Term Spread Spillovers to Latin America and Emergence of the 'Twin Ds'

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Abstract

This paper investigates the relationship between depreciation and default risks in five key Latin American markets—Brazil, Chile, Colombia, Peru, and Mexico—in response to shifts in the US yield curve slope. Excluding serial defaulters like Argentina, our focus lies on countries still susceptible to the Twin Ds phenomenon amidst high debt levels. We find that global economic spillovers significantly influence the Twin Ds in these markets; with fluctuations in the US term spread serving as an indicator of broader shifts in global economic conditions. Our analysis reveals asymmetric spillover effects, particularly during periods of positive and increasing spreads such as the Global Financial Crisis, where changes in the term spread disproportionately impact the depreciation tail in currency markets and the high-risk tail in sovereign CDS markets. Notably, such effects are absent in stock markets, which accentuate the particular dynamics of currency and sovereign debt markets. The asymmetry of spillover effects, although still present during the most recent Covid-19 crisis, was less pronounced, which may be linked to the accumulation of international FX reserves in the region during the last decades. Our findings emphasize the necessity of incorporating risk spillovers into policy frameworks, highlighting the dominance of risk spillovers over price spillovers and the obscured nature of shocks at the center of the variables' distribution.

Keywords: Risk spillovers; Price spillovers; US term spread; Twin Ds; Emerging markets.
JEL Codes: F34; E43; G01.

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1. Introduction

The concurrent risks of default and depreciation are in today's landscape significant concerns for emerging market economies, once again placing Latin American countries under the spotlight of international debt markets. This attention comes from relatively high debt levels in the region— even by today's standards—coupled with timid prospects for future economic growth. In an environment of high interest rates, these factors converge to create substantial debt burdens that are challenging to sustain in the medium and long terms. This situation may lead to default and inflation becoming policy options, despite the considerable economic and political costs associated with them.

Previous literature has established that greater sovereign risk leads to higher depreciation risk (Della-Corte et al., 2022). Conversely, a significant expectation of currency depreciations increases the risk of default (Bernoth and Herwartz, 2021). These risks are so closely intertwined that they are commonly referred to as the 'Twin Ds'—for default and devaluation—in the literature (Na et al., 2018; Augustin et al., 2018; Augustin et al., 2020; Chernov et al., 2023; Della-Corte et al., 2023).

As demonstrated by Na et al. (2018) devaluing the domestic currency can indeed be optimal at the same time when defaulting on debt is. According to these authors' framework, when confronted with a series of adverse outcome shocks leading to default (due to limited commitment), governments are inclined to devalue the local currency to mitigate the impact on real wages. By doing so, governments can offset the downward pressure on labor demand resulting from the contraction in domestic absorption caused by these negative shocks. The optimality of these actions helps to explain the simultaneous occurrence of devaluations (or depreciations) and defaults, a phenomenon first documented by Reinhart (2002).

Building on the insights of Na et al. (2018), we posit that this original sequence of negative shocks could be due to changes in expectations regarding global economic conditions, and in particular to the compression or expansion of the yield curve in the global bonds market. From this perspective, we empirically investigate whether the Twin Ds manifests in the data during such episodes, offering compelling evidence that this is, indeed, the case.

In short, we add one ingredient to the contemporaneous narrative surrounding the Twin Ds, by postulating that changes in the slope of the yield curve, the term spread, serve as significant triggers of the phenomenon in the region. We specifically focus on the case of the five largest Latin American markets: Brazil, Chile, Colombia, Peru, and Mexico, examining how changes in the US term spread, a gauge of shifting expectations in global economic conditions, play a significant role in driving these twin risks.

Our empirical strategy relies on the recently developed Quantile Vector Autoregressions (QVAR) framework proposed by Ando et al. (2022), to construct spillover statistics that capture the dynamic effects of changes in global economic expectations. For each Latin American country in our sample, we estimate bivariate models, incorporating the US Term Spread and a domestic market price at a given time, including, Credit Default Swaps (CDS) of sovereign debt, foreign exchange rates, and, for comparison, stock prices.

QVAR estimators extend the conventional framework developed by Diebold and Yilmaz (2012, 2014) for assessing market spillovers. Unlike the –now- more traditional approaches that focus solely on average spillovers, QVAR models allow to estimate both directed and undirected relationships among the study variables across the entire conditional distribution of such variables.

In particular, we examine shocks corresponding to extremely high and low realizations of sovereign credit risk, substantial depreciation or appreciation risks, and significant losses and gains in the stock market. This enables us to distinguish between risk spillovers (occurring at the tails of the distributions) and pricing spillovers (located at the center of these distributions) and compare their magnitudes over time.

In summary, our contribution reveals that the Twin Ds in Latin America are largely influenced by global spillovers, with fluctuations in the US term spread serving as indicators of shifts in global economic conditions, including expectations regarding monetary policy and future growth prospects. We found asymmetric effects of global economic conditions on sovereign credit risk and currency risk distributions, particularly during periods of positive and increasing spreads like the Global Financial Crisis (GFC) and the Covid-19 crisis. For all countries, during the GFC these effects were much more pronounced in the depreciation tail of currency markets and the high-risk tail of sovereign CDS markets, than in the lower tail in both markets. This situation improved during the Covid-19 crisis for the FX markets, probably due to the accumulation of international FX reserves by the region, which took place in the time elapsed between the two crises.

Furthermore, our findings stress the importance of incorporating risk spillovers into policy design and portfolio evaluation for international investors when analyzing emerging market economies, especially concerning the twin risks. These risk spillovers outweigh price spillovers, which may obscure the true magnitude of the effects of the original shocks, given their asymmetric nature, documented in our empirical results.

The remainder of this document consists of a review of the closest existing works, which serves to place our contribution against the broader discourse on the Twin Ds literature. Following this, the third section provides a detailed description of our dataset. The fourth section presents our main findings, while the fifth section offers concluding remarks.

2. Related Literature

Our study is connected to the literature examining the relationship between sovereign risk and depreciation risk. The roots of this literature can be traced back to seminal works on currency crises by Krugman (1979) and Flood and Garber (1984). These classical studies suggest that exchange rate crises are influenced by significant government deficits and declining reserves, which are utilized to finance such deficits in a pecking order manner, prior to resorting to money growth as a funding source. A key insight from these early models is the significant impact of fiscal solvency on currency crises, a notion that has been recently revitalized in the context of the fiscal theory of the price level, particularly by Daniel (2010).

More directly, our study is motivated by the empirical assessment conducted by Reinhart (2002), who first documented that sovereign defaults are typically, if not invariably, accompanied by significant devaluations of the nominal exchange rate. This empirical regularity was subsequently confirmed by Na et al. (2018), who examined data from over 70 countries spanning 117 default events between 1975 and 2013. These authors also put forward a model of the 'Twin Ds', where the two Ds stand for default and devaluation.

Na et al.'s (2018) work has sparked a new generation of empirical studies that examine the phenomenon (e.g., Della-Corte et al., 2022; Bernoth and Herwartz, 2021) and are therefore related to our study. This line of research complements earlier analyses that treated devaluation as an implicit form of default but only focused on local-currency debt (e.g., Aguiar et al., 2013; Sunder-Plasddmann, 2020; Da Rocha et al., 2013; Du and Schreger, 2022; Corsetti and Dedola, 2016). These two bodies of literature are inherently linked given that, as demonstrated by Ottonello and Perez (2019), during economic booms, the proportion of debt denominated in local currency tends to be higher than during recessions, because governments substitute foreign by local currency debt. Such dynamics create incentives to mitigate debt repayment by depreciating the currency and hence linking default and depreciation pressures.

In contrast to this literature, we postulate that both default and depreciation risks in emerging market economies may stem from a third external shock. Specifically, we argue that they are, to a significant extent, domestic responses to shifts in global economic conditions and external monetary policy. Alongside the feedback loops already identified by prior research between sovereign and depreciation risks (e.g., Reinhart 2002; Na et al., 2018; Bernoth and Herwartz, 2021; Della-Corte et al., 2022), we emphasize, by the first time, the role of the external factors. We examine how the Twin Ds manifest in the data following changes in global economic and financial conditions, as proxied by the US Term spread.

Consequently, our study is also connected to the extensive body of literature that has recently documented spillover effects from global conditions such as monetary policy (e.g. Avdjiev and Takáts, 2019; Albagli et al, 2019) or uncertainty (Lakdawala et al., 2021; Lastauskas and Nguyen, 2023) onto international markets and, in particular, emerging market economies (e.g. Tillman, 2016; Anaya et al., 2017; Hoek et al., 2022; Akinci and Queralto, 2023). However, our focus is not solely on these spillover effects as we specifically investigate the Twin Ds.

We employ the US Term spread as an overarching variable to assess changes in both global monetary policy stances and economic conditions. The US Term spread has long been regarded as a reliable gauge of future economic conditions at least since seminal works by Laurent (1988) and Harvey (1988). It currently serves as a primary variable for forecasting future economic conditions and serves as a benchmark for new indicators proposed for this purpose, as seen in recent studies by Erdogan et al. (2015), Liu and Moench (2016), and van Os and van Dijk (2024). Additionally, it is utilized to predict future financial market movements, as seen in works by Gungor and Luger (2020), Fan et al. (2021), and Odendahl et al. (2023).

3. Methodology

Our empirical methodology relies upon the estimation of Quantile Vector Autoregressions to construct spillover statistics capturing the dynamic effects of changes in global economic expectations on Latin American markets. For each Latin American country in our sample, we estimate bivariate models, including the US Term Spread and a domestic market price at a time, that is, Credit Default Swaps (CDS) in sovereign debt markets, foreign exchange, and, for the sake of comparison, stocks.

We leverage the QVAR estimators proposed by Ando et al. (2022), which build upon the conventional framework developed by Diebold and Yilmaz (2012, 2014) for assessing market spillovers. Unlike traditional approaches that focus on estimating average spillovers, the QVAR estimates directed and undirected relationships between the study variables, across their full conditional distribution.

