattern in terms of their response to international capital flows and with no clear pattern regarding the relative importance of equity vs. debt flows in facilitating spillover effects across the stock and currency markets. However, considering the finding that international flows contribute to spillover effects in the direction of the currency market from the equity market, it is imperative for market regulators to closely monitor capital flow dynamics in order to mitigate the possible negative effects of shock spillovers emanating from the equity market in the direction of the currency market, possibly generated by informed investors that can, in turn, propagate further through uninformed investors via speculative or herding behaviour.

It must also be noted that unlike regression analysis, causality tests do not provide us with the sign of the relationship in a direct way. However, given its robust nature to misspecifications errors, the causality-in-quantile model is more suitable than regression analysis to capture the underlying dependence structure, which is our main purpose. Furthermore, the focus on causality rather than regression analysis frees us from making any assumptions regarding the presence of a predictive relationship between flows and the connectedness series. This is, in fact, in line with the standard linear Granger causality tests presented in Table 2, which yield no evidence of a causal relationship for a large majority of EMEs based on a linear framework. In essence, the presence of significant causality in a particular quantile of connectedness implies that flows have predictive power over subsequent connectedness patterns when the connectedness series falls into that particular

quantile. In our case, evidence of significant causality at lower quantiles of total connectedness means that flows capture predictive information over subsequent market states when the stock and FX markets are less connected. This in turn indicates that past realizations of flows are associated with a lower degree of spillovers across the stock and FX markets during subsequent periods.

The causal effects of flows on the connectedness series, particularly at lower quantiles of connectedness, are indeed supported by multivariate quantile regressions conducted along the lines of Ordu-Akkaya and Soytas (2020). Specifically, we estimate quantile regressions for each connectedness series against lagged flows along with several country-specific control variables discussed in the next section. The results from these additional tests are reported in the Appendix (see tables A1 and A2). By using one lag of the flow variable in these regressions, our findings generally confirm the negative effects of flows at lower quantiles of total connectedness and the negative effects on the net connectedness series, especially at lower quantiles, implying that flows contribute to return spillovers in the direction of the currency market from the stock market.

5.3 Robustness Checks

It is worth highlighting that the results reported so far may be driven by country-specific factors that induce spillover effects across the stock and currency markets and do not necessarily reflect the effect of capital flows. In order to explore whether this is indeed the case, we undertake an indirect approach of testing the robustness of our findings and accommodate for the possibility of important omitted variables that account for country-specific factors. The problem here though is that, unlike the traditional linear Granger causality test, which allows for multivariate specifications, all known nonlinear causality tests are in fact bivariate (see, e.g., Hiemstra and Jones, 1994; Diks and Panchenko, 2005, 2006; Nishiyama et al. 2011; Jeong et al. 2011). Therefore, our indirect approach involves two steps. First, we estimate a linear Granger causality model that includes the control variables representing country-specific factors in the regression equation for

each country. Second, we apply the nonparametric causality-in-quantiles test on the residuals of this augmented causality specification. The country-specific control variables considered include the log of real FX return, stock market capitalization as a percentage of GDP, log of GDP pc (in USD), and long-term interest rate. By doing so, we control for the effect of country-level factors and create a filtered series for spillovers whose movements are no longer due to domestic drivers.

The results of the robustness checks are reported in Tables 6 and 7 for the TCI and net spillovers, respectively. It can be seen that the findings are generally robust even after controlling for country-level factors. With the exception of the Czech Republic, the results hold that foreign capital flows generally have a significant causal effect on total return connectedness at lower quantiles in which the stock and equity markets are less connected. Therefore, one can argue that the arrival of new information via capital flows tends to alleviate shock transmissions across these markets as it helps to dissipate informational asymmetries and/or market uncertainty. Further examining the results in Table 7, once again, we observe that the causal effects of capital flows on the net connectedness estimates are largely confined to the lower quantiles in which net connectedness is negative. Considering that negative values for the net connectedness estimates imply net return spillovers into the currency market, it can be concluded that cross-border capital flows contribute to the propagation of information (shocks) from the stock to the currency market.

Insert Table 6 about here

Insert Table 7 about here

6. Conclusion

International capital flows into emerging economies have seen extraordinary growth since the beginning of the 21st century mainly due to the liberalization of international financial transactions, economic and financial globalization and improved information technology. Clearly, foreign portfolio investment is a vital source of financing in most developing countries where domestic

funding sources are sparse and, therefore, may play a critical role in the economic development of EMEs. However, the high variability and, especially, sudden reversals in cross-border portfolio flows can contribute to informational asymmetries among foreign and domestic investors and unexpected market fluctuations, leading to financial instability in emerging nations.

This paper extends previous research on the impact of international capital flows on local financial markets by examining the causal effects of foreign portfolio flows on the degree of return connectedness between the stock and FX markets in twelve major emerging economies. To this end, we first measure the connectedness between the stock and FX markets using the popular spillover index approach of Diebold and Yilmaz (2012). Then, we employ the nonparametric causality-in-quantiles test to analyze the possible causal effects of international capital flows on return spillovers across the equity and FX markets.

Our empirical findings show that cross-border debt and equity flows appear as a significant driver of information spillovers across the stock and FX markets of EMEs. The causal effect of capital flows is particularly important at lower connectedness quantiles, suggesting that international capital flows predict subsequent informational spillovers that are smaller in magnitude, alleviating the effect of shock transmissions across the two markets. The lack of significant causal effects from foreign capital flows to stock-FX market connectedness at upper quantiles of connectedness suggests that debt and equity flows are not a major contributor to return spillovers in EMEs. In parallel, the analysis of net spillovers reveals that capital flows contribute to the transmission of information (shocks) from the equity to the currency markets, in line with the portfolio rebalancing model that links the stock and currency market dynamics.

These results imply that policy authorities and investors in EMEs should pay special attention to the dynamics of cross-border debt and equity flows as a facilitator of shock transmissions from the stock to the currency markets in those countries. Similarly, emerging countries competing for foreign capital flows should consider the possible repercussions of debt and equity flows on the level of vulnerability of their stock and currency markets to financial shocks. Our evidence can

also have remarkable implications for policymakers in EMEs concerned about the possible impact of foreign capital volatility on financial market stability. Considering the finding that capital flows contribute to information spillovers from the equity to the currency market, policymakers must be aware that international debt and equity portfolio flows can pose a greater risk of financial instability, especially during periods in which stock and FX markets are primarily driven by their idiosyncratic factors. Accordingly, their response to extreme capital flow episodes should differ largely depending on the extent of connectedness across equity and FX markets when such extreme movements occur. Thus, policymakers in emerging countries should watch out for sudden and sharp fluctuations in foreign portfolio investment flows during periods of relatively low connectedness between stock and FX markets in order to avoid undesirable fluctuations in both markets due to spillover effects.

