Nexus between credit default swap spreads and foreign exchange rates: evidence from BRICST, E7, MINT and Fragile Five countries

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Abstract: The study investigates the nexus between credit default swap (CDS) spreads and foreign exchange (FX) rates in leading emerging countries, most of which CDS spreads are high and volatile. In this context, six leading emerging countries are included, daily data between October 8, 2004 and July 23, 2021 is used, nonlinear econometric models such as wavelet coherence (WC), Granger causality in quantiles (GCQ), and quantile-on-quantile regression (QQR) approaches are applied, and quantile regression (QR) is performed for robustness checks. The WC results show that there is bidirectional nexus between the CDS spreads and the FX rates. While the CDS spreads drive the FX rates until 2012, the FX rates drive the CDS spreads after this date. Also, the GCQ and QQR outcomes present that the nexus exists in almost all quantiles excluding middle quantiles (0.35, 0.40, 0.45, 0.50) and the highest quantile (0.95) for some countries whereas country-based results change.

Keywords: CDS spreads; FX rates; emerging countries; nonlinear approaches.

JEL codes: C32, F31.

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1 Introduction

In economies, there are a variety of macroeconomic and financial indicators like economic growth, credit default swap (CDS) spreads and foreign exchange (FX) rates (Ayhan and Kartal, 2021). These indicators can be used for different purposes like monitoring the progress of economies because they are significant for the stability of economies and the well-being of societies (Rahman et al., 2021). Hence, countries aim to

develop the living quality of citizens by achieving sustainability in such indicators as well as economic growth and development (Kartal et al., 2021a).

Although there are a lot of indicators, CDS spreads and FX rates take place among the most significant ones. These indicators reflect how economies are sound, risky, vulnerable and predictable against shocks (Kartal, 2020). Countries can decrease the uncertainty and volatility that result from such indicators. Moreover, achieving stability in such indicators can contribute to price, financial stability, and macroeconomic stability as well (Waqas et al., 2017; Rahman et al., 2021).

CDS spreads take place among important indicators. Generally, they are used as an insurance vehicle by lenders against the default risk of debt securities (Hibbert and Pavlova, 2017; Kartal, 2020). Besides, CDS spreads are used as an indicator of country risk. That is why because CDS spreads reflect the demanded premium. It is expected that CDS spreads are low when the risk of a country is low and vice versa.

Another important indicator is the FX rates. They are significant for almost all countries and economies since international activities are realised with FX payments, especially US dollar (USD) payments. Besides, FX rates can be used as an investment vehicle. Moreover, FX rates can affect domestic activities through cost channels.

When evaluating CDS spreads and FX rates together, it can be expected that FX rates increase while CDS spreads increase because they are both risk indicators (Ertuğrul and Öztürk, 2013; Fontana and Scheicher, 2016; Hassan et al., 2017; Kartal, 2020). Hence, it is expected that CDS spreads are high when FX rates are high and vice versa.

Due to the deep nexus between CDS spreads and FX rates, developments in CDS spreads and FX rates have an important effect on economies in a globalising world. They can affect a variety of decisions including international and domestic investors that have funds to be used for either direct or portfolio investments. Therefore, any adverse development in these indicators can affect economies negatively through different channels like increasing prices, deprecation of national currency, sudden-stop in portfolio flows, etc. For this reason, the progress of the CDS spreads and FX rates are monitored strictly by countries' economic management to prevent negative effects that can be resulted from these indicators on the macroeconomic, price, and financial stability.

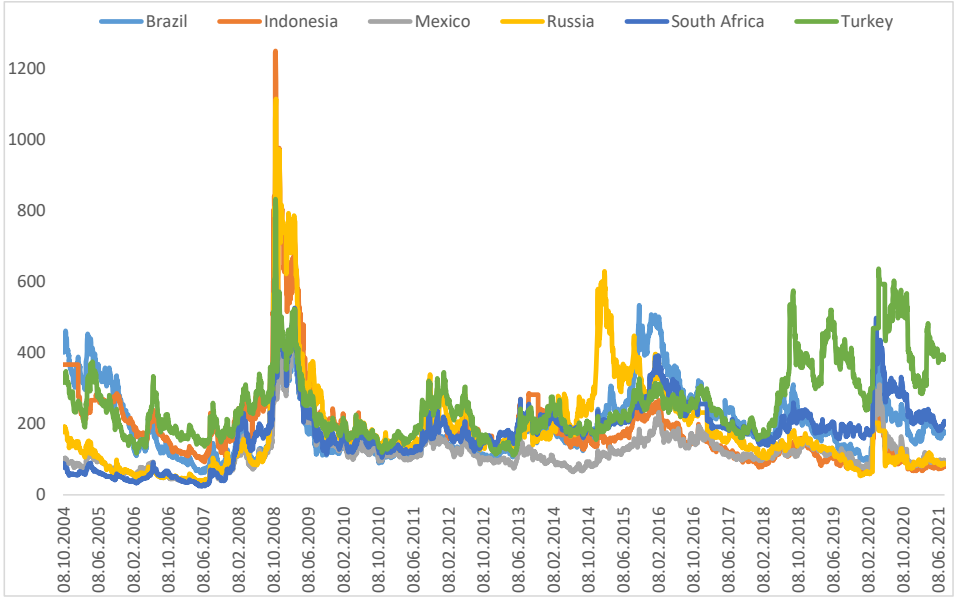
In developed countries, the CDS spreads and FX rates have a generally stable trend over time. Unfortunately, the case is different for emerging countries most of the time. They can face generally high volatility in CDS spreads and FX rates. Specifically, some emerging countries in BRICST, E7, MINT, and Fragile Five countries have a high and volatile trend. When the CDS spreads and FX rates are evaluated together, it can be stated that such emerging countries are negatively outlier countries. Thus, Figure 1 presents the progress of the CDS spreads for such emerging countries.

As Figure 1 presents, the CDS spreads of the emerging countries have a high and volatile trend. Especially, there is a quite high level around 2008 when the global crisis occurred. Also, a new increasing and volatile trend have been seen since 2018. Besides, Turkey has the highest CDS spreads among these countries currently followed by South Africa, Brazil, Mexico, Russia and Indonesia. Hence, Figure 1 implies that these emerging countries do not have a good conditions in terms of the progress of the CDS spreads. Moreover, Figure 2 presents the progress of the USD against the local currencies of these countries.