Specifically, we investigate these relationships during extremely high and low realizations of sovereign credit risk, large depreciation or appreciation risks, and significant losses and gains in the stock market. This allows us to differentiate between risk spillovers (at the tails of the respective distributions) and pricing spillovers (at the center of these distributions) and compare their magnitudes over the time.

In economic terms, our bivariate approach is justified by the theoretical assumption that the US Term Spread is at least contemporaneously exogenous from the perspective of the domestic Latin American economies under analysis, on a daily basis.

A QVAR model of order p is described by the following equation:

$$\boldsymbol{y}_t = \boldsymbol{\mu}(\tau) + \sum_{j=1}^{p} \boldsymbol{\Phi}_j(\tau)\boldsymbol{y}_{t-j} + \boldsymbol{u}_t(\tau), \quad (1)$$

where $\boldsymbol{y}_t$ and $\boldsymbol{y}_{t-j}$ represent $k \times 1$ dimensional vectors containing the system variables at time t and $t-j$, respectively. In our specific case, the $QVAR$ model is bivariate as it includes $k = 2$ variables. These variables consist of the US Term Spread and the log-returns of one of the three markets (CDS, FX and stocks) within a selected Latin American country.

We are particularly interested in quantiles τ, with $\tau \in [0,1]$, which are located at the tails and center of the respective domestic variable's distributions. Hence, we focus on quantiles $\tau \in (0.05, 0.50, 0.95)$. In equation 1, p represents the autoregressive order of the QVAR model, $\boldsymbol{\mu}(\tau)$ stands for a $k \times 1$ conditional mean vector, $\boldsymbol{\Phi}_j(\tau)$ is a $k \times k$ matrix encompassing the parameters of the QVAR system, and $\boldsymbol{u}_t(\tau)$ denotes a $k \times 1$ dimensional vector associated with a variance–covariance matrix of dimension $k \times k$, given by $\boldsymbol{\Sigma}(\tau)$.

We can rely on the moving average representation of the $QVAR(p)$ system, $QVMA(\infty)$, using the Wold's Theorem, which offers the following perspective:

$$\boldsymbol{y}_t = \boldsymbol{\mu}(\tau) + \sum_{i=0}^{\infty} \boldsymbol{\psi}_i(\tau)\boldsymbol{u}_{t-i}, \quad (2)$$

where the $k \times k$ dimensional matrix $\boldsymbol{\psi}_i(\tau)$, follows the recursion $\boldsymbol{\psi}_i(\tau) = \boldsymbol{\Phi}_1\boldsymbol{\psi}_{i-1}(\tau) + \boldsymbol{\Phi}_2\boldsymbol{\psi}_{i-2}(\tau) + \cdots + \boldsymbol{\Phi}_p\boldsymbol{\psi}_{i-p}(\tau)$, where $\boldsymbol{\psi}_0(\tau)$ is the identity matrix and, $\boldsymbol{\psi}_i(\tau) = 0$, for $i < 0$.

This moving average representation serves as the basis for constructing the spillovers statistics in our main analysis. These indicators are derived from the forecast error variance decomposition of the system at a specified horizon in the future. In particular, assuming an order-invariant variance decomposition of the QVAR system, following the generalized framework due to Koop et al. (1996) and Pesaran and Shin (1998), we can construct spillover statistics for horizons, $H = 1,2, \ldots$ in the following way:

$$\theta_{ij}^{g}(H) = \frac{\Sigma(\tau)_{ii}^{-1} \sum_{h=0}^{H-1} \left(\boldsymbol{e}_i' \boldsymbol{\psi}_h(\tau)\boldsymbol{\Sigma}(\tau)\boldsymbol{e}_j\right)^2}{\sum_{h=0}^{H-1} \left(\boldsymbol{e}_i' \boldsymbol{\psi}_h(\tau)\boldsymbol{\Sigma}(\tau)\boldsymbol{\psi}_h(\tau)'\boldsymbol{e}_i\right)}, \quad (3)$$

where $\Sigma(\tau)_{ii}$ represents the standard deviation of the error of the i-th equation at quantile τ, and $\boldsymbol{e}_i$ denotes a selection vector with value of one at the i-th element and zero elsewhere. Since the sum of the elements of each row in Equation (3) is not necessarily equal to 1, to achieve a unit sum, we can renormalize each entry in the equation as follows:

$$\tilde{\theta}_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{k} \theta_{ij}^{g}(H)}. \tag{4}$$

In this case it follows that $\sum_{j=1}^{k} \tilde{\theta}_{ij}^{g}(H) = 1$ and $\sum_{i,j=1}^{k} \tilde{\theta}_{ij}^{g}(H) = k$. Equation (4) therefore serves as a measure of the pairwise directional spillover from variable j to variable i, describing the extent to which the expected variation in variable i H periods ahead can be attributed to variations in variable j.

Additionally, we can compute a total directional spillover statistic for variable i, by adding up all spillovers received from other variables j in the system, as follows:

$$S_{i\leftarrow\circ}^{g}(H) = \sum_{\substack{j=1 \\ j\neq i}}^{k} \tilde{\theta}_{ij}^{g}(H), \tag{5}$$

Similarly, the total directional spillover transmitted by variable i to other variables j is given by:

$$S_{\circ\leftarrow i}^{g}(H) = \sum_{\substack{j=1 \\ j\neq i}}^{k} \tilde{\theta}_{ji}^{g}(H), \tag{6}$$

Other statistics commonly employed in this literature, such as the "net spillover", which quantifies the difference between shocks given to and received from specific markets, are not utilized in the subsequent analysis. Our focus remains solely on spillovers originating from the US Term Spread to all other variables.

4. Data

Our dataset comprises daily trading data between January 5, 2005, and February 4, 2024, incorporating Credit Default Swaps, foreign exchange rates, and stock market prices across Brazil, Chile, Colombia, Mexico, and Peru. The US Term Spread was calculated as the difference between 10-year and 3-month US government bond yields. All other series underwent log-differentiation to ensure stationarity before incorporation into the QVAR system, except for the Term Spread. We retrieved our data from Bloomberg.

Regarding the stock markets, we utilized MSCI indexes for Colombia and Peru, IBOVESPA for Brazil, IPC for Mexico, and IPSA for Chile. We employed a 5-year senior maturity for CDS, with results for a 10-year maturity presented in the Appendix for all markets except Chile due to missing data at the beginning of the sample period at this specific maturity. Foreign exchange rates were expressed as domestic currency units per US dollar, with high quantiles corresponding to "depreciations" and low quantiles to "appreciations".

In Table 1 we present the descriptive statistics of our variables, including the number of observations, mean, standard deviation, minimum and maximum of each variable. As can be observed all variables re-centered at zero, except for the Term Spread, as expected. The most volatile variables are in all cases the CDS series and the least volatile the FX market.

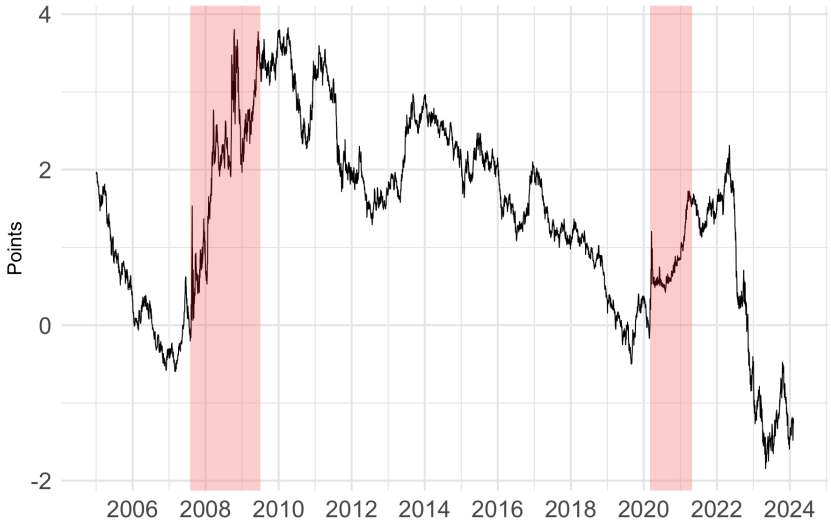
In Figure 1, our main variable, the US Term Spread is depicted. The red shadowed areas correspond to the Global Financial Crisis (August 1, 2007, to June 30, 2009) and the COVID-19 crisis (March 1, 2020, to April 30, 2021). It can be observed that these two crisis periods were characterized by increasing spreads, while other periods were mainly associated with decreasing spreads. In addition to these two global crisis episodes, the sample period also includes the European debt crisis, from 2009 to late 2010.

Table 1. Summary Statistics

Variable	N	Mean	St. Dev.	Min	Max
Term_Spread_US	4,982	1.384	1.218	-1.845	3.826
Stock_Colombia	4,982	0.005	0.796	-9.51	7.163
FX_Colombia	4,982	0.005	0.349	-3.301	2.613
CDS_5Y_Colombia	4,982	-0.005	1.498	-16.194	18.687
Stock_Brazil	4,982	0.014	0.72	-6.946	5.94
FX_Brazil	4,982	0.005	0.448	-3.295	3.089
CDS_5Y_Brazil	4,982	-0.007	1.499	-16.181	17.579
Stock_Peru	4,982	0.014	0.814	-7.167	5.658
FX_Peru	4,982	0.001	0.151	-1.237	1.543
CDS_5Y_Peru	4,982	-0.009	1.515	-16.148	20.847
Stock_Mexico	4,982	0.013	0.503	-3.156	4.534
FX_Mexico	4,982	0.004	0.334	-2.889	3.464
CDS_5Y_Mexico	4,982	0.001	1.598	-18.068	19.739
Stock_Chile	4,982	0.011	0.483	-6.608	5.126
FX_Chile	4,982	0.005	0.316	-3.201	2.032
CDS_5Y_Chile	4,982	0.007	1.604	-23.89	23.484

Note: The table presents the number of observations (N), mean, standard deviation, minimum, and maximum values of each variable in the study sample. The frequency of the variables is daily, covering trading days from January 3, 2005, to February 4, 2024. The source of this data is Bloomberg.