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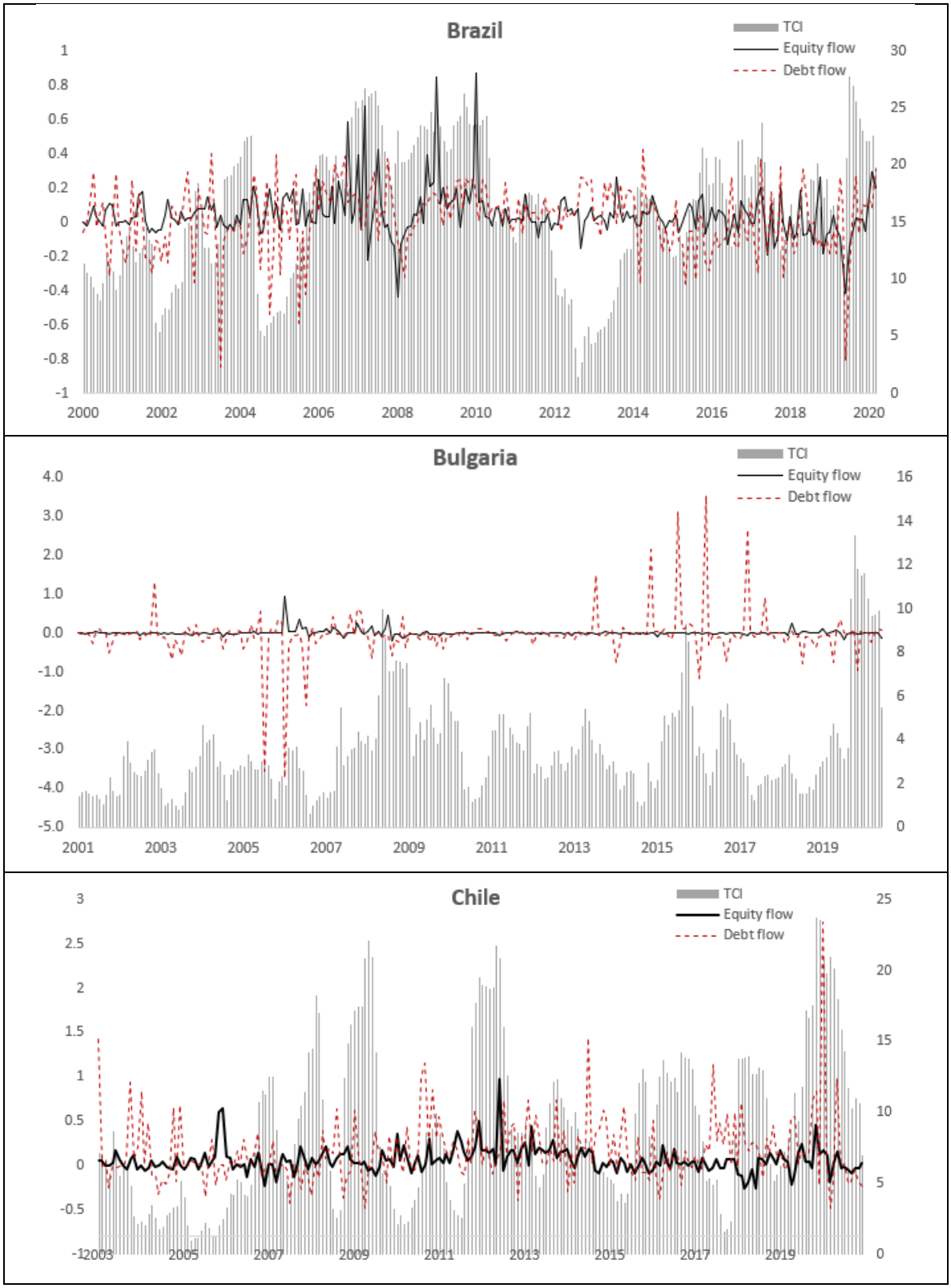
Figure 1. Monthly capital flows and total connectedness of stock and currency markets.



Note: The figure presents the monthly equity and debt flows measured by net non-resident purchases of equities or bonds as a percentage of the GDP. Total connected index (TCI) estimates for the stock and currency returns for each country are displayed on the secondary axis in each plot.