As Figure 2 presents, the FX rates in emerging countries have been increasing constantly. However, similar to the CDS spreads, FX rates changed around 2008 as well

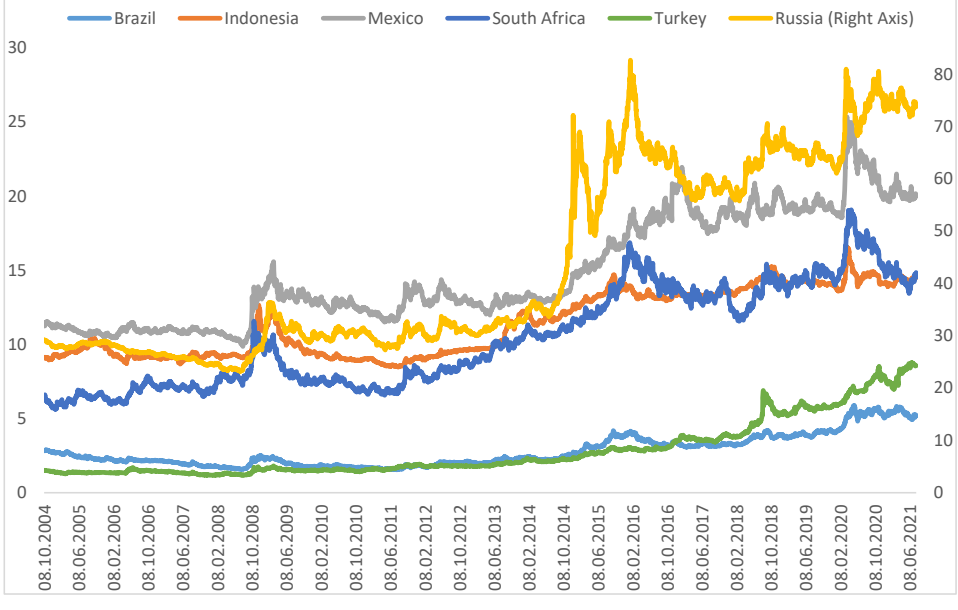
as in recent periods. Hence, Figure 2 implies that the emerging countries do not have a good conditions in terms of the stability of the FX rates.

Figure 1 The progress of the CDS spreads (see online version for colours)



Source: Bloomberg (2021)

Figure 2 The progress of the USD against local currencies (see online version for colours)



Source: Bloomberg (2021)

When considering the progress of the CDS spreads and FX rates in the leading emerging countries as presented in Figures 1 and 2, the following questions can be asked that:

1 what is characteristic of the nexus between CDS spreads and FX rates

2 does increase in CDS spreads (FX rates) cause an increase in FX rates (CDS spreads)?

3 is the nexus at the causality relevel (if any)?

4 does the nexus change at different quantiles of the variables and countries.

Thus, it can be hypothesised that there is a bidirectional nexus between CDS spreads and FX rates in emerging countries. By considering the leading position in the world economy and negatively outlier conditions in terms of the progress of the CDS spreads and FX rates, this study focuses on the leading emerging countries taking place in BRICST, E7, MINT, and Fragile Five countries groups. Hence, this study investigates the causal nexus between CDS spreads and FX rates by benefiting from examples of emerging countries. In the context of empirical analysis, novel nonlinear approaches such as the wavelet coherence (WC), Granger causality in quantiles (GCQ), and quantile-on-quantile regression (QQR) are applied. Besides, the quantile regression (QR) is applied for robustness checks of the QQR results. Also, daily data between October 8, 2004 and July 23, 2021 covering a long period is used. The outcomes of the analysis reveal that there is a significant linkage between CDS spreads and FX rates. Thus, the results highlight the importance of the CDS spreads (FX rates) for the FX rates (CDS spreads). By considering the analysis results, policy recommendations are also discussed. Hence, decision-makers in these countries can apply policies by considering the nexus between CDS spreads and FX rates.

This study has some contributions as follows: this study:

1 focuses on the leading emerging countries due to the having negative outlier condition in terms of the CDS spreads' progress

2 is the pioneering study that examines the nexus between two important indicators as the CDS spreads and FX rates for a bundle of six emerging countries as Brazil, Indonesia, Mexico, Russia, South Africa and Turkey

3 includes a very large and recent high-frequency (i.e., daily) data between October 8, 2004 and July 23, 2021 consisting of 4,381 observations

4 applies novel nonlinear methods as the WC, GCQ and QQR approaches.

Moreover, some policy recommendations are constructed based on the empirical results obtained from novel nonlinear approaches.

The remaining study consists of five sections. Section 2 reviews the literature. Section 3 explains objectives, scope, data and methodology. Section 4 presents the empirical results, discussion and policy recommendations. Section 5 concludes.

2 Literature review

In the literature, various studies handle both CDS spreads and FX rates. In the first group, various global and national (including macroeconomic and financial) factors are considered in terms of their effects on CDS spreads. For example, Afonso et al. (2007) investigate the function of the reserves in terms of sovereign risk. Hibbert and Pavlova (2017) consider global and local factors while studying CDS spreads. Kartal (2020) examines the CDS spreads by including global and macroeconomic factors. Also, Kartal et al. (2022a) consider international, macroeconomic, and market variables in examining CDS spreads' changes of Turkey. Similarly, Kartal et al. (2022b) include global, macro, and market variables. On the other hand, Akçelik and Fendoğlu (2019) use only macroeconomic factors. Similarly, Kartal (2022) use only macroeconomic and market variables while examining Turkey case by not considering international factors. Hence, it can be concluded that various indicators are considered to examine CDS spreads.

In the second group, FX rates are examined by many researchers. For example, the nexus between the FX rates and central bank reserves are examined by Chowdhury et al. (2014), Aizenman et al. (2015) and Ghosh (2016). Also, Kartal et al. (2018) study FX rates and consider a variety of indicators. Bahmani-Oskooee et al. (2020) investigate FX rates and money demand nexus, while Ben Doudou et al. (2022) focus on FX rates and trade balance nexus. Kartal et al. (2020) investigate the stock market index and consider FX rates as well as CDS spreads. Bernoth and Herwartz (2021) study the nexus between FX rates and sovereign risk. Depren et al. (2021a, 2021b) uncover FX rates and interest rates nexus. Besides, Kartal et al. (2021b) examine the nexus between FX rates and stock market indices. Kartal et al. (2021c) uncover the nexus between FX rates and indicators, which reflect monetary policy measures, including also CDS spreads. Moreover, Kirikkaleli et al. (2022) investigate the nexus between FX rates and country risk. Hence, different factors are used in investigating FX rates by such studies.