Figure 1. Term Spread US



Note: The spread was constructed as the yield difference between 10-year and 3-month US government bonds. Shadowed areas correspond to the Global Financial Crisis and the Covid-19 crisis.

5. Results

Our focus is on understanding how global economic shocks, represented by the US treasury bond term-spread, affect twin risks in five important Latin American economies. We hypothesize that these twin risks stem from significant global economic shocks. Given that systemic shocks are typically much larger than average, it's uncertain whether their propagation mirrors that of smaller shocks. To address this uncertainty, we employ the QVAR framework introduced by Ando et al. (2022) to compute spillovers.

For each Latin American country in our dataset, we estimate bivariate models integrating two variables: the US Term Spread and a domestic market indicator. Our primary domestic indicators consist of sovereign debt CDS and foreign exchange rates, aimed at discerning the impact of global economic shocks on default and depreciation risks. Additionally, we include stock prices for comparative purposes.

Our results are summarized in Figures 2 to 6 and Table 2. Figures 2 through 6 illustrate directional spillovers at the 5th, 50th, and 95th percentiles from the US Term Spread. The Global Financial Crisis (GFC) and the Covid-19 pandemic crises are highlighted in red for reference. Table 2 presents a summary of the statistics

used to construct the figures, partitioning the samples into the GFC, the Covid-19 crisis, and the entire sample period. We start our analysis with Table 2, which helps us to extract general patterns regarding our study questions.

Table 2 illustrates the transmission of spillovers from the US Term spread to the FX and CDS markets of Latin American countries. Each sub-table's initial column shows the statistic's name, specifying whether it pertains to the FX or CDS markets, alongside the percentile at which it was constructed (0.95, 0.05, or median). Following this, the second column represents the data subset during the Global Financial Crisis, the third column depicts the Covid-19 crisis subset, the fourth column captures the entire dataset, and the final column pertains again to the complete dataset, but this time excluding the two crises. All indicators are expressed in percentage points (pp), indicating the forecasting power of the US Term spread across different quantiles and during specific time periods, ranging from 0 to 100 by design.

Table 2. Time Average Spillovers at Different Quantiles for FX and CDS Markets

Brazil	GFC	Covid-19	Full	Exc. Crises
FX median	0.7	0.85	3.16	3.65
FX 0.95	46.37	31.9	35.35	34.22
FX 0.05	33.05	31.91	32.76	32.79
CDS med.	0.56	7.95	5.99	6.53
CDS 0.95	46.63	41.28	35	33.04
CDS 0.05	33.56	23.95	31.08	31.31

Chile	GFC	Covid-19	Full	Exc. Crises
FX median	0.6	3.77	1.98	2.02
FX 0.95	43.55	35.5	35.36	34.31
FX 0.05	33.53	30.34	33.4	33.62
CDS med.	0.26	8.67	3.87	3.95
CDS 0.95	48.54	38.28	35.9	34.11
CDS 0.05	28.75	24.72	31.18	31.99

Colombia	GFC	Covid-19	Full	Exc. Crises
FX median	1.62	6.14	2.81	2.71
FX 0.95	48.58	32.17	35.43	34
FX 0.05	33.53	27.28	33.04	33.43
CDS med.	0.64	10.25	6.1	6.48
CDS 0.95	43.95	34.97	34.75	33.56
CDS 0.05	32.83	20.87	30.79	31.3

Mexico	GFC	Covid-19	Full	Exc. Crises
FX median	0.8	5.3	5.23	5.78
FX 0.95	45.49	42.35	35.91	34.2
FX 0.05	30.55	27.96	32.29	32.85
CDS med.	0.72	11.01	5.88	6.14
CDS 0.95	47.06	40.4	35.28	33.38
CDS 0.05	32.51	23.04	30.91	31.32

Peru	GFC	Covid-19	Full	Exc. Crises
FX median	0.69	1.94	1.62	1.72
FX 0.95	47.71	31.05	34.71	33.34
FX 0.05	33.68	29.83	33.02	33.18
CDS med.	0.63	9.48	5.66	6
CDS 0.95	46.28	35.76	35.11	33.64
CDS 0.05	32.95	25.58	31.18	31.39

Note: The table displays the spillovers from the US Term spread to the FX and CDS markets of five major Latin American countries: Brazil, Chile, Colombia, Peru, and Mexico. The first column in each sub-table shows the name of the statistic, indicating whether it concerns to the FX or CDS markets, and the percentile at which it was computed (0.95, 0.05, or median). Subsequently, the second column corresponds to the subsample during the Global Financial Crisis, the third column to the Covid-19 crisis, the fourth column to the entire sample, and the last column presents the full sample excluding the two crises.

5.1. Price versus risk spillovers

Here we focus on the statistics for the whole sample period, which is located at the fourth column of each sub-table in Table 2. Several notable findings deserve attention. *Firstly, median (price) spillovers consistently appear lower than tail (risk) spillovers across all markets and countries throughout the sample period.*

For instance, in the FX market of Brazil for the full sample, price spillovers amount to 3.16 percentage points, whereas the corresponding risk spillovers for the two tails of the distribution range between 33 and 34 pp. This pattern is also evident in the sovereign debt market. For the same country, price spillovers in this case stand at approximately 5.99 pp, while they heighten to between 31 and 35 pp for the two tails, which measure the risk spillovers.

The situation is remarkably similar for the other markets in our sample. In Chile, price spillovers amount to 1.98 and 3.87 pp for the FX and CDS markets, respectively. However, these spillovers escalate to between 33.4 and 35.36 in the case of the FX market and between 31.18 and 35.9 for the sovereign debt market at the extreme quantiles, presenting an even greater contrast than that observed in Brazil. In Colombia, Mexico, and Peru, the increases from the median to the tails are equally noteworthy, consistently rising from single-digit spillovers in the median to over 30 pp spillovers in the tails, which are associated with risk spillovers.

This general pattern suggests that examining the entire distribution of spillovers offers a more comprehensive understanding of shock transmission to local Latin American markets compared to solely focusing on traditional median spillovers as per the approach of Diebold and Yilmaz (2012, 2014). This also points out that the transmission of global economic spillovers exhibits greater intensity in the extreme tails of the distributions of sovereign credit risk and currency risk compared to the median of these distributions. Consequently, solely computing price spillovers results in their underestimation.

5.2. Asymmetric tail (risk) spillovers

Our models are capable of tracking two distinct types of risk spillovers, each corresponding to one tail of the CDS and FX returns distributions. In FX markets, right-tail spillovers (at the 0.95 quantile) are associated with depreciation risks, while left-tail spillovers (at the 0.05 quantile) are linked to appreciation risks. Conversely, in the CDS market, spillovers lack a direct interpretation but rather reflect downside and upside risks in the CDS prices. Upside risks involve periods of significant increases in CDS prices, whereas downside risks entail the opposite. However, given the nature of CDS contracts, one might argue that the aforementioned downside risk, in practical terms, implies reduced sovereign risk overall. Interestingly, as CDS are traded frequently and

regulations concerning short positions in the region are lacking, they resemble other financial instruments and can be viewed as entailing risks in both tails, contingent upon the position of the contract holder (long or short).

As a general rule, depreciation spillovers tend to be greater than appreciation spillovers. However, this discrepancy is relatively modest, reaching a maximum of 1.43 percentage points in Brazil and a minimum of 0.16 pp in Peru. Similarly, when considering upside and downside risks in the CDS market, the overall pattern remains consistent, with upside risks outweighing downside risks. The difference, again, is only a matter of a few percentage points, slightly larger than the difference observed in the FX markets. The maximum difference recorded is 2.26 percentage points, observed in Colombia, while the minimum is 1.73 pp, observed in Brazil in this instance.

In short, during the sample period, *upside risks in both CDS and FX markets, influenced by shifts in the US Term spread, exceed downside risks, in a modest fashion*. Upside risks in sovereign markets are positively correlated with depreciation risks in FX markets, while downside risks reflect dynamics akin to appreciation risks in FX markets. This phenomenon serves as direct evidence of the Twin Ds phenomenon in the region, originating from changes in the Term spread.

5.3. Pricing spillovers in crises versus calm periods

The dynamics of pricing spillovers exhibit significant differences between the Global Financial Crisis and the Covid-19 crisis. In Section A, we analyze the case of the GFC, while Section B addresses the Covid-19 crisis.

A. Pricing spillovers during the GFC

Price spillovers were smaller during the GFC than in regular times for all five countries. For instance, in Brazil's FX market, price spillovers amounted to 0.7 pp during the GFC, whereas for the full sample, this number was 3.16 pp. Similarly, for Chile's FX market, these numbers were 0.6 pp and 1.98 pp, respectively. This pattern is consistent across the other markets: Colombia (1.62 and 2.81), Mexico (0.8 and 5.23), and Peru (0.69 and 1.62).

Turning to the CDS markets, the difference is even more remarkable. Price spillovers in Brazil averaged 0.56 pp during the GFC, while they increased to 5.99 pp for the full sample. Regarding Chile, Colombia, Mexico, and Peru, the numbers are 0.26-3.87, 0.64-6.1, 0.72-5.88, and 0.63-5.66, respectively, indicating a reduction of the spillovers during the GFC compared to regular times.

These results contrast with those of Odendahl et al. (2023), who find that during low-growth periods, the Term spread holds greater forecasting power on financial markets (in particular stocks) than during other economic states. However, this disparity does not contradict our findings, as our focus lies on the predictive power of the US Term spread at the median of the non-US markets of CDS and FX. This is interesting as it implies that while the Term spread serves as a useful domestic predictor from the US perspective, in the stock market, the decoupling of markets occurring during this major global financial debacle prevented it from being useful for forecasting external markets, particularly Latin American markets.

B. Pricing spillovers during the Covid-19

Notably, the predictability patterns observed regarding price spillovers at the median during the GFC did not emerge during the pandemic crisis. With the sole exception of currency markets in Brazil, which witnessed a reduction in price spillovers to 0.85 from 3.16 in the full sample period, all other major Latin American markets either experienced no significant increase in price spillovers during the pandemic (such as Mexico FX, with 5.3 pp during the Covid-19 period versus 5.23 during the whole period; and Peru FX with 1.94 versus 1.62, respectively), or even demonstrated an increase in predictability in line with Odendahl et al. (2023).