Fig. 1 continued

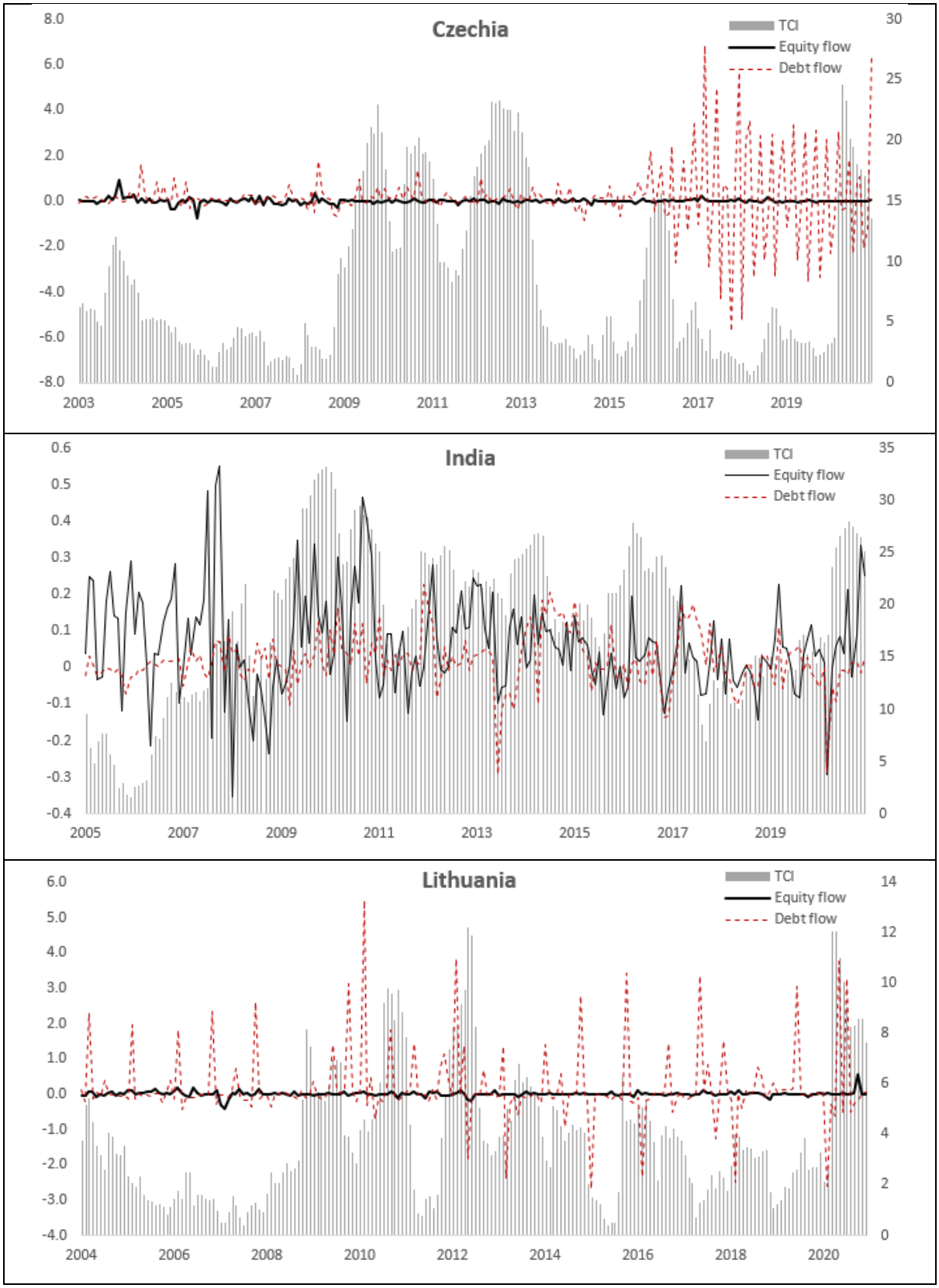
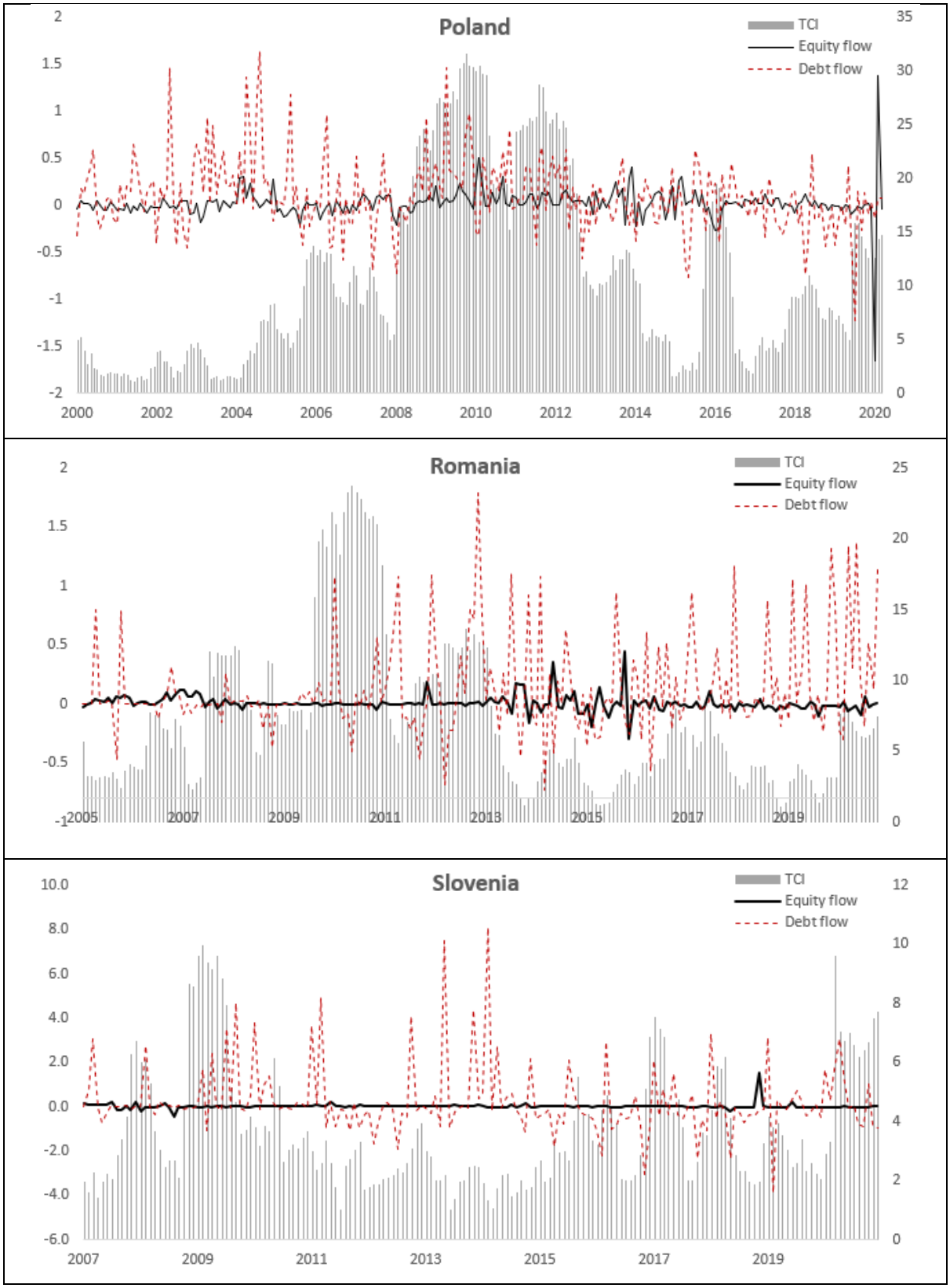


Fig. 1 continued



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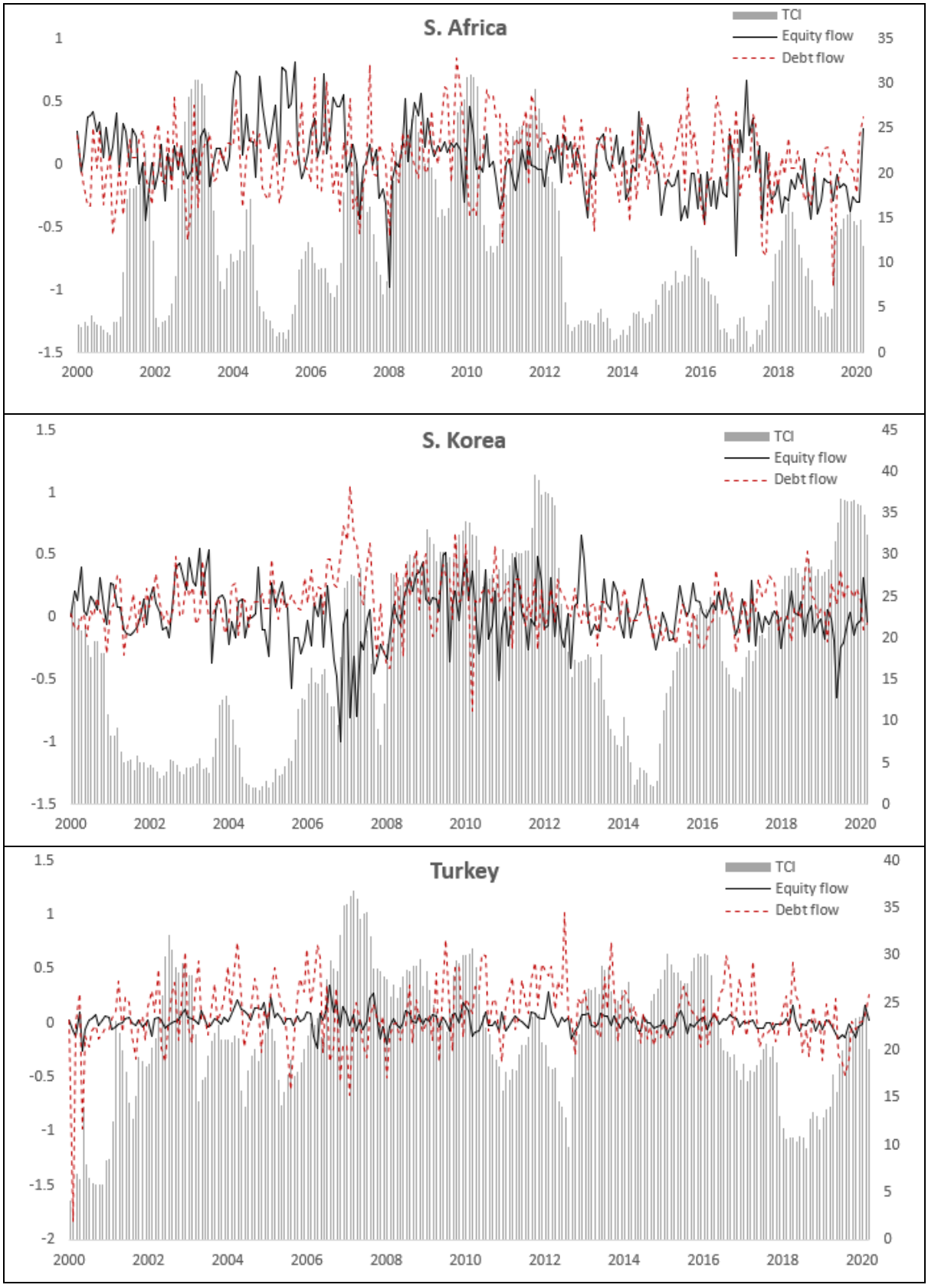