When the literature is examined in terms of the two variables (i.e., CDS spreads and FX rates) together, it can be concluded that the literature includes some studies. Grammatikos and Vermeulen (2012), Ertuğrul and Öztürk (2013), Fontana and Scheicher (2016), Hassan et al. (2017), Kartal (2020, 2022), Augustin et al. (2020), Bernoth and Herwartz (2021) and Kartal et al. (2021a, 2021b, 2021c, 2022a, 2022b) are some of these studies that examine the nexus between CDS spreads and FX rates. In such studies, traditional econometric models like autoregressive distributed lag, bound test, causality test, cointegration test, and ordinary least squares are applied and generally limited areas such as Euro Area, Economic and Monetary Union countries are examined. From this perspective, it can be concluded that the literature is not rich enough and there is a gap that novel models can be applied to close the gap in new studies.

In summary, although there are a variety of studies examining the nexus between CDS spreads and FX rates, novel nonlinear approaches can still be used in new studies to make a contribution to the literature. Moreover, emerging countries can be examined by considering the recent development in terms of both CDS spreads and FX rates. Hence, the study investigated the nexus in leading emerging countries by performing novel nonlinear approaches.

3 Research objectives, scope, data and methodology

3.1 Research objectives

By focusing on emerging countries and including CDS spreads and FX rates, this study aims:

- to define a characteristic of the nexus (e.g., either unidirectional or bidirectional)
- to test whether an increase in one variable causes an increase in another
- to investigate whether the nexus between the variables is at causality level (if any)
- to examine whether the nexus between the variables changes according to the quantiles and countries.

3.2 Scope and data

This study aims at examining the nexus between CDS spreads and FX rates in leading emerging countries. To address these aims, the study prefers to focus on the emerging country groups as BRICST, E7, MINT and Fragile Five. These groups include the following countries:

- BRICST: Brazil (BRA), Russia (RUS), India (IND), China (CHN), South Africa (ZAF) and Turkey (TUR)
- E7: Brazil, China, India, Indonesia (IDN), Mexico (MEX), Russia and Turkey
- MINT: Mexico, Indonesia, Nigeria (NGA) and Turkey
- Fragile Five: Brazil, India, Indonesia, South Africa and Turkey.

Hence, a total of nine countries as Brazil, China, India, Indonesia, Mexico, Nigeria, Russia, South Africa, and Turkey are targeted to be included in the empirical analysis. However, data of CDS spreads for India and Nigeria is not available. Also, the CDS spreads of China are not high and volatile. For these reasons, a total of six countries except for China, India, and Nigeria consist of the study for empirical analysis.

Data for CDS spreads and FX rates are gathered from Bloomberg (2021). In this study, we use high-frequency (e.g., daily) data by considering data availability. Moreover, the dataset started October 8, 2004 because data for all countries start from this date. Moreover, the data longs until July 23, 2021. Hence, the dataset includes 4,381 observations for each country.

3.3 Methodology

It is necessary to apply a multi-phase model in the empirical analysis to investigate the nexus between CDS spreads and FX rates as shown in Figure 3.

In the context of the empirical analysis:

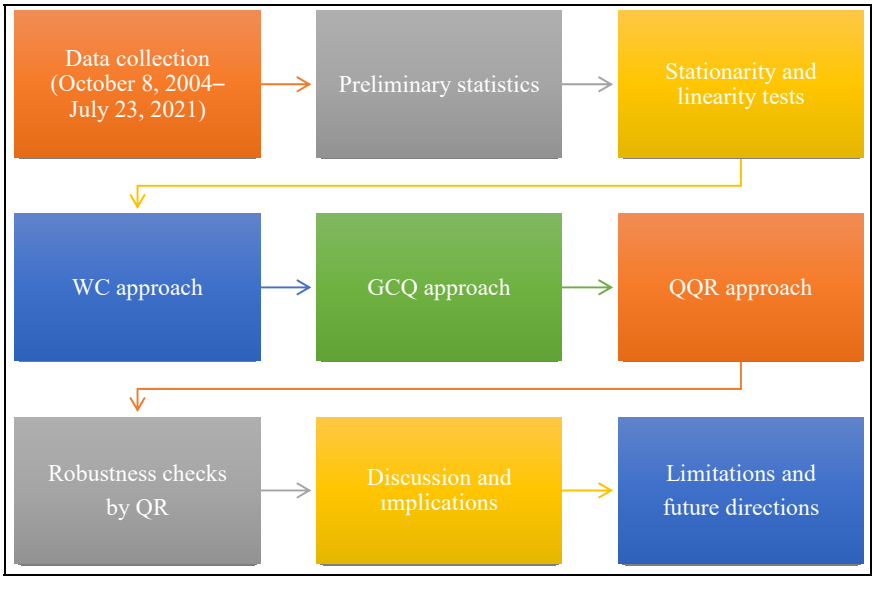
- First, descriptive statistics of the variables are examined.

- Second, stationarity tests are applied for variables to examine unit root tests. In this context, the augmented Dickey-Fuller (ADF) test and Philip and Perron (PP) test are performed [Dickey and Fuller, (1979), p.1988].
- Third, the linearity conditions of the variables are investigated. In this context, the BDS test is performed (Broock et al., 1996). The nonlinear techniques should be applied when the results show that variables are not linear. Also, the WC approach is performed. The WC approach captures the nexus between variables by considering time and frequency (Torrence and Compo, 1998). The WC approach captures the nexus between variables considering both time and frequency (Kartal et al., 2021a; Kirikkaleli, 2021).
- Fourth, the GCQ approach is performed (Troster, 2018).
- Fifth, the QQR approach is performed (Sim and Zhou, 2015).

Both the GCQ and QQR approaches present the nexus between variables at quantiles.

- Sixth, the QR approach is performed for robustness checks of the QQR results (Koenker, 2005). It presents details about the causality nexus at different quantiles (Koenker, 2005).
- Seventh, discussion and policy implications are presented based on the results of the empirical analysis.
- Lastly, limitations and future directions are discussed in the conclusions section.

Figure 3 The proposed structure (see online version for colours)



By following up this proposed structure (i.e., a multi-step methodology) and performing times, frequency, and quantile-based models, it is possible to make a comprehensive analysis of CDS spreads and FX rates nexus for the included countries. Hence, applied

methods present the CDS spreads and FX rates nexus at different times, frequencies and quantiles. Moreover, the impact of each indicator on another one and the causality nexus between these indicators are investigated at each quantile.