This increase was observable in Colombia's currency markets (6.14 during the pandemic against 2.81 in total) and Chile (3.77 versus 1.98 pp, respectively), as well as in all five CDS markets, where the increment in predictability was widespread. This increment ranged from the maximum difference observed in Mexico's sovereign market as high as 5.13 pp (11.01 in the Covid pandemic and 5.88 for the whole sample) to the minimum, yet still significant, difference of 3.82 pp for Peru, which changed from 5.66 in the full sample analysis to 9.48 pp during the pandemic.

This divergence in the signals that the US Term spread sends to Latin American markets may be attributable to the accumulation of international reserves in the region between the two crisis periods (almost USD 0.32 trillion for the region as a whole, and USD 0.31 trillion for the whole sample between 2009 and 2020 according to the IMF). Increased reserves denominated in US dollars may contribute to greater market integration, thereby aligning the fate of global financial markets more closely with those of Latin America, at least in terms of the pricing predictability exerted by global economic shocks.

5.4. Risk spillovers in crises versus calm periods

Just as with pricing spillovers, there are notable differences in the dynamics of risk spillovers during the GFC and the Covid-19 crisis. Section A provides an analysis of the GFC, while Section B explains the specifics of the Covid-19 crisis.

A. Risk spillovers during the GFC

Risk spillovers manifested asymmetrically in both CDS and currency markets during the GFC. Across the five countries examined in our study, during the GFC, marked by positive and expanding spreads- term-spread shocks wield a disproportionately greater impact on the depreciation tail within currency markets compared to the appreciation tail, which indeed remained unaltered during this crisis. This signifies that currency markets were more sensitive to negative shocks, leading to greater depreciation risks during this period of economic turmoil.

To illustrate our point, let's consider the case of Brazil. During the GFC, depreciation spillovers amounted to 46.37 percentage points, compared to 35.35 pp for the full sample. Conversely, appreciation tail spillovers in the FX market averaged 33.05 pp during this crisis, a figure very close to the total average spillover for the full sample, which is 32.76 percentage points. This pattern holds true for all other markets as well. In Chile, there was a notable increase in depreciation risks during the GFC, rising from 35.36 to 43.55 percentage points. Similar increments were observed in Colombia (from 35.43 to 48.48), Mexico (from 35.91 to 45.49), and Peru (from 34.71 to 47.71), all showing very similar patterns. In contrast, akin to the case of Brazil, appreciation tail spillovers remained largely unchanged during the crisis, with differences of less than one percentage point in all cases, and even negative in the case of Mexico (-1.74), indicating a reduction in appreciation tail spillovers during the GFC.

Regarding the sovereign debt markets, fluctuations in the term spread also exerted a more pronounced effect on the upside risk tail than on the downside risk tail, highlighting the increased vulnerability of countries to credit risk during times of heightened uncertainty. In Brazil, Chile, Colombia, Mexico and Peru CDS upside risks spillovers during the GFC amounted to 46.63, 48.54, 43.95, 47.06 and 46.28 while for the full sample these values correspond in the same countries to 35, 35.9, 34.75, 35.28 and 35.11. That is, increments of around 10 percentage points in each case. This contrast with what happened for the left tail, which either increased very few, around 2 percentage points (Brazil, Colombia, Mexico, Peru) with respect to regular times, or decreased (Chile, -2.43 pp).

Combining evidence from both FX and CDS markets, we can infer that upside risk tails are significantly more responsive to the US Term spread. This observation indeed reflects a manifestation of the Twin Ds phenomenon.

Finally, the noteworthy observation that risk spillovers in both CDS and currency markets significantly escalate across all five countries in our sample during the GFC, despite the differing macroprudential measures adopted by these countries, highlights the increase in tail risk during periods of heightened global uncertainty. Notably, countries like Brazil, Chile, and Colombia implemented capital controls during this tumultuous period, whereas others like Mexico and Peru did not. This finding suggests that the amplification of tail risk during times of elevated global uncertainty remains consistent irrespective of the macroprudential measures implemented in the recipient countries of these spillovers.

B. Risk spillovers during the Covid-19

For all countries in both CDS and FX markets, the left tail decreased during the Covid-19 crisis. The situation was more varied for the right tail but, in general, effects were lower in magnitude than during the GFC. This observation can also be linked to the accumulation of international reserves during the two periods.

Regarding the CDS market, the right tail spillovers were by general rule greater during the Covid-19 crisis, than in the full sample. Although there are notorious differences between countries: the increments in Colombia (0.22 pp) and Peru (0.65) were small, while in increments in Brazil (6.28), Chile (2.38) and Mexico (5.12) were notable larger.

Regarding the FX market, again there are heterogeneities which merit consideration. While the risk spillovers decreased for Brazil (-3.45 pp), Colombia (-3.26), and Peru (-3.66), for Chile it remained almost unaltered (0.14 pp of change), and only for Mexico the risks spillover on the depreciation tails increased by 6.44 percentage points. Although this difference is indeed notorious it is still smaller than the increment observed for the same market and country during the GFC, amounting to 9.58 percentage points.

5.5. Dynamics during the sample period and comparison to stock markets

Now, we turn our attention to Figures 2 to 6, where we illustrate the time evolution of the spillover statistics, including spillovers to the stock markets for the sake of comparison. The plots illustrate the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps, foreign exchange, and stock markets in our set of countries. All statistics are based in a bivariate QVAR(1) model.

The forecast error variance decomposition depicted in the diagrams has a horizon of 20 days. The GFC and Covid-19 crises are highlighted in red. In general, a visual examination of the first two panels of each figure validates the findings outlined in our analysis in the previous sections 5.1 to 5.4.

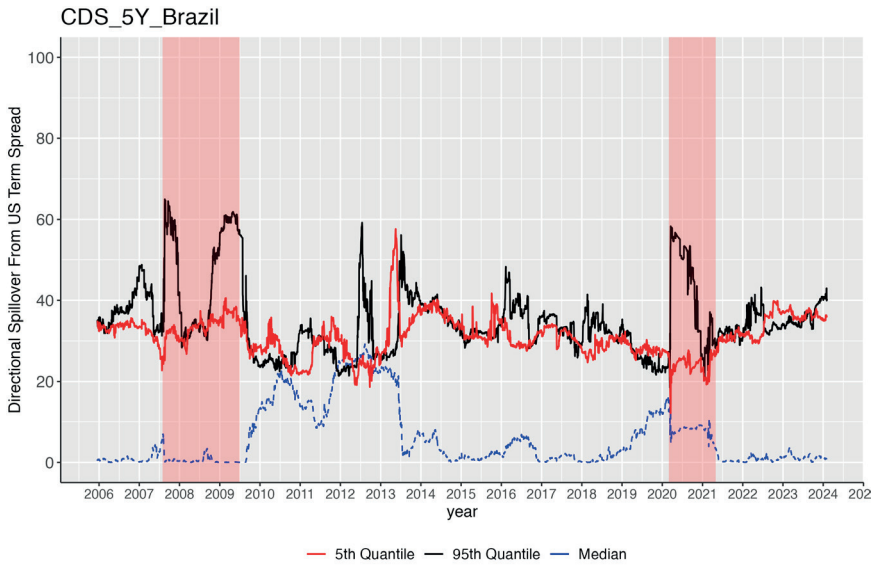
The patterns documented before are not mirrored in stock markets, which exhibit a distinct behavior from the parallel dynamics observed in currency and sovereign debt markets throughout the duration of our analysis. In particular, the most affected tail in stocks is once again the upside risk tail. However, in this case, the tail corresponds to increments in prices of domestic companies (i.e. positive returns) listed on the stock market rather than to losses. Additionally, it is noteworthy that for Mexico, the timing of the shock during the GFC on the right tail differed compared to the twin markets; it was delayed until the end of the crisis. For other countries such as Chile, Colombia, and Peru, which also experienced significant spillovers at the beginning of the crisis, these spillovers were considerably less persistent than those observed in the CDS and FX markets. Only in Brazil were the dynamics similar compared to the twin markets during the GFC, with two spillover peaks slightly less persistent than those of CDS and FX.

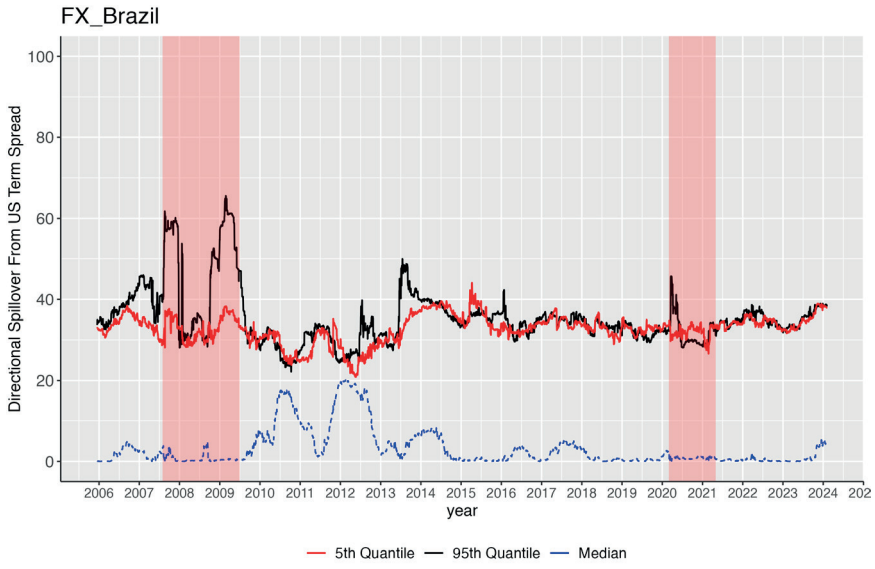
While the dynamics of the twin markets and the stock market exhibited some similarities during the GFC crisis, these resemblances vanished entirely during the Covid-19 Crisis. An aspect that becomes evident from the plots, and which escaped our analysis in Table 2, is that during the Covid-19 crisis, there was indeed a peak in the spillovers of both CDS and FX upside risk tails. However, these peaks were very short-lived and, as a result, did not significantly influence the average spillover statistics for the entire sub-period. In contrast, these peaks were entirely absent from the stock market. We can venture that although present at the onset of the pandemic, the risk of the Twin Ds dissipated when major central banks worldwide, including the Federal Reserve and the European Central Bank, intervened in the market on an unprecedented scale to provide liquidity and solvency, not only to financial intermediaries but also to the real economy. This dissipated the fears of a liquidity drought that had been fueling the potential for a sudden stop in the Latin American region, thus allowing the shock from the Term spread to dissipate rapidly. Interestingly, the shock never manifested in our statistics constructed for the stock markets, validating that the Term spread, especially in recent times, primarily acts as a driver of the Twin Ds rather than other general shocks affecting all globally integrated markets.