Table 1. Summary statistics

	Brazil (Oct. 2000-Dec. 2020)		**Bulgaria (Jul 2001-Dec 2020)**		**Chile (Jan 2003-Dec 2020)**		**Czech. Rep. (Jan 2003-Dec 2020)**		**India (Jan 2005-Dec 2020)**		**Lithuania (Jan 2004-Dec 2020)**	
	Panel A: Currency and Stock Market Returns (daily)											
	FX	Stock	FX	Stock	FX	Stock	FX	Stock	FX	Stock	FX	Stock
Mean	0.021%	0.037%	-0.006%	0.031%	0.005%	0.028%	-0.009%	0.014%	0.008%	0.048%	-0.003%	0.039%
Std. Dev.	1.029%	1.758%	0.575%	1.197%	0.659%	1.044%	0.722%	1.307%	0.381%	1.402%	0.590%	0.992%
Min.	-11.778%	-15.994%	-4.613%	-11.360%	-3.799%	-15.216%	-5.219%	-16.185%	-3.064%	-13.881%	-4.617%	-13.515%
Max.	9.677%	13.678%	3.848%	8.883%	5.462%	11.803%	5.540%	12.364%	3.251%	15.490%	3.844%	11.866%
Skewness	0.103	-0.389	-0.092	-0.582	0.385	-0.796	-0.0068	-0.5450	0.3007	-0.5351	-0.1320	-0.7423
Kurtosis	9.933	7.433	2.999	12.559	4.579	21.044	4.1146	14.2124	6.9447	10.7435	2.7970	32.4078
	Panel B: Diebold-Yilmaz Spillovers (monthly)											
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net
Mean	16.022	-1.110	3.570	-0.077	8.859	0.232	8.091	0.028	18.428	-0.268	3.869	0.383
Std. Dev.	5.820	1.650	2.221	1.840	5.469	0.996	6.694	1.469	7.268	0.839	2.664	1.248
Min.	1.450	-5.239	0.642	-7.044	0.954	-2.025	0.684	-6.078	1.621	-3.112	0.375	-3.531
Max.	27.753	3.031	13.387	3.545	23.704	3.672	24.628	2.985	33.220	1.891	12.233	4.641
Skewness	-0.203	-0.197	1.813	-1.304	0.686	0.846	0.948	-1.845	-0.267	-0.574	1.111	0.037
Kurtosis	-0.712	-0.428	3.911	4.067	-0.296	1.253	-0.493	5.631	-0.521	1.068	0.810	1.526
	Panel C: Normalized Capital Flows (monthly)											
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
Mean	0.019	0.050	-0.033	0.009	0.161	0.060	0.182	0.004	0.018	0.063	0.174	0.006
Std. Dev.	0.194	0.142	0.588	0.088	0.371	0.142	1.472	0.120	0.074	0.137	1.000	0.074
Min.	-0.847	-0.434	-3.747	-0.194	-0.489	-0.263	-5.775	-0.738	-0.294	-0.353	-2.670	-0.424
Max.	0.425	0.871	3.542	0.955	2.754	0.978	6.843	0.950	0.228	0.552	5.506	0.546
Skewness	-0.866	1.981	0.207	6.469	2.331	2.035	0.453	1.105	-0.254	0.564	1.789	0.582
Kurtosis	2.357	10.815	23.156	61.930	11.326	9.708	6.341	24.260	2.692	1.538	7.389	20.919

Table 1. continued

	Poland (Oct. 2000-Dec. 2020)		**Romania (Mar 2005-Dec 2020)**		**S. Africa (Oct 2000-Dec 2020)**		**S. Korea (Oct 2000-Dec 2020)**		**Slovenia (Jan 2007-Dec 2020)**		**Turkey (Oct 2000-Dec 2020)**	
	Panel A: Currency and Stock Market Returns (daily)											
	FX	Stock	FX	Stock	FX	Stock	FX	Stock	FX	Stock	FX	Stock
Mean	-0.001%	0.021%	0.015%	0.058%	0.016%	0.038%	0.000%	0.020%	0.002%	-0.012%	0.047%	0.042%
Std. Dev.	0.811%	1.243%	0.642%	1.477%	1.044%	1.195%	0.634%	1.453%	0.581%	1.410%	1.132%	2.010%
Min.	-6.697%	-13.527%	-4.968%	-13.117%	-8.523%	-10.227%	-13.265%	-12.805%	-4.617%	-40.354%	-16.252%	-19.978%
Max.	5.696%	6.443%	4.435%	11.544%	9.808%	7.261%	10.351%	11.284%	3.844%	40.474%	37.462%	17.765%
Skewness	0.1745	-0.5785	0.2423	-0.5527	0.2891	-0.3488	-0.6112	-0.5693	-0.125	-0.239	7.3677	-0.0737
Kurtosis	4.9766	6.2222	5.6711	11.0607	4.6559	5.4144	55.4829	7.5072	3.904	366.100	244.5355	8.5664
	Panel B: Diebold-Yilmaz Spillovers (monthly)											
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net
Mean	10.784	-0.189	7.216	0.132	11.821	0.007	18.518	-0.035	3.714	-0.114	21.735	0.165
Std. Dev.	8.567	1.244	5.383	1.210	8.402	0.837	10.816	0.855	2.074	1.183	6.741	1.215
Min.	1.118	-5.354	1.060	-2.791	0.723	-1.953	1.669	-3.102	0.994	-4.470	2.859	-4.321
Max.	31.525	2.905	23.784	2.952	30.968	3.601	39.655	3.035	9.976	2.207	36.784	4.951
Skewness	0.860	-1.325	1.488	-0.177	0.621	1.006	0.010	-0.051	1.275	-1.212	-0.373	-0.244
Kurtosis	-0.412	3.380	1.725	-0.332	-0.771	2.387	-1.277	1.625	0.936	2.345	-0.069	3.009
	Panel C: Normalized Capital Flows (monthly)											
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
Mean	0.105	0.018	0.137	0.007	0.037	0.040	0.106	0.026	0.245	0.022	0.081	0.020
Std. Dev.	0.383	0.173	0.407	0.068	0.286	0.274	0.221	0.238	1.572	0.133	0.307	0.081
Min.	-1.225	-1.662	-0.731	-0.293	-0.967	-0.977	-0.752	-0.998	-3.911	-0.425	-1.831	-0.256
Max.	1.628	1.379	1.790	0.450	0.845	0.817	1.048	0.659	8.111	1.517	1.014	0.344
Skewness	0.699	-1.604	1.416	1.883	-0.106	0.187	0.368	-0.544	1.985	8.387	-0.887	0.309
Kurtosis	2.559	51.188	2.283	14.588	0.514	0.791	1.882	1.937	6.641	96.808	6.036	2.043