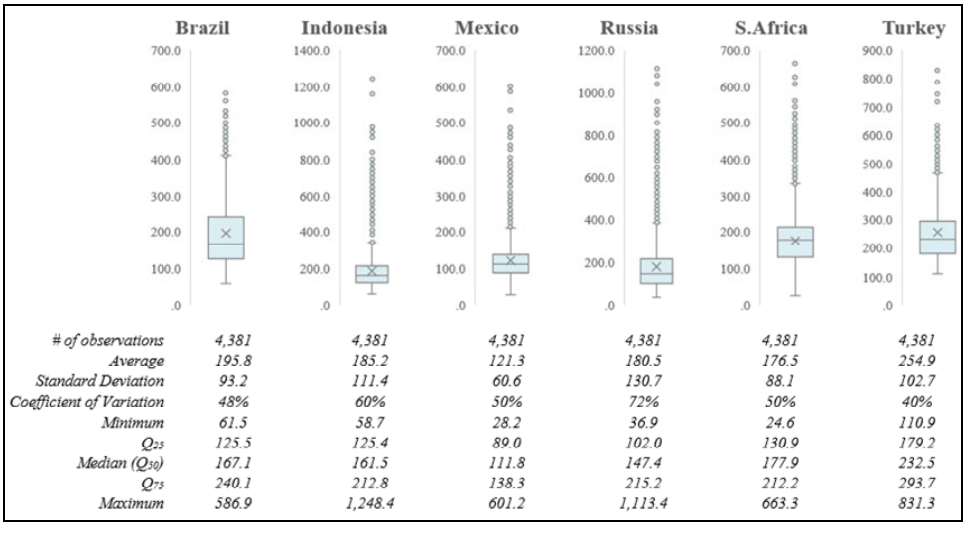
To avoid the extending article so much, the methods used are not detailed too much. More information about these methods can be obtained from the original studies of Dickey and Fuller (1979) for the ADF unit root test, Phillips and Perron (1988) for the PP unit root test, Broock et al. (1996) for the BDS test, Goupillaud et al. (1984) and Torrence and Compo (1998) for the WC approach, Sim and Zhou (2015) for the QQR approach, Troster (2018) for the GCQ approach and Koenker (2005) for the QR.

4 Empirical analysis

4.1 Preliminary statistics

Preliminary statistics and Box-Jenkins plots of CDS and FX for each country are given in Figures 4 and 5, respectively.

Figure 4 Summary statistics and Box-Jenkins plots of CDS (see online version for colours)



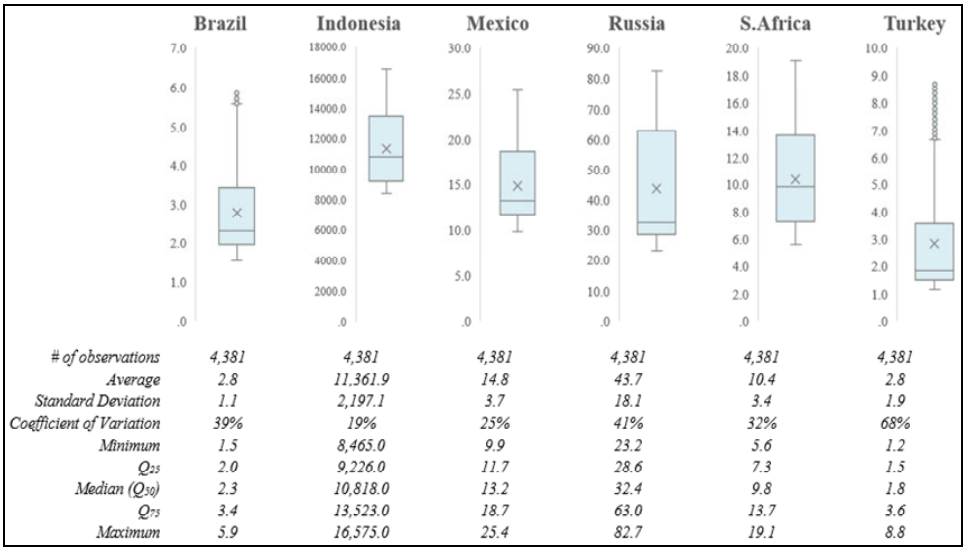
	Brazil	Indonesia	Mexico	Russia	S.Africa	Turkey
# of observations	4,381	4,381	4,381	4,381	4,381	4,381
Average	195.8	185.2	121.3	180.5	176.5	254.9
Standard Deviation	93.2	111.4	60.6	130.7	88.1	102.7
Coefficient of Variation	48%	60%	50%	72%	50%	40%
Minimum	61.5	58.7	28.2	36.9	24.6	110.9
Q_{25}	125.5	125.4	89.0	102.0	130.9	179.2
Median (Q_{50})	167.1	161.5	111.8	147.4	177.9	232.5
Q_{75}	240.1	212.8	138.3	215.2	212.2	293.7
Maximum	586.9	1,248.4	601.2	1,113.4	663.3	831.3

As presented in Figure 4, it is seen that there are too many outliers in CDS data for each country thereby standard deviation and coefficient of variation statistics are quite high, especially for Indonesia and Russia. Turkey has the highest CDS spreads at 254.9 followed by Brazil (195.8), Indonesia (185.2), Russia (180.5), South Africa (176.5) and Mexico (121.3). Although the coefficient of variation of Turkey is the lowest among others, Turkey has the highest spreads in terms of CDS. This means that the CDS spread of Turkey has been at a high level for a long time. Furthermore, CDS in Turkey has had an increasing trend since the beginning of 2013.

According to Figure 5, contrary to CDS, there are not many outliers in the dataset used, except in the Turkey dataset. Therefore, Turkey has the highest coefficient of variation among others, which is 68%. In other countries, the coefficient of variation is

below 40%. Also, Indonesia has the lowest figure at 19% in terms of coefficient of variation. In addition, the distribution of FX in each country has a right-skewed distribution.

Figure 5 Summary statistics and Box-Jenkins plots of FX (see online version for colours)



4.2 Stationarity and linearity test

The ADF and PP tests are applied to examine the stationarity of the variables and the results are presented in Table 1.