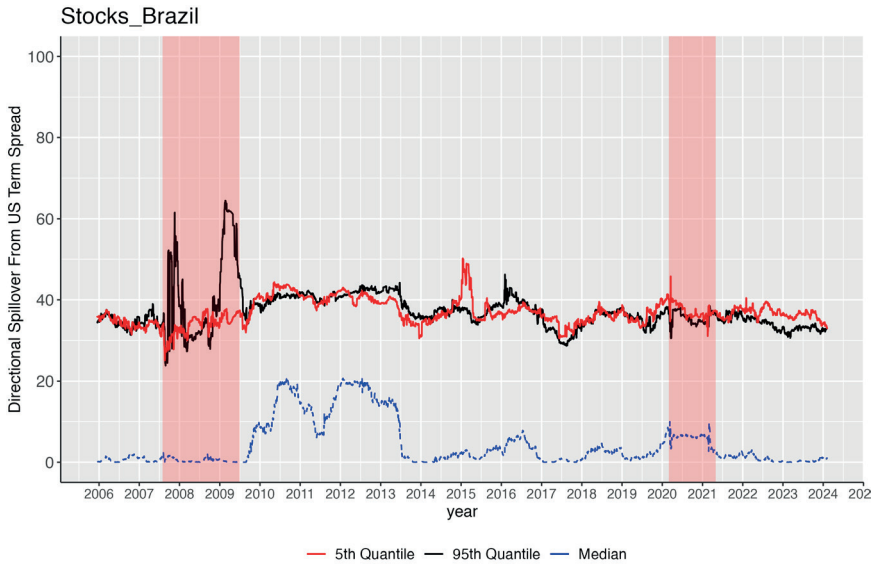
Another noteworthy observation from the plots, which has eluded our consideration thus far due to Table 2 emphasis solely on the two major crisis periods, is that in all countries, the years 2012-2014 also exhibited increases in the spillover statistics of the twin markets, thereby heightening the likelihood of a Twin Ds occurrence (this fact is also evident in the CDS with 10 years maturity in the Appendix, especially for Peru and Colombia). This period was marked by another significant event in sovereign markets, linked to the European debt crisis, and the debt issues of southern and peripheral European countries, notably Greece and Ireland,

as well as concerns regarding Spain, Portugal and Italy. These crises cast doubt on sovereign debt and heightened global fears of default, naturally reflected in our spillover statistics for that period. Once again, this dynamic was evident only in the twin markets, while the stock market remained unaffected, reinforcing our interpretation of Term spillovers in terms of the Twin Ds phenomenon.

Figure 2. Directional Spillovers: Brazil

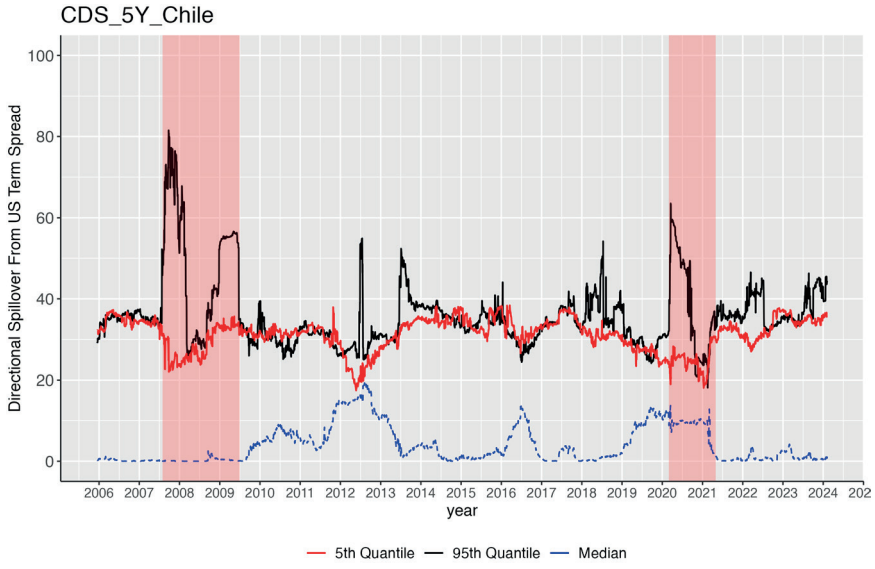


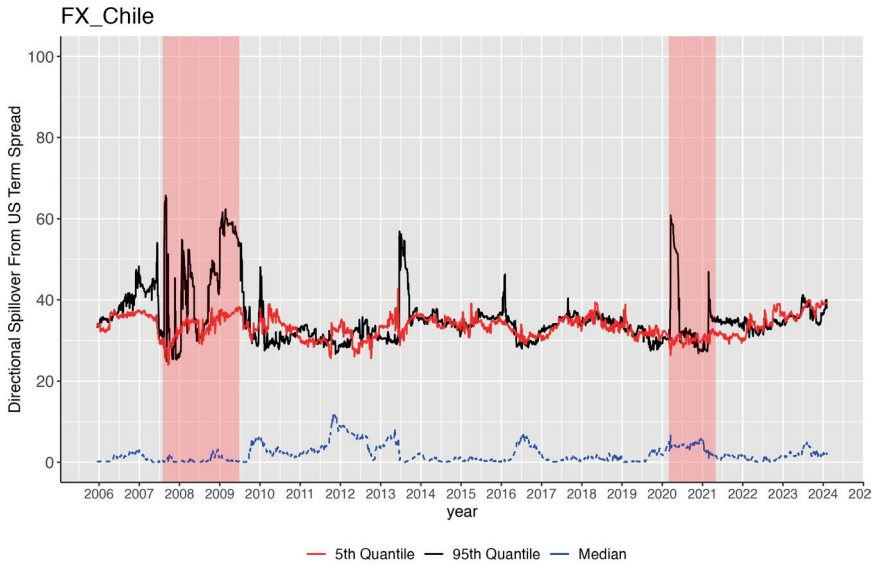


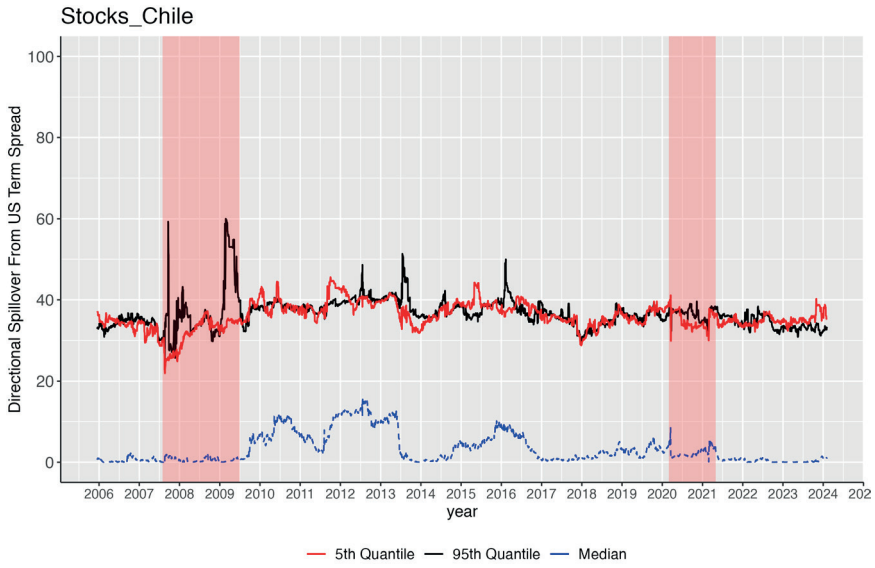


Note: The figure shows the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps, foreign exchange, and stock markets in Brazil. All variables underwent log-difference transformation before being incorporated into the QVAR(1) model. The forecast error variance decomposition used in the figure has a horizon of 20 days. The GFC and Covid-19 crises are marked in red.