Note: Panel A presents the descriptive statistics for the daily currency (FX) and stock market returns used to compute the DY return spillovers. Panel B presents the statistics for the monthly total (TCI) and net spillover estimates obtained as the average of daily spillovers for a given month. Panel C presents the descriptive statistics for the monthly equity and debt flows measured by net non-resident purchases of equities or bonds as a percentage of the GDP. The sample period for each country is listed in the first row next to the country name.

Table 2. Linear Granger causality tests

Brazil		**Bulgaria**		**Chile**		**Czech Rep.**		**India**		**Lithuania**	
Panel A1: Total Connectedness (TCI)											
Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
1.401	0.384	2.273	0.314	0.074	0.796	1.219	0.275	**3.168***	0.875	1.195	0.391
Panel B1: Net Spillover											
Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.879	0.654	1.410	0.314	1.948	0.402	2.262	0.884	1.798	2.281	0.338	0.294
Poland		**Romania**		**S. Africa**		**S. Korea**		**Slovenia**		**Turkey**	
Panel A2: Total Connectedness (TCI)											
Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.979	0.397	0.345	0.165	0.721	0.219	0.568	2.608	0.582	0.883	0.935	0.088
Panel B2: Net Spillover											
Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
2.824	0.004	2.857	0.118	0.050	0.727	1.102	0.505	0.233	2.772	1**0.605***	**6.404***

Note: The table reports the $\chi^2(2)$ statistic for the standard linear Granger causality test associated with the causality running from each type of capital flow to total connectedness for the currency and stock markets (Panels A1 and A2) and to net spillovers from the currency to the stock market (Panels B1 and B2). * indicates the rejection of the null hypothesis that capital flows do not Granger cause spillovers at a 5% level of significance, suggesting evidence of predictability due to capital flows based on a linear specification.

Table 3. BDS nonlinearity test of Broock et al. (1996)

Brazil		**Bulgaria**		**Chile**		**Czech Rep.**		**India**		**Lithuania**	
Panel A1: Total Connectedness (TCI)											
Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
45.664*[*]	40.615[*]	18.529[*]	19.165*	34.400[*]	35.999*	32.940*	34.541*	42.789[*]	37.188*	23.353*	24.118*
Panel B1: Net Spillover											
Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
37.609*	34.378*	21.105*	22.050*	18.969[*]	18.227*	16.917*	17.086*	20.476[*]	19.820[*]	19.522*	17.087*
Poland		**Romania**		**S. Africa**		**S. Korea**		**Slovenia**		**Turkey**	
Panel A2: Total Connectedness (TCI)											
Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
38.783*	40.458*	21.320*	21.377*	43.571*	44.748*	61.964*	62.988*	17.831	16.765*	36.901*	34.770*
Panel B2: Net Spillover											
Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
19.774*	18.925*	23.829*	24.163*	17.017*	16.453*	20.581*	19.298*	15.524*	15.614*	19.583*	19.715*

Note: Entries correspond to the χ-statistic of the BDS test for the null of *i.i.d.* residuals, with the test applied to the residuals recovered from the total connectedness (Panels A1 and A2) or net spillover (Panels B1 and B2) equation with 2 lags each of the respective connectedness measure and net capital flows. [*] indicates rejection of the null hypothesis at a 1% level of significance.

Table 4. Causality-in-quantiles tests for total connectedness (TCI)

	Brazil		Bulgaria		Chile		Czech Rep.		India		Lithuania	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	2.983*	3.405*	6.555*	4.359*	0.330	2.139*	2.395*	0.435	0.771	3.401*	0.264	2.432*
0.20	2.068*	2.394*	3.136*	2.234*	0.516	1.526	1.552	0.529	0.528	2.053*	0.215	1.507
0.30	1.428	1.968*	2.375*	1.623	0.663	1.017	1.717	0.815	0.627	1.681	0.403	.515
0.40	1.097	1.582	1.586	1.282	0.632	1.179	1.636	0.965	1.332	1.120	0.274	1.599
0.50	0.833	1.288	1.031	0.962	0.435	1.205	1.206	1.171	2.182*	0.868	0.277	1.273
0.60	0.696	1.029	1.087	0.947	0.198	1.025	0.958	1.185	2.600*	0.742	0.484	0.957
0.70	0.552	0.592	0.678	0.714	0.414	0.746	0.797	1.198	2.015*	0.640	0.672	0.647
0.80	0.283	0.304	0.541	0.512	1.055	0.520	0.890	0.838	1.339	0.621	0.496	0.271
0.90	0.096	0.615	0.189	0.178	0.235	0.481	0.110	0.692	1.354	0.674	0.271	0.094
	Poland		Romania		S. Africa		S. Korea		Slovenia		Turkey	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	2.039*	2.443*	0.848	2.769*	2.911*	3.449*	0.695	2.097*	1.448	2.412*	0.236	1.767
0.20	1.279	2.337*	0.546	2.028*	1.782	2.378*	0.763	1.998*	1.185	2.047*	0.426	2.178*
0.30	1.656	1.989*	0.632	1.367	1.216	1.989*	1.022	2.614*	1.289	1.710	0.871	2.670*
0.40	1.149	1.242	0.427	1.032	0.930	1.448	1.190	2.795*	1.027	1.614	1.995*	2.172*
0.50	0.904	0.965	0.495	0.885	0.815	1.185	0.754	2.440*	1.147	1.038	2.265*	2.100*
0.60	0.709	0.704	0.574	0.699	0.619	1.085	0.852	2.348*	0.553	0.790	2.085*	1.897
0.70	0.984	0.644	0.453	1.140	0.528	0.925	1.030	2.156*	0.400	0.632	1.730	1.892
0.80	0.436	1.191	0.601	0.286	0.271	0.597	0.762	1.944	0.364	0.527	0.567	1.705
0.90	0.150	0.155	0.257	0.696	0.098	0.098	0.265	1.315	0.379	1.081	0.278	0.889

Note: * indicates rejection of the null hypothesis of no Granger causality at the 5% level of significance (critical value of 1.96) from equity (debt) flows to total connectedness (TCI) between the stock and currency markets for a given quantile listed in the first column.