Table 1 Stationarity test results

Country	*Parameter*	*ADF test*		*PP test*		*Outcome*
		Level	*1st difference*	*Level*	*1st difference*	
BRA	CDS	0.0059		0.0084		I(0)
	FX	0.9758	0.0000	0.9818	0.0001	I(1)
IDN	CDS	0.0058		0.0026		I(0)
	FX	0.7324	0.0000	0.7801	0.0001	I(1)
MEX	CDS	0.0025		0.0017		I(0)
	FX	0.7580	0.0000	0.7703	0.0001	I(1)
RUS	CDS	0.0264		0.0100		I(0)
	FX	0.8931	0.0000	0.9202	0.0001	I(1)
ZAF	CDS	0.0111		0.0185		I(0)
	FX	0.7298	0.0001	0.7305	0.0001	I(1)
TR	CDS	0.0126		0.0090		I(0)
	FX	0.9999	0.0000	1.0000	0.0001	I(1)

Note: Lag length is automatically selected based on Akaike information criterion in the ADF test and Bartlett kernel in the PP test.

As Table 1 shows, the ADF test results indicate that CDS is stationary at I(0) FX is stationary at I(1) for all countries. Moreover, the PP test presents similar results. Therefore, it is defined that CDS is I(0) whereas FX is I(1).

After examining the stationarity of the variables, the BDS test is applied to examine the linearity of the variables and the results are shown in Table 2.

Table 2 Linearity test results

Countries	*Variables*	*Dimensions*				
		2	*3*	*4*	*5*	*6*
BRA	CDS	0.0000	0.0000	0.0000	0.0000	0.0000
	FX	0.0000	0.0000	0.0000	0.0000	0.0000
IDN	CDS	0.0000	0.0000	0.0000	0.0000	0.0000
	FX	0.0000	0.0000	0.0000	0.0000	0.0000
MEX	CDS	0.0000	0.0000	0.0000	0.0000	0.0000
	FX	0.0000	0.0000	0.0000	0.0000	0.0000
RUS	CDS	0.0000	0.0000	0.0000	0.0000	0.0000
	FX	0.0000	0.0000	0.0000	0.0000	0.0000
ZAF	CDS	0.0000	0.0000	0.0000	0.0000	0.0000
	FX	0.0000	0.0000	0.0000	0.0000	0.0000
TR	CDS	0.0000	0.0000	0.0000	0.0000	0.0000
	FX	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Values denote the p-values. The null hypothesis is that a variable is linearly distributed.

The BDS test results reveal that both CDS spreads and FX rates are not linear for all countries. Hence, using nonlinear techniques is better than performing linear methods.

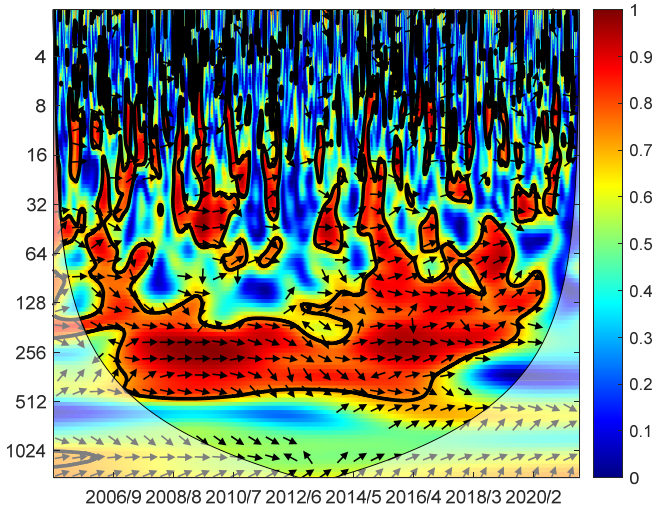
4.3 The WC results

Based on the characteristics of the variables as nonlinear, the WC approach is performed to determine the nexus between CDS spreads and FX rates by considering the time and frequency. The following graph shows the WC results (Figure 6).

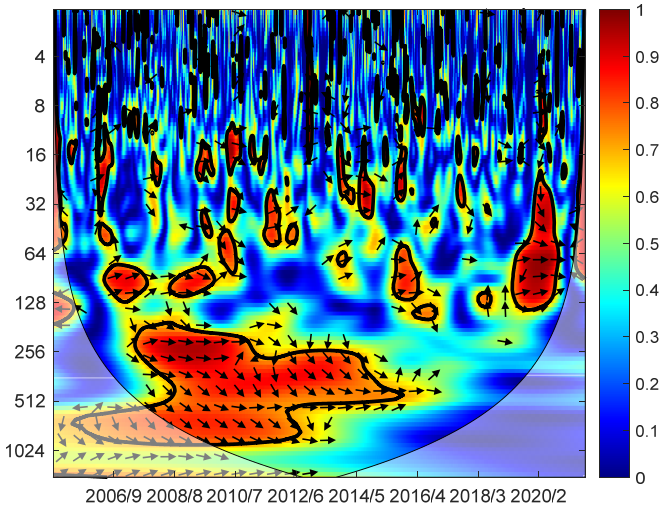
The results of the WC approach reveal that there is a significant correlation between CDS spreads and FX rates in each country in the different periods. In specific, CDS spreads lead FX rates positively in the very long-term until 2012 while the FX rates lead the CDS spreads positively in a long-term (and also very long-term) between 2012 and 2021 in Brazil. Similar to Brazil, the CDS spreads cause the FX rates positively in a very long-term until 2012 while the FX rates cause the CDS spreads positively in a long-term after 2012 in Indonesia.

The nexus between the CDS spreads and FX rates are more complex in Mexico, South Africa and Turkey. In these countries, the FX rates cause the CDS to spread positive change in the medium-term, but the CDS spreads cause the FX rates positively in the long and very long-term. In Russia, the CDS spreads lead the FX rates positive change in the very long-term until 2010. Also, the same correlation occurs in the medium-term in 2011–2012. Just after 2012, the FX rates lead the CDS to spread positively in the medium and long-term.