Figure 3. Directional Spillovers: Chile

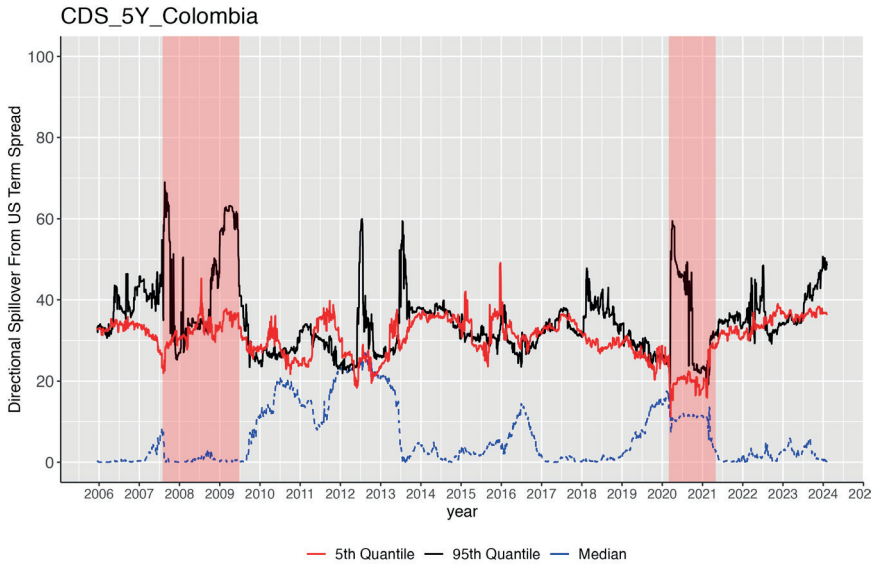


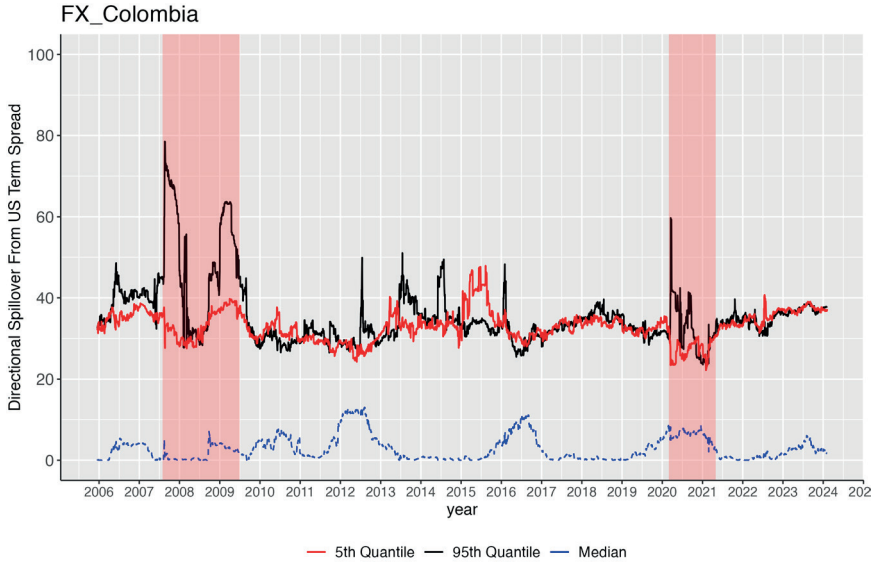


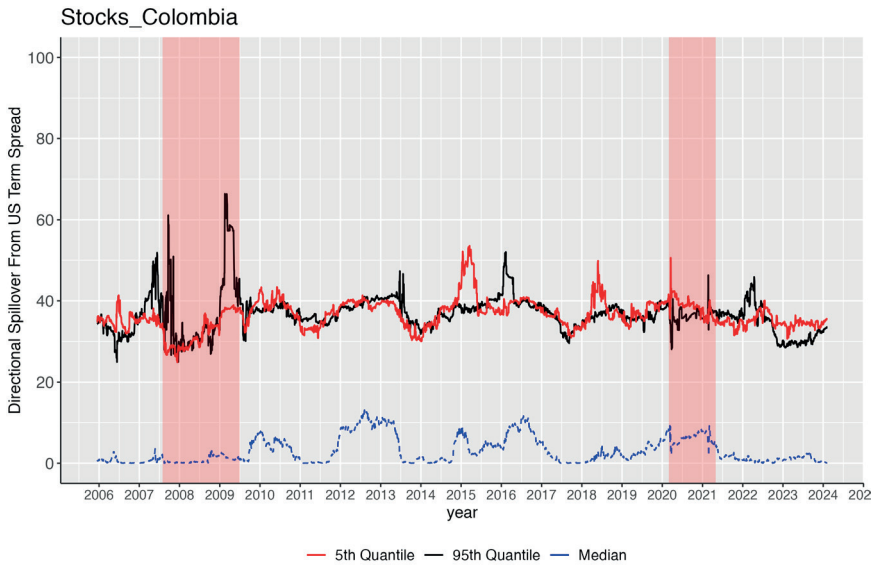


Note: The figure shows the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps, foreign exchange, and stock markets in Chile. All variables underwent log-difference transformation before being incorporated into the QVAR(1) model. The forecast error variance decomposition used in the figure has a horizon of 20 days. The GFC and Covid-19 crises are marked in red.

Figure 4. Directional Spillovers: Colombia

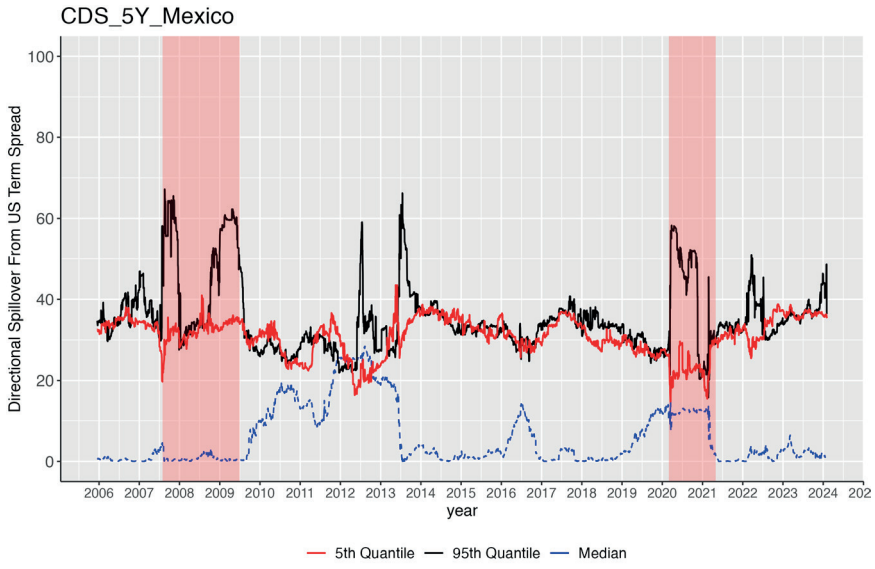


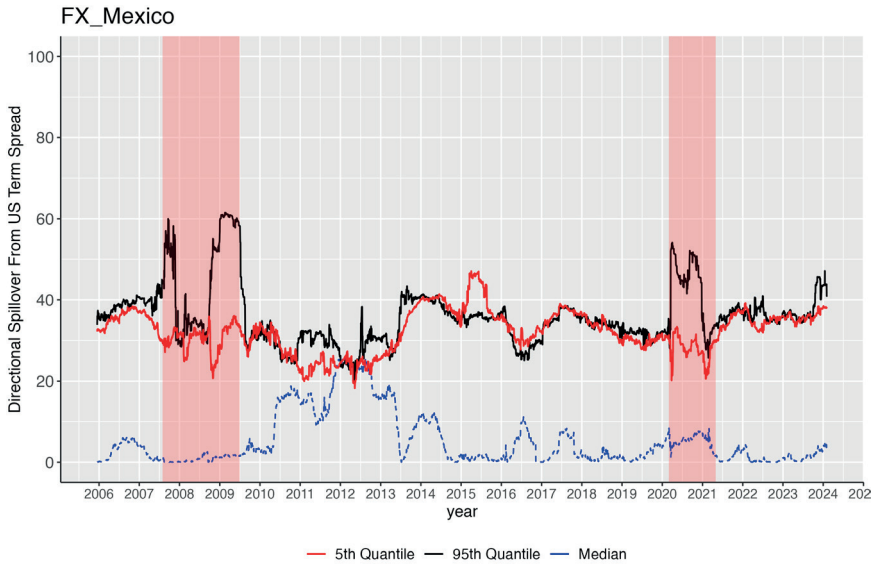


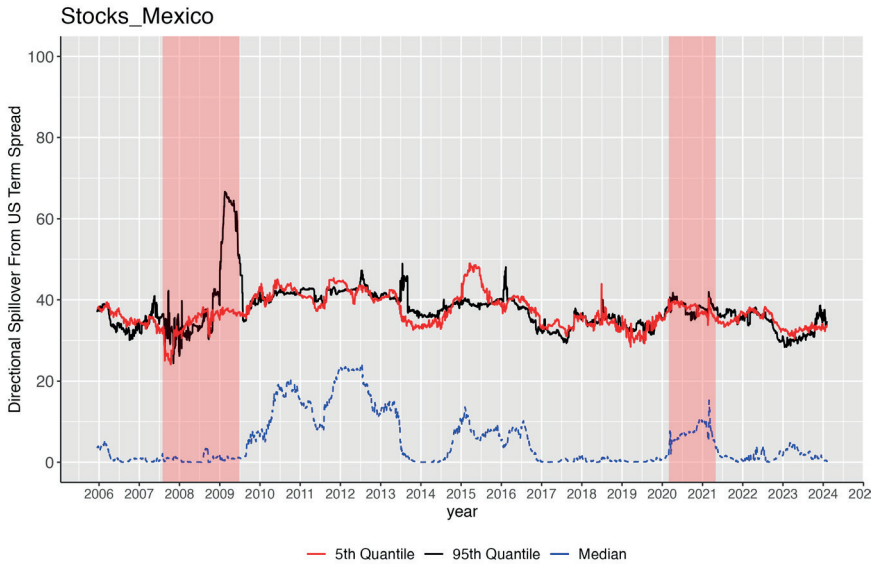


Note: The figure shows the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps, foreign exchange, and stock markets in Colombia. All variables underwent log-difference transformation before being incorporated into the QVAR(1) model. The forecast error variance decomposition used in the figure has a horizon of 20 days. The GFC and Covid-19 crises are marked in red.