Table 5. Causality-in-quantiles tests for net return spillovers

	Brazil		Bulgaria		Chile		Czech Rep.		India		Lithuania	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	1.286	3.096*	2.125*	0.631	0.472	2.367*	2.883*	0.595	1.115	3.476*	0.852	3.070*
0.20	1.563	2.272*	2.112*	0.842	0.536	2.064*	1.841	0.595	1.083	2.046*	1.035	1.398
0.30	2.656*	1.803	1.348	0.472	0.644	2.139*	1.996*	1.029	1.707	1.740	1.321	1.302
0.40	2.069*	1.539	1.065	0.478	0.619	0.712	1.603	1.336	1.069	1.136	1.171	1.450
0.50	1.798	1.332	1.145	0.474	0.759	1.334	1.254	1.070	1.189	0.922	1.196	1.193
0.60	1119	1.026	0.848	0.363	0.959	1.191	1.065	1.175	1.136	0.783	0.756	0.978
0.70	0.674	0.601	0.761	0.434	0.444	0.849	0.709	1.119	1.108	0.567	0.599	0.838
0.80	0.456	0.308	0.397	0.257	0.570	0.627	0.887	0.840	0.811	0.604	0.319	0.346
0.90	0.148	0.604	0.139	0.225	0.404	0.597	0.093	0.353	0.359	0.654	0.221	0.121
	Poland		Romania		S. Africa		S. Korea		Slovenia		Turkey	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	2.488*	2.273*	2.747*	2.031*	3.730*	2.678*	2.586*	2.133*	1.634	0.330	1.291	1.549
0.20	0.943	2.102*	1.262	1.080	2.341*	2.319*	1.992*	2.126*	1.040	0.766	1.286	2.065*
0.30	1.018	1.630	.342	1.285	1.988*	1.636	1.266	2.901*	1.155	0.448	2.086*	2.586*
0.40	1.207	1.896	1.061	1.037	1.182	1.283	1.061	2.998*	1.232	0.464	2.088*	2.253*
0.50	1.184	1.241	1.094	1.079	0.885	1.091	1.213	2.638*	1.083	0.420	2.916*	2.053*
0.60	0.861	1.406	0.766	0.878	1169	0.923	1.029	1.979	1.040	0.530	2.558*	1.713
0.70	0.690	0.966	0.594	0.641	0.965	0.515	0.669	2.093*	0.696	0.561	2.592*	1.294
0.80	0.340	0.664	0.590	0.337	0.583	0.264	0.437	1.675	0.706	0.357	1.937	1.613
0.90	1.055	0.461	0.611	1.095	0.110	0.091	0.150	0.941	0.433	0.259	1672	1.055

Note: * indicates rejection of the null hypothesis of no Granger causality at a 5% level of significance (critical value of 1.96) from equity (debt) flows to net spillovers from the currency to the stock market in each country for a given quantile listed in the first column. Lower quantiles for net spillovers are associated with net spillovers from the stock to the currency market.

Table 6. Robustness checks for total connectedness (TCI)

	Brazil		Bulgaria		Chile		Czech Rep.		India		Lithuania	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	1.371	2.295*	2.194*	2.022*	2.201*	2.444*	1.899	0.875	1.273	2.352*	1.597	1.106
0.20	1.217	1.796	1.178	1.110	1.435	1.533	1.536	1.238	1.411	1.460	0.901	1.565
0.30	0.984	1.906	1.474	0.951	1.246	1.836	1.376	1.244	1.496	1.073	1.551	0.818
0.40	1.101	1.764	0.936	0.875	1.182	1.082	1.140	1.458	2.114*	0.796	1.962	0.857
0.50	0.675	1.891	1.115	0.887	0.884	1.006	1.052	1.778	2.693*	0.938	1.232	0.925
0.60	0.522	1.928	1.087	0.730	0.626	0.923	0.986	1.201	2.410*	0.726	1.091	0.703
0.70	0.796	1.463	0.542	0.524	0.670	0.560	0.996	1.427	2.614*	0.542	0.711	0.723
0.80	0.951	1.292	0.232	0.294	0.531	0.420	0.462	0.639	2.151*	0.278	0.422	0.441
0.90	0.790	1.032	0.424	0.498	0.307	0.474	0.141	0.536	1.009	0.095	0.385	0.498
	Poland		Romania		S. Africa		S. Korea		Slovenia		Turkey	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	1.995*	2.164*	0.344	2.012*	3.938*	3.148*	1.704	1.871	0.215	2.610*	0.564	1.799
0.20	0.910	2.327*	0.947	1.134	2.740*	1.891	1.161	2.132*	0.229	2.152*	0.726	1.896
0.30	0.916	1.528	0.676	1.021	2.119*	1.384	1.084	1.287	0.189	1.281	1.261	2.200*
0.40	1.047	1.273	1.047	1.503	1.607	1.205	0.659	1.312	0.317	1.224	2.359*	2.210*
0.50	0.883	0.898	1.066	1.424	1.328	1.091	0.611	1.094	0.222	1.124	2.622*	2.691*
0.60	0.602	0.856	1.064	1.482	0.974	0.860	0.745	0.635	0.168	0.884	2.175*	2.200*
0.70	0.469	0.812	0.725	1.091	0.973	0.753	0.330	0.939	0.240	0.614	1.791	2.358*
0.80	0.353	0.994	0.593	0.616	0.605	0.320	0.136	0.440	0.331	0.655	1.002	2.092*
0.90	1.051	0.447	0.416	0.496	0.107	0.111	0.479	0.151	0.118	1.165	0.410	1.078

Note: * indicates rejection of the null hypothesis of no Granger causality at a 5% level of significance (critical value of 1.96) from equity (debt) flows to total connectedness (TCI) between the stock and currency markets for a given quantile listed in the first column.

Table 7. Robustness checks for net spillovers

	Brazil		Bulgaria		Chile		Czech Rep.		India		Lithuania	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	0.876	2.157*	2.000*	1.969*	2.088*	2.652*	0.418	0.540	1.294	3.666*	0.934	1.005
0.20	1.678	2.069*	1.591	1.240	2.110*	1.971	0.595	0.672	1.181	2.179*	1.037	1.334
0.30	2.209*	2.274*	1.584	1.502	1.320	1.742	0.856	1.070	1.456	1.912	0.928	1.443
0.40	1.718	1.987*	1.632	0.986	0.908	1.421	0.594	1.129	1.108	1.066	1.131	1.808
0.50	1.503	2.142*	1.175	1.479	1.256	1.179	0.905	1.141	0.775	0.802	1.097	2.051*
0.60	0.993	2.150*	0.752	1.074	1.122	0.900	0.586	1.133	0.919	0.665	0.638	2.115*
0.70	1.081	1.975*	0.400	0.898	1.168	0.841	0.827	0.964	0.615	0.565	0.699	1.164
0.80	0.519	1.693	0.441	0.593	0.588	0.589	0.386	0.768	0.544	0.571	0.476	0.541
0.90	0.136	1.091	0.573	0.155	0.523	0.619	0.370	0.364	0.337	0.608	0.182	0.655
	Poland		Romania		S. Africa		S. Korea		Slovenia		Turkey	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	2.663*	2.257*	1.964*	2.229*	2.625*	3.373*	2.156*	2.249*	1.424	0.644	0.278	1.480
0.20	1.537	2.601*	0.436	1.629	1.504	1.970*	1.046	2.087*	0.894	0.920	0.170	2.133*
0.30	1.384	1.753	0.947	1.091	1.072	1.405	.086	1.672	0.764	0.947	0.417	2.222*
0.40	1.384	1.612	0.764	0.818	1.059	1.366	0968	1.253	0.747	0.599	1.318	2.197*
0.50	1.195	1.281	0.861	0.718	1.405	1.365	0.829	1.278	1.074	0.385	1.353	2.179*
0.60	1.143	1.101	0.566	0.806	0.880	1.151	0.876	0.963	0.855	0.398	1.326	2.151*
0.70	0.850	0.957	0.842	1.109	0.642	0.773	0.562	0.770	0.633	0.551	1.283	1.606
0.80	0.360	2.041*	0.457	0.273	0.353	0.320	0.544	0.345	0.364	0.558	0.676	1.600
0.90	0.125	0.352	0.536	0.687	0.636	0.111	0.124	0.121	0.127	0.502	0.191	0.877