Figure 6 The WC results, (a) BRA (b) IDN (c) MEX (d) RUS (e) ZAF (f) TR (see online version for colours)



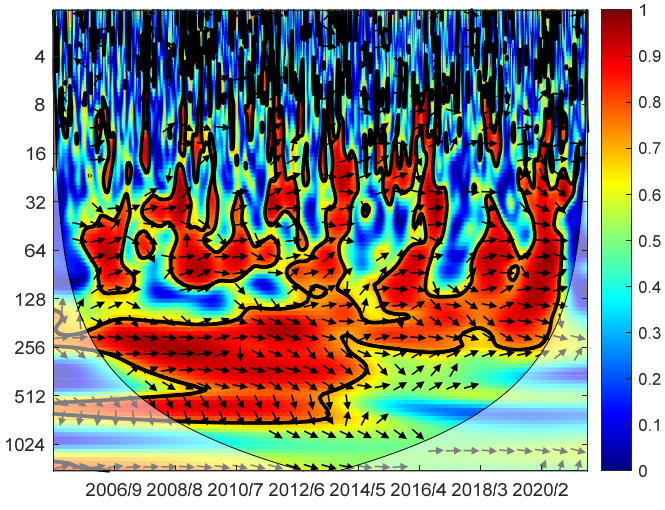
(a)



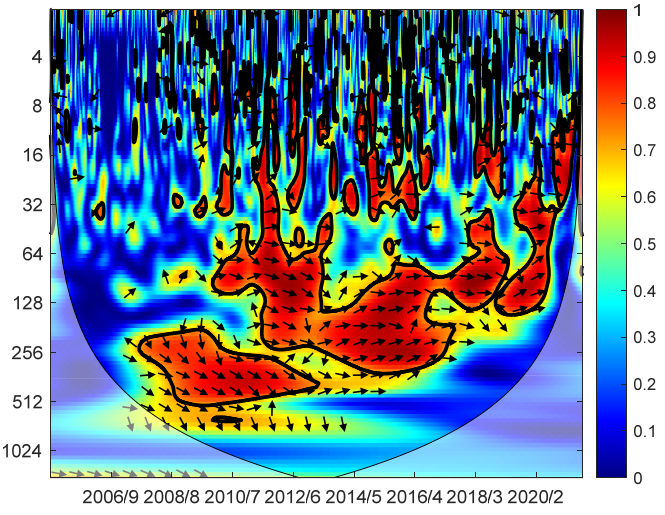
(b)

Notes: The vertical axis shows the period in days while the horizontal axis shows time. The black cone shows the influence area. The warmer colours show a higher degree of dependence between the two variables. 0–16 scale shows short-term, 16–64 scale shows medium-term, 64–256 scale shows long-term, and 256–1,024 scale shows very long-term. 0–0.4 shows low-frequency, 0.4–0.6 shows medium-frequency, and 0.6–1.0 shows high-frequency. Left arrows show a negative correlation while right arrows show a positive correlation. Right-down and left-up arrows show that the first variable causes the second variable. Also, right-up and left-down arrows show that the second variable causes the first variable. In all figures, the first variable is CDS spreads and the second one is FX rates.

Figure 6 The WC results, (a) BRA (b) IDN (c) MEX (d) RUS (e) ZAF (f) TR (continued) (see online version for colours)



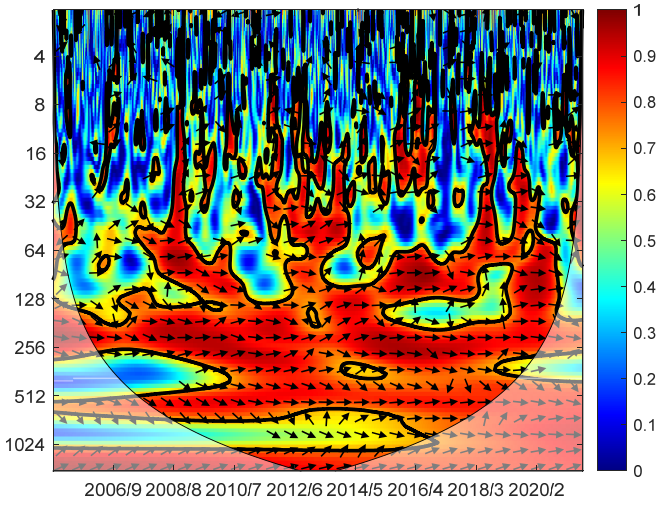
(c)



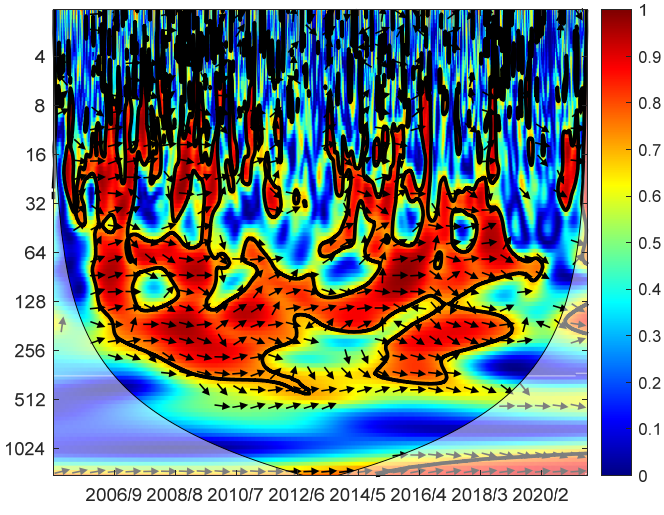
(d)

Notes: The vertical axis shows the period in days while the horizontal axis shows time. The black cone shows the influence area. The warmer colours show a higher degree of dependence between the two variables. 0–16 scale shows short-term, 16–64 scale shows medium-term, 64–256 scale shows long-term, and 256–1,024 scale shows very long-term. 0–0.4 shows low-frequency, 0.4–0.6 shows medium-frequency, and 0.6–1.0 shows high-frequency. Left arrows show a negative correlation while right arrows show a positive correlation. Right-down and left-up arrows show that the first variable causes the second variable. Also, right-up and left-down arrows show that the second variable causes the first variable. In all figures, the first variable is CDS spreads and the second one is FX rates.

Figure 6 The WC results, (a) BRA (b) IDN (c) MEX (d) RUS (e) ZAF (f) TR (continued) (see online version for colours)



(e)



(f)

Notes: The vertical axis shows the period in days while the horizontal axis shows time. The black cone shows the influence area. The warmer colours show a higher degree of dependence between the two variables. 0–16 scale shows short-term, 16–64 scale shows medium-term, 64–256 scale shows long-term, and 256–1,024 scale shows very long-term. 0–0.4 shows low-frequency, 0.4–0.6 shows medium-frequency, and 0.6–1.0 shows high-frequency. Left arrows show a negative correlation while right arrows show a positive correlation. Right-down and left-up arrows show that the first variable causes the second variable. Also, right-up and left-down arrows show that the second variable causes the first variable. In all figures, the first variable is CDS spreads and the second one is FX rates.