Figure 5. Directional Spillovers: Mexico

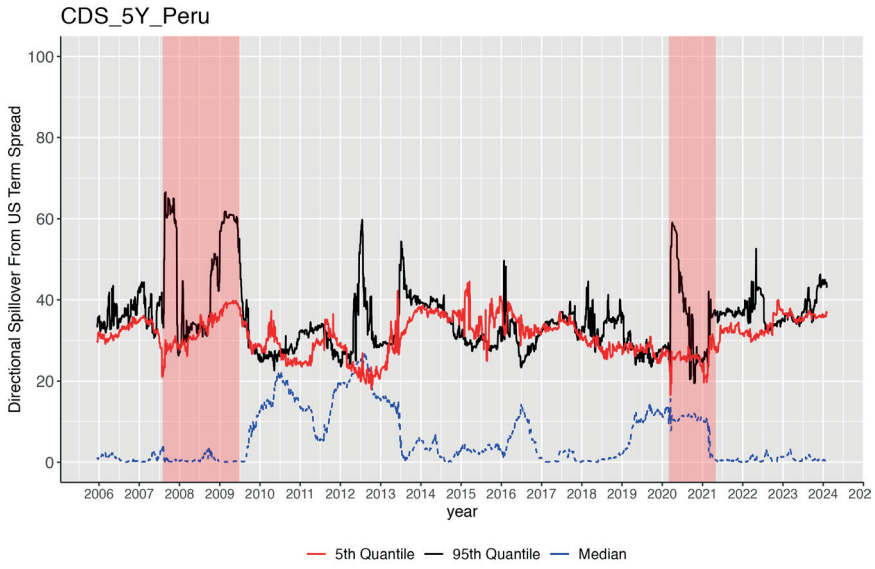


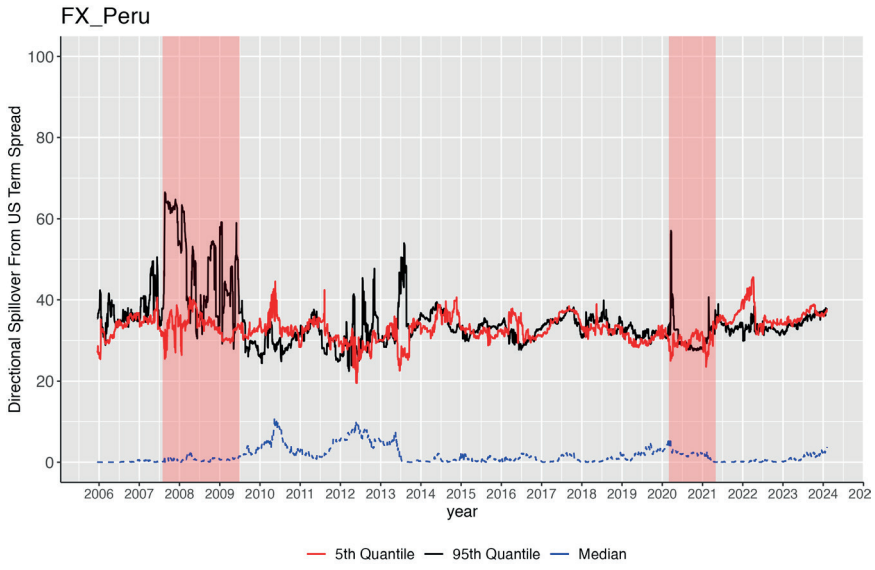


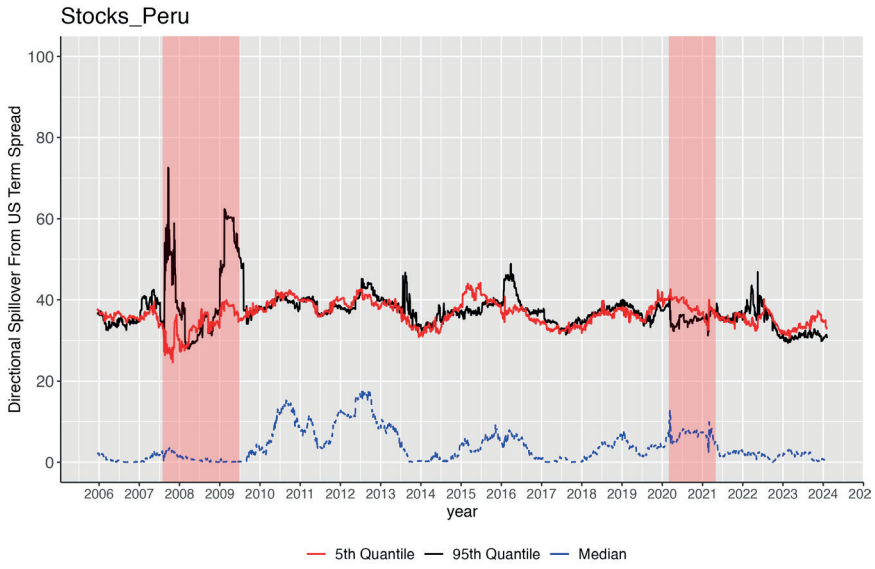


Note: The figure shows the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps, foreign exchange, and stock markets in Mexico. All variables underwent log-difference transformation before being incorporated into the QVAR(1) model. The forecast error variance decomposition used in the figure has a horizon of 20 days. The GFC and Covid-19 crises are marked in red.

Figure 6. Directional Spillovers: Peru







Note: The figure shows the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps, foreign exchange, and stock markets in Peru. All variables underwent log-difference transformation before being incorporated into the QVAR(1) model. The forecast error variance decomposition used in the figure has a horizon of 20 days. The GFC and Covid-19 crises are marked in red.

Our previous analysis emphasizes the importance of global economic factors, represented by the US Treasury bond term spread, in shaping the Twin Ds phenomenon in Latin American countries. It highlights that these factors don't uniformly affect all markets within these countries but instead wield significant influence on both default risk and depreciation risk.

Upon examination of these patterns, common to all markets in our sample, we emphasize the necessity of integrating risk spillovers into the formulation of policy instruments across the region, as well as in other significant emerging market economies globally. It's worth highlighting that our analysis reveals how risk spillovers surpass price spillovers, which aligns with expectations. This is because, at the core of the variables' distribution, the asymmetric effects counterbalance each other, resulting in a masking of the true nature and magnitude of the original shocks.

In essence, the more traditional examination of price or volatility spillovers in currency and sovereign debt markets inherently imposes a certain symmetry on the analysis, implicitly assuming that for any given country, the situation equates to facing either depreciation or appreciation pressures, or upside and downside risks in the CDS markets. This assumption is, at the very least, debatable. In the worst-case scenario, central banks

may resist market pressures when faced with appreciation, to the extent they are willing or politically prone to intervene. Conversely, their capacity to respond is much more constrained during episodes of depreciation, where they are constrained by the lower limit of international reserves.

It's worth noting that by definition, currency crises are associated with periods of depreciation or devaluation, rather than episodes of appreciation or revaluation (Krugman, 2000). Therefore, the Twin Ds phenomenon emerges predominantly on the right tails of both markets, rather than on the left tails. In terms of financial stability, episodes of depreciation hold greater significance than those of appreciation, particularly for Latin America. The indicators employed to monitor the twin markets should explicitly recognize this distinction. Our tail-spillover estimates can be used to construct a new financial stability indexes for the FX and CDS markets.

Our methodology allows for a specific focus on upside risk in currency markets, particularly pertaining to instances of global currencies depreciating against the US dollar, which closely aligns with the definition of a currency crisis. Recent empirical research suggests an asymmetric transmission of shocks, depending on whether they are linked to depreciation or appreciation episodes. This observation is supported by studies such as those conducted by Galagedera and Kitamura (2012), Baruník et al. (2017), and Chulia et al. (2018).

These works are in line with our findings, as they demonstrate that during the GFC, depreciation and appreciation pressures exhibited notable differences. Baruník et al. (2017) highlight dominant asymmetries in spillovers, which are predominantly associated with bad volatility. They also indicate that negative spillovers are often related to sovereign debt concerns, while positive spillovers are primarily associated with the global financial crisis. Similarly, Chulia et al. (2018) estimate quantile spillovers using data from 20 FX markets and find that quantile spillovers at the depreciation tails significantly differ from volatility spillovers, which are symmetric by construction, consistent with our empirical results.

The asymmetries in how shocks from the global economy, represented by the US Term spread, propagate become apparent when comparing different quantiles in our figures. The metrics we introduce are particularly pertinent for emerging market economies. In these contexts, depreciation pressures pose significant concerns as they have the potential to destabilize the balance of payments.

Conversely, for mature economies with more liquid currencies, appreciation or depreciation is often more closely linked to portfolio diversification, with comparatively smaller ramifications for the real economy.

That is, during periods of US dollar appreciation, typically characterized by a flight to quality and rising Term spreads, international investors tend to unwind their positions in less liquid currencies to invest in assets de-

nominated in US dollars, which are perceived as safer and more liquid. As a result, spillovers in both CDS and FX markets become more pronounced, leading to the manifestation of the Twin Ds phenomenon in the Latin American region.

According to our results, we have that for instance, given to the possibility of a currency crisis that a Latin American market may eventually face, less liquid currencies are more sensitive to depreciations than to appreciations and, therefore, sovereign risk exposure also increases, because CDS contracts will reflect a greater risk of default. For instance, in the event of a potential currency crisis that a Latin American market may encounter, after the realization of Term spread spillovers to the regions, currencies are more susceptible to depreciations than appreciations. Consequently, sovereign risk exposure also escalates, as CDS contracts would reflect a heightened risk of default on debt but also a simultaneous depreciation pressure coming from global markets.

Time-varying risk aversion may also play a significant role to understand our results. During stressful periods, when Term spreads are increasing, risk-averse investors are likely to be more responsive to changes in the valuation of their foreign asset holdings. This heightened sensitivity could lead to the propagation of upside risk across global currency markets, including in Latin America and to simultaneous increments in sovereign risks.

Aggregate risk aversion may fluctuate due to changes in either the risk aversion of the representative investor or the distribution of wealth among investors with varying risk aversion levels. The variation in risk aversion emerges as a significant factor to explain the dynamics described, especially given that our sample period encompasses the two major financial crises of the last century.

Indeed, previous literature has presented compelling evidence of a shift in risk aversion following the GFC. On one hand, studies by Bekaert et al. (2013) and Bekaert et al. (2022) decompose the VIX into a time-varying risk aversion component and a pure volatility component (or what they term uncertainty). They document an increase in risk aversion during the global financial crises, its aftermath, and the European debt crisis. On the other hand, Guiso et al. (2018) have provided evidence of a shift in individual risk aversion following the GFC. They accomplish this by analyzing portfolio choices and survey-based measures of risk aversion obtained from a sample of clients of a large Italian bank in 2007 and then repeated on the same individuals in 2009.