Note: * indicates rejection of the null hypothesis of no Granger causality at a 5% level of significance (critical value of 1.96) from equity (debt) flows to net spillovers from the currency to the stock market in each country for a given quantile listed in the first column. Lower quantiles for net spillovers are associated with net spillovers from the stock to the currency market.

APPENDIX.

Table A1. Quantile regression results for total connectedness (TCI).

	Brazil		Bulgaria		Chile		Czech Rep.		India		Lithuania	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	-5.90[a]	-1.141	-0.16[c]	-0.383	-0.239	0.453	-0.012	0.890	0.772	0.563	-0.067	-1.79[b]
	(1.853)	(8.579)	(0.088)	(7354)	(0.213)	(0.765)	(0.094)	(0.560)	(1.831)	(0.537)	(0.160)	(0.705)
0.20	-5.29[a]	-3.771	-0.20[c]	0.762	-0.41[c]	1.014	0.065	-0.152	-0.716	0.083	-0.087	-1.12
	(2.083)	(5.160)	(0.108)	(0.700)	(0.236)	(0.541)	(0.082)	(0.758)	(1.303)	(0.417)	(0.115)	(0.700)
0.30	-3.68[c]	2.249	-0.15	0.606	-0.46[c]	0.967	0.037	-0.408	-0.900	0.001	-0.103	-0.999
	(2.109)	(9.510)	(0.133)	(0.832)	(0.259)	(0.611)	(0.064)	(0.446)	(1.040)	(0.390)	(0.103)	(0.776)
0.40	-2.695	4.411	-0.144	0.406	-0.064	1.006	0.061	-0.057	-0.928	0.188	-0.036	-1.196
	(2.509)	(2.129)	(0.157)	(0.912)	(0.361)	(0.664)	(0.046)	(0.839)	(0.906)	(0.374)	(0.071)	(0.850)
0.50	-0.890	3.648	-0.106	0.186	-0.121	0.868	0.047	0.232	-1.50[c]	0.300	0.011	-0.960
	(2.629)	(2.149)	(0.172)	(0.947)	(0.369)	(0.695)	(0.044)	(0.774)	(0.813)	(0.396)	(0.059)	(0.885)
0.60	0.923	4.327	-0.022	2.060	0.030	0.837	0.034	0.530	-1.151	0.270	0.022	-0.296
	(2.516)	(2.237)	(0.175)	(1.962)	(0.337)	(0.732)	(0.041)	(0.713)	(0.705)	(0.416)	(0.061)	(0.895)
0.70	1.323	2.505	0.155	1.181	-0.129	1.482[b]	0.012	-0.143	-1.56[b]	0.012	0.067	-0.586
	(2.029)	(2.135)	(0.152)	(1.564)	(0.383)	(0.605)	(0.047)	(1.279)	(0.672)	(0.433)	(0.127)	(1.075)
0.80	1.175	0.825	-0.022	0.911	-0.039	1.136[b]	0.073	0.589	-1.266	-0.001	0.053	0.566
	(1.754)	(1.983)	(0.215)	(1.298)	(0.426)	(0.594)	(0076)	(0.672)	(0.890)	(0.473)	(0.206)	(1.010)
0.90	1.859	2.403	-0.28[c]	0.327	1.079[b]	0.073	0.043	-0.039	0.050	0.306	-0.026	0.969
	(2.256)	(2.718)	(0.170)	(1.238)	(0.484)	(0.570)	(0.107)	(1.189)	(1.316)	(0.470)	(0.230)	(0.953)
	Poland		Romania		S. Africa		S. Korea		Slovenia		Turkey	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	-0.355	-0.11[c]	-0.148	-1.935	-0.134	-0.69[b]	-0.80[b]	2.485	-0.044	-2.018	-1.809	-3.659
	(0.795)	(0.062)	(0.436)	(1.288)	(0.376)	(0.285)	(0.252)	(2.398)	(0.076)	(2.264)	(1.877)	(7.481)
0.20	-0.774	-0.069	-0.707	0.288	-0.408[c]	-0.64[a]	-0.48[b]	-0.937	-0.011	-1.055	-2.761	-10.50
	(0.731)	(0.082)	(0.467)	(4.968)	(0.229)	(0.248)	(0.200)	(2.632)	(0.073)	(2.348)	(2.226)	(8.404)
0.30	-0.786	0.025	-0.681	3.333	-0.251	-0.546[b]	-0.52[b]	-2.816	-0.005	-0.892	-1.758	-0.127
	(0.906)	(0.159)	(0.429)	(1.746)	(0.201)	(0.252)	(0.239)	(2.719)	(0.085)	(1.022)	(2.194)	(11.99)

0.40	0.0006	0.120	-0.676	1.584	-0.266	-0.633[b]	-0.66[b]	0.216	0.019	-0.617	-3.91[c]	12.83
	(0.187)	(0.257)	(0.500)	(2.346)	(0.190)	(0.246)	(0.265)	(3.238)	(0.097)	(0.588)	(2.329)	(15.13)
0.50	-0.211	-0.122	-0.013	-0.117	-0.267	-0.623[b]	-0.75[b]	-2.355	-0.006	-1.21[b]	-4.32[c]	6.161
	(0.195)	(0.271)	(0.474)	(1.874)	(0.181)	(0.269)	(0.371)	(2.901)	(0.095)	(0.605)	(2.215)	(14.400)
0.60	-0.318	-0.284	0.077	-0.389	-0.354[c]	-0.727[b]	-0.84[b]	-2.361	-0.007	-1.10[c]	-5.77[b]	7.124
	(0.202)	(0.264)	(0.362)	(1.762)	(0.181)	(0.281)	(0.374)	(2.971)	(0.089)	(0.585)	(2.313)	(13.107)
0.70	0.519	-0.315	0.096	0.823	-0.234	-0.351	-0.612	-0.800	0.054	-1.42[b]	-6.04[b]	1.841
	(0.890)	(0.196)	(0.308)	(2.146)	(0.180)	(0.316)	(0.397)	(3.100)	(0.098)	(0.585)	(2.687)	(12.438)
0.80	0.911	-0.128	0.230	0.001	-0.418[b]	-0.075	-0.475	-0.305	-0.062	-2.31[a]	-5.71[b]	1.240
	(1.148)	(0.260)	(0.278)	(2.518)	(0.187)	(0.217)	(0.381)	(3.744)	(0.141)	(0.709)	(2.801)	(12.684)
0.90	0.426	-0.619	-0.018	0.855	-0.699[b]	-0.811	-0.677	-2.527	0.114	-3.08[a]	-4.97[c]	-4.030
	(0.565)	(0.461)	(0.258)	(4.080)	(0.281)	(0.295)	(0.442)	(4.075)	(0.225)	(0.645)	(2.88)	(9.442)

Note: [a, b,] and [c] indicate level of statistical significance at 1%, 5% and 10% respectively.