Table 3 The GCQ results

Countries	*Causality path*	*Tau*																		
		0.05	*0.10*	*0.15*	*0.20*	*0.25*	*0.30*	*0.35*	*0.40*	*0.45*	*0.50*	*0.55*	*0.60*	*0.65*	*0.70*	*0.75*	*0.80*	*0.85*	*0.90*	*0.95*
BRA	FX => CDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CDS => FX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
IDN	FX => CDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CDS => FX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MEX	FX => CDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CDS => FX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RUS	FX => CDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CDS => FX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ZAF	FX => CDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CDS => FX	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.51	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43
TR	FX => CDS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CDS => FX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: Numbers represent p-values. The null hypothesis is that the first variable does not Granger cause the second variable.

4.4 The GCQ results

After presenting bidirectional causality between the CDS spreads and the FX rates for all countries, we proceed to measure the causality in quantiles by using the GCQ approach. Table 3 shows the results of the GCQ.

According to Table 3, almost at all quantiles, the Granger causality from the CDS spreads to the FX rates and vice versa is well evident at a 1% level of statistical significance. This means that there is bidirectional causality between the CDS spreads and FX rates in all low and high tails of quantiles for all countries. In Brazil and South Africa, the impact of the FX rates on the CDS spreads at the highest quantile (0.90) is not significant while in other countries generally in the low-middle quantiles (0.35-0.50) Granger causality is not significant.

4.5 The QQR results

In addition to the GCQ approach, the QQR approach is applied to examine the power of the nexus between the CDS spreads and the FX rates at the different levels of the dependent variable. For each country, the results of the QQR approach are visualised in Figure 7 using the impact of the t^{th} quantile coefficient of the independent variable on the q^{th} quantile of the dependent variable and vice versa.

In Brazil, it is ascertained that the impact of the FX rates on the CDS spreads in the area compounding the lower to middle quantiles is positive but weak. On the other hand, from lower quantiles to higher quantiles, the impact of the FX rates on the CDS spreads is increasing significantly, especially over the 0.8 quantiles. On the contrary, once the impact of the CDS spreads on the FX rates is examined, it is revealed that the impact of the CDS spreads on the FX rates is generally positive and at the middle level, except for the higher quantiles of both variables. Moreover, the impact of the CDS spreads on the FX rates turns negative in the area where the quantiles are above 0.8.

In Indonesia, it is observed that the impact of the FX rates on the CDS spreads is negative across all the quantiles. Also, the negative impact of the FX rates on the CDS spreads increases from the higher to the lower quantiles of FX. On the other hand, the FX rates are not negatively influenced by the CDS spreads across all quantiles. The negative impact of the CDS spreads on the FX rates in the area combining the lower and middle quantiles is significant while this impact is getting weaker from the lower to the upper quantiles of the FX rates.

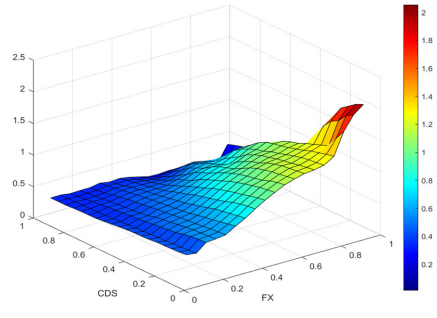
In Mexico, it is observed that the impact of the FX rates on the CDS spreads is positive in all quantiles yet generally not strong, except in the lower quantiles of the FX rates. The impact of the FX rates on the CDS spreads is significantly positive and strong in the lower quantiles of the FX rates. There is a similar case in analysing the impact of the CDS spreads on the FX rates in Mexico. The impact is generally not strong in all quantiles, except in the higher quantiles of both variables. However, the impact of the CDS spreads on the FX rates in the area combining the upper quantiles of the CDS spreads and the lower quantiles of the FX rates is significant and positive.

In Russia, the impact of the CDS spreads and the FX rates on each other is differentiated from quantiles to quantiles at a medium level. Nevertheless, the impact of the FX rates on the CDS spreads in the area combining the higher quantiles of the FX rates and the lower quantiles of the CDS spreads is positive and strong while in other combining areas this impact is weak. Similarly, the impact of the CDS spreads on the FX

rates in the area combining the higher quantiles of the CDS spreads and the lower quantiles of the FX rates is positive and strong.

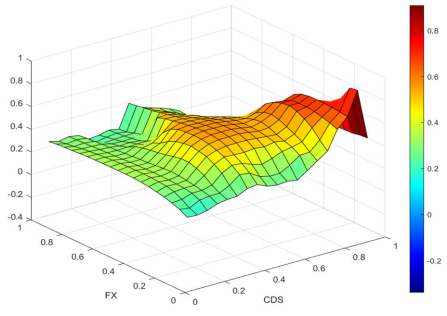
Figure 7 The QQR results (see online version for colours)

BRA



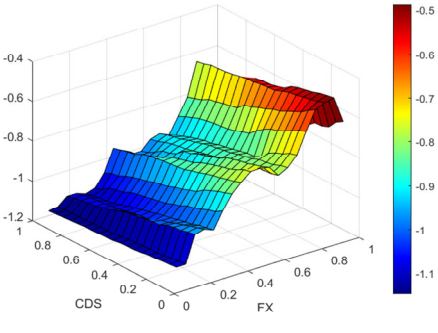
Impact of the FX rates on the CDS spreads

BRA



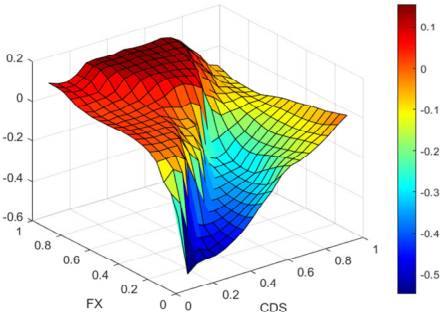
Impact of the CDS spreads on the FX rates

IDN



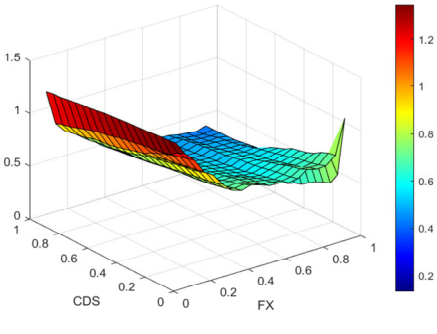
Impact of the FX rates on the CDS spreads