This insight suggests that policy frameworks need to account for the nonlinearities of global risk transmission, as these spillovers can have far-reaching implications for financial stability and economic resilience. By understanding and effectively managing risk spillovers, policymakers can better safeguard against potential vulnerabilities and enhance the resilience of their economies to external shocks. This is crucial for emerging

markets, and in particular, Latin American markets, where susceptibility to global economic fluctuations often necessitates proactive risk management strategies.

6. Conclusions

We present evidence for the five Latin American markets - Brazil, Chile, Colombia, Peru, and Mexico - regarding the concomitant occurrence of depreciation and default risks resulting from shifts in the US yield curve slope. Our sample excludes serial defaulters such as Argentina, focusing instead on countries that still raise significant concerns due to the potential emergence of the Twin Ds in a context characterized by high debt and debt burdens.

Our results point out that the Twin Ds in the region are, to a great extent, product of global spillovers. We interpret fluctuations in the US term spread as indicative of shifts in global economic conditions, encompassing expectations regarding monetary policy and future growth prospects.

Our statistics clearly indicate that the influence of global economic conditions is asymmetric in the two tails of the distributions of sovereign credit risk and currency risk. Specifically, for the five markets in our sample, during periods of positive and increasing spreads such as the global financial crisis or the Covid crisis, changes in the term spread have a greater impact on the depreciation tail in the currency markets compared to the appreciation tail. Additionally, they have a more pronounced impact on the high-risk tail in sovereign CDS markets than on the low-risk tail. This evidence stresses the significance of global economic conditions in explaining the Twin Ds in Latin America. Interestingly, these effects are not observed in the stock markets, which do not mirror the very similar dynamics observed in the currency and sovereign debt markets during the sample period.

The significant asymmetries we unveil by contrasting high, median, and low quantile spillovers are crucial for financial stability and should be factored into exercises aimed at monitoring financial fragility worldwide. Our findings also hold relevance for designing hedging mechanisms, which are of paramount importance for international investors.

For instance, international mutual fund managers typically maintain portfolios within specific target regions such as Latin America or Asian markets. Consequently, exchange rate volatility spillovers among neighboring countries could undermine the benefits of portfolio diversification for international investors.

This consideration is particularly pertinent in light of our results, when depreciation spillovers coming from changes in global economic conditions are observed. This is essential for understanding the diversification benefits of investing in non-mature markets, especially concerning positions in sovereign debt markets.

Emerging markets are particularly susceptible to fiscal sovereign crises (Gomez-Gozalez et al., 2023) and depreciation pressures, thus making them vulnerable to the depreciation spillovers addressed in our analysis. Indeed, quantile spillovers play a crucial role in understanding the speed of market adjustment to new information and the extent to which a country is exposed to potential contagion following the realization of a shock to global economic expectations, as measured by the Term spread.

Our key findings carry significant policy implications as well. Depreciation spillover poses a considerable concern for vulnerable economies, particularly emerging countries. In such contexts, accumulating international reserves and montery policy credibility emerge as optimal policy responses for countries highly susceptible to depreciation spillovers, especially those that are recipients of shocks, as the five we analyzed. The observed differences between the GFC and the Covid-19 crises appear to support this assertion.

Such a strategy has the potential to alleviate the burden imposed by depreciation pressures, primarily associated with the risk of currency crises. The accumulation of reserves and credible monetary policy frameworks send a signal to the markets, indicating the country's preparedness to counteract strong depreciation pressures. However, this process necessitates clear and systematic responses from monetary authorities, outlining the extent to which they would pursue stabilization policies when necessary to preserve the value of the domestic currency, and also necessary to signal commitment to debt repayment.

Our findings emphasize the importance of incorporating risk spillovers into the design of policy tools in the region, as well as in other major emerging market economies. It is notable that risk spillovers outweigh price spillovers, which is to be expected given that at the center of the variables' distribution, the asymmetric effects counterbalance each other, thereby obscuring the true nature and magnitude of the shocks.

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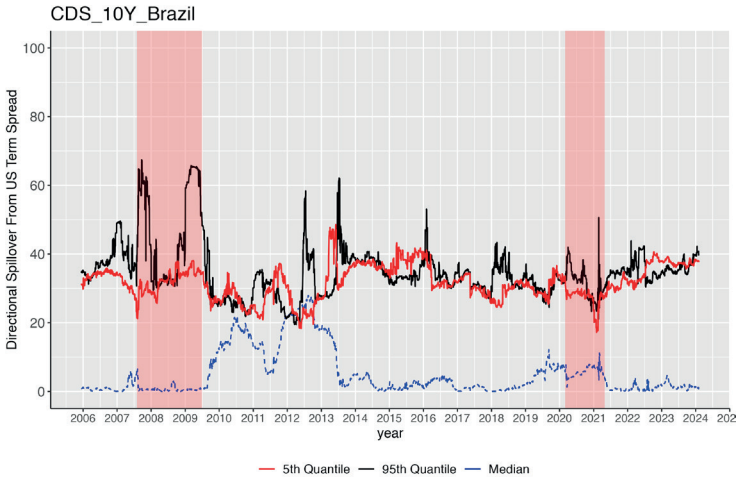
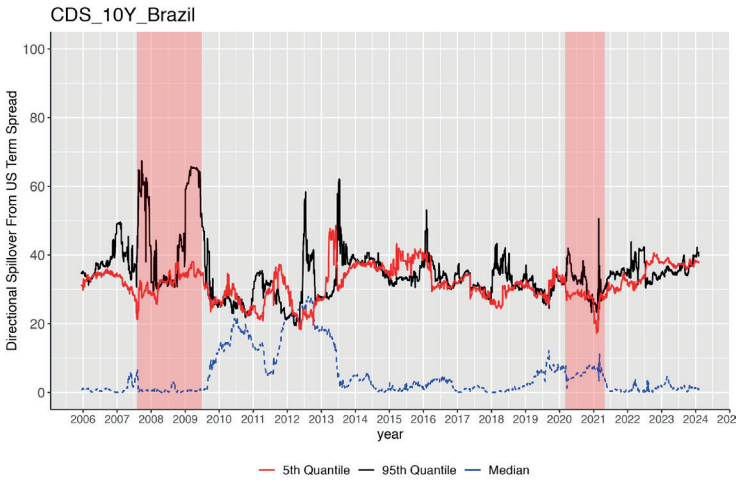
Appendix

Figure A1. Directional Spillovers: Brazil



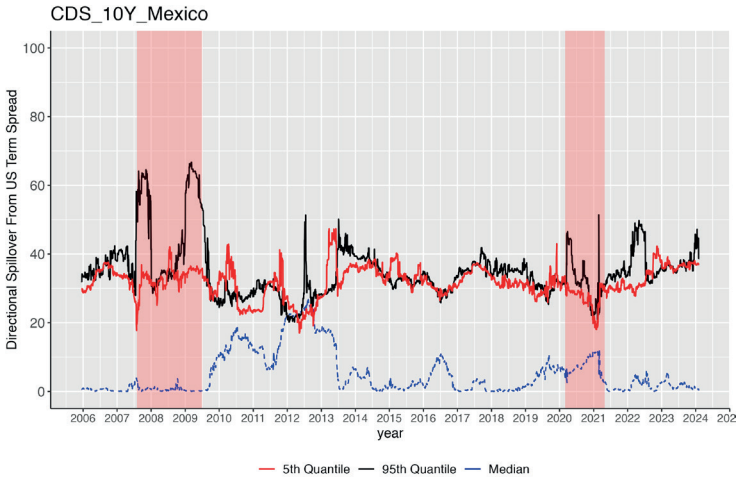
Note: The figure shows the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps with 10 years maturity in Brazil. All variables underwent log-difference transformation before being incorporated into the QVAR(1) model. The forecast error variance decomposition used in the figure has a horizon of 20 days. The GFC and Covid-19 crises are marked in red.

Figure A2. Directional Spillovers: Colombia



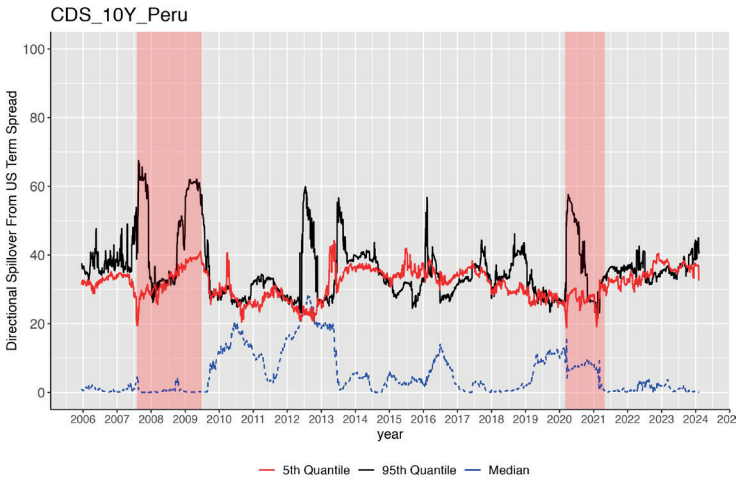
Note: The figure shows the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps with 10 years maturity, foreign exchange, and stock markets in Colombia. All variables underwent log-difference transformation before being incorporated into the QVAR(1) model. The forecast error variance decomposition used in the figure has a horizon of 20 days. The GFC and Covid-19 crises are marked in red.

Figure A3. Directional Spillovers: Mexico



Note: The figure shows the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps with 10 years maturity in Mexico. All variables underwent log-difference transformation before being incorporated into the QVAR(1) model. The forecast error variance decomposition used in the figure has a horizon of 20 days. The GFC and Covid-19 crises are marked in red.

Figure A4. Directional Spillovers: Peru



Note: The figure shows the directional spillover at the 5th, 50th, and 95th percentiles from the US Term Spread to sovereign credit default swaps with 10 years maturity in Peru. All variables underwent log-difference transformation before being incorporated into the QVAR(1) model. The forecast error variance decomposition used in the figure has a horizon of 20 days. The GFC and Covid-19 crises are marked in red.

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