Table A2. Quantile regression results for net connectedness.

	Brazil		Bulgaria		Chile		Czech Rep.		India		Lithuania	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	-1.622[c]	-3.481[b]	-0.298[a]	1.537[a]	-0.49[b]	1.379[b]	-0.23[a]	0.711	-1.586	-0.231	-0.33[b]	-2.54[a]
	(0.596)	(1.840)	(0.082)	(0.499)	(0.190)	(0.661)	(0.082)	(0.465)	(2.728)	(1.019)	(0.142)	(0.504)
0.20	-0.871	-2.092	-0.113	0.823	-0.347	0.701	-0.035	0.139	-0.256	1.041	-0.108	-1.70[c]
	(0748)	(1.902)	(0.108)	(0.511)	(0.242)	(0.534)	(0.111)	(0.600)	(0.900)	(0.633)	(0.145)	(0.869)
0.30	-0.479	-1.536[c]	-0.060	0.865	-0.329	0.540	0.049	-0.411	-0.560	0.912[c]	-0.102	-1.041
	(0.933)	(0.842)	(0.112)	(0.646)	(0.318)	(0.526)	(0.079)	(0.432)	(0.747)	(0.480)	(0.109)	(0.896)
0.40	0.127	-1.884[b]	-0.023	0.373	0.044	0.886[c]	-0.008	-0.201	0.031	0.563	-0.071	0.789
	(0.910)	(0.802)	(0.121)	(0.696)	(0.162)	(0.503)	(0.058)	(0.561)	(0.748)	(0.493)	(0.090)	(0.981)
0.50	0.074	-1.285[c]	-0.041	0.167	0.063	0.506	0.0005	0.137	0.391	0.847[c]	-0.023	-1.886
	(0.908)	(0.723)	(0.129)	(0.736)	(0.172)	(0.518)	(0.051)	(0.821)	(0.748)	(0.443)	(0.069)	(1.951)
0.60	-0.030	-1.631[b]	0.0750	-0.316	0.029	1.233[b]	0.030	0.195	-0.304	0.430	0.038	-1.663
	(0.796)	(0.778)	(0.181)	(0.770)	(0.185)	(0.560)	(0.049)	(0.782)	(0.973)	(0.429)	(0.068)	(2.193)
0.70	0.332	-1.939	0.193	-0.713	0.016	1.146[b]	0.0009	-0.171	0.519	0.420	0.007	-2.199
	(0.727)	(0.784)	(0.181)	(0.734)	(0.244)	(0.552)	(0.052)	(1.107)	(0.890)	(0.403)	(0071)	(3.075)
0.80	0.021	-2.393[a]	0.351[b]	-1.355[b]	0.188	1.085[b]	0.046	0.594	0.911	0.492	-0.119	-2.983
	(0.659)	(0.774)	(0.142)	(0.637)	(0.645)	(0.485)	(0.057)	(0.688)	(1.148)	(0.386)	(0.085)	(3.231)
0.90	-0.205	-3.031[a]	0.196	-0.487	1.147[c]	0.376	0.051	0.023	1.147	0.376	-0.187	-6.156
	(0.736)	(0.787)	(0.396)	(1.771)	(0.693)	(0.461)	(0.126)	(1.388)	(1.676)	(0.596)	(0.116)	(4.896)
	Poland		Romania		S. Africa		S. Korea		Slovenia		Turkey	
	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity	Debt	Equity
0.10	-0.613	1.374	-0.42[c]	-0.515	-0.146	-0.047	-0.248	0.195	0.077	-0.488	0.589	-1.517
	(1.112)	(8.309)	(0.240)	(1.610)	(0.327)	(0.303)	(0.293)	(0.250)	(0.164)	(0.290)	(0.852)	(1.816)
0.20	-1.425	-1.283	-0.66[b]	2.185	-0.067	-0.137	0.021	0.206	0.058	-0.99[a]	0.568	-1.192
	(1.301)	(9.776)	(0.300)	(2.505)	(0.255)	(0.228)	(0.290)	(0.211)	(0.046)	(0.289)	(0.645)	(1.594)
0.30	-1.203	-2.620	-0.84[a]	2.427	-0.107	-0.282	-0.259	0.402[b]	0.006	-1.20[a]	0.987[c]	-1.924
	(1.289)	(3.741)	(0.319)	(1.561)	(0.209)	(0.218)	(0.300)	(0.202)	(0.048)	(0.347)	(0.587)	(1.608)
0.40	-2.262	5.887	-0552	2.088	-0.083	-0.39[c]	-0.49[c]	0.537[a]	-0.013	-0.668	0.897[b]	-1.798
	(1.361)	(4.118)	(0.460)	(1.694)	(0.192)	(0.200)	(0.253)	(0.202)	(0.054)	(2.111)	(0.423)	(1.766)

0.50	1.341	4.435	-0.224	1.155	-0.064	-0.281	-0.46 [c]	0.416 [c]	-0.014	-0.501	0.776[c]	-0.404
	(1.574)	(4.348)	(0.366)	(1.750)	(0.203)	(0.205)	(0.273)	(0.226)	(0.055)	(2.274)	(0.396)	(1.732)
0.60	1.371	2.777	0.125	0.288	-0.275	-0.36 [c]	-0.231	0.323	-0.048	-1.63 [a]	0.756[b]	-0.607
	(3.561)	(4.294)	(0.314)	(1.632)	(0.193)	(0.216)	(0.314)	(0.285)	(0.053)	(0.383)	(0.375)	(1.581)
0.70	7.151 [b]	0.870	0.015	0.046	-0.315	-0.48[c]	-0.260	0.194	-0.074	-1.86 [a]	0.643[c]	-2.037
	(3.193)	(1.958)	(0.288)	(1.468)	(0.196)	(0.251)	(0331)	(0.302)	(0049)	(0.383)	(0.353)	(1.783)
0.80	11.06 [a]	5.319	-0.133	0.668	-0.128	-0.50[c]	-0.646	0.267	0.0009	-2.05 [a]	0.359	-0.858
	(2.719)	(3.673)	(0.265)	(1.480)	(0.260)	(0.280)	(0.673)	(0.499)	(0.083)	(0.230)	(0.318)	(1.785)
0.90	7.496 [b]	7.308[a]	0.412	-2.375	-0.619	-0.682	-0.531	-0.451	-0.027	-2.22 [a]	0.163	-0.600
	(3.174)	(1.873)	(0.413)	(1.536)	(0.461)	(0.570)	(0.455)	(0.836)	(0.072)	(0.253)	(0.322)	(2.125)

Note: [a, b,] and [c] indicate level of statistical significance at 1%, 5% and 10% respectively.