IDN



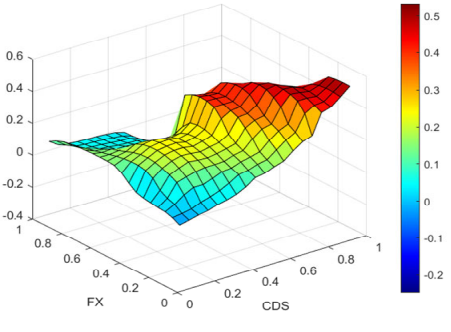
Impact of the CDS spreads on the FX rates

MEX



Impact of the FX rates on the CDS spreads

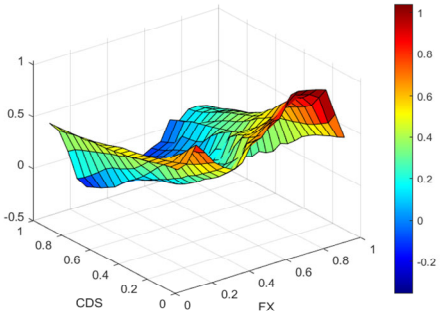
MEX



Impact of the CDS spreads on the FX rates

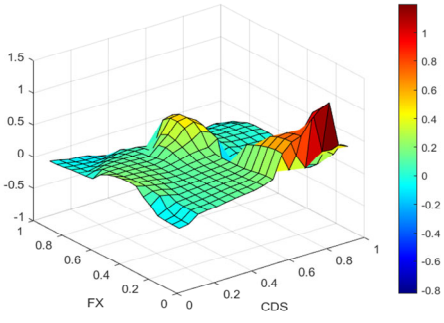
Figure 7 The QQR results (continued) (see online version for colours)

RUS



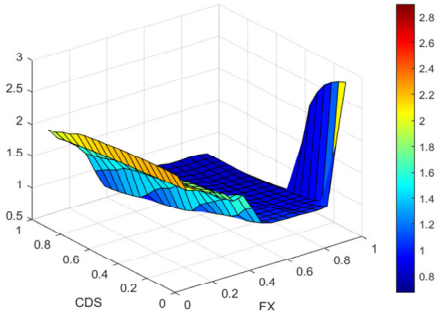
Impact of the FX rates on the CDS spreads

RUS



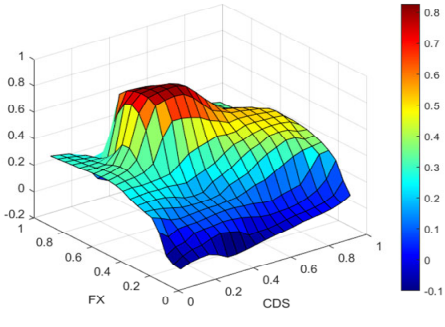
Impact of the CDS spreads on the FX rates

ZAF



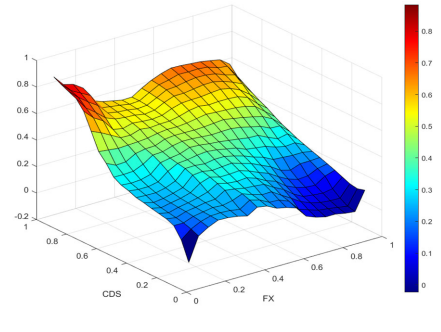
Impact of the FX rates on the CDS spreads

ZAF



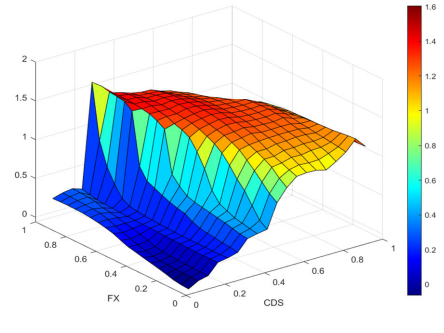
Impact of the CDS spreads on the FX rates

TR



Impact of the FX rates on the CDS spreads

TR



Impact of the CDS spreads on the FX rates

In South Africa, the impact of the FX rates on the CDS spreads is positive across all the quantiles. Also, the impact of the FX rates on the CDS spreads in the lower quantiles of the FX rates is positive and strong in the area of all quantiles of the CDS spreads. On the

other hand, the impact of the CDS spreads on the FX rates is strong in the area combining the higher quantiles of the FX rates and the middle quantiles of the CDS spreads. In other areas, this impact is relatively weak.

In Turkey, the impact of the CDS spreads and the FX rates on each other is, generally, positive in all across quantiles. The impact of the FX rates on the CDS spreads is strong in the area combining the lower quantiles of the FX rates and the upper quantiles of the CDS spreads. In other areas, especially in the area adjoining the higher quantiles of the FX rates and the lower quantiles of the CDS spreads, this impact is relatively weak. On the other hand, the impact of the CDS spreads on the FX rates is relatively strong and positive in the area combining the middle and upper quantiles of the CDS spreads.

4.6 Robustness check by the QR approach

To check the robustness of the QQR results and confirm the performance of a heterogeneous population, a more detailed analysis is conducted by applying the QR model. Table 4 shows the correlation coefficients between the slope coefficients obtained from the QR and QQR approaches.

Table 4 Correlations between the slope coefficients of QQR and QR approaches

Country	*Impact of the FX rates on the CDS spreads*	*Impact of the CDS spreads on the FX rates*
Brazil	0.921	0.764
Indonesia	0.996	0.809
Mexico	0.996	0.561
Russia	0.967	0.946
South Africa	0.927	0.654
Turkey	0.727	0.979

While analysing the impact of the FX rates on the CDS spreads in Table 4, it is observed that the correlation between the QR and QQR approaches is alike in all countries except for Turkey. Nevertheless, the correlation coefficient is significantly high in Turkey. Similar to the analysis results of the impact of the FX rates on the CDS spreads, the correlation coefficient of slopes for the impact of the CDS spreads on the FX rates are significant and relatively high, except for Mexico and South Africa. Nevertheless, these correlation coefficients are statistically significant. As can be noticed from Table 4, it can be said that there is a complex bidirectional impact in Mexico and South Africa in terms of the impact of the CDS spreads on the FX rates in terms of quantile-based coefficients.

4.7 Discussion and policy recommendations

The WC outcomes show that there is bidirectional nexus between the CDS spreads and the FX rates. Also, the GCQ and QQR outcomes present that the nexus exists in almost all quantiles excluding middle quantiles (i.e., 0.35, 0.40, 0.45, 0.50) and the highest quantile (i.e., 0.95) for some countries. Moreover, the QR reveals that the outcomes of the QQR approach are robust.

The empirical outcomes of the novel nonlinear approaches show that both variables have a significant effect on each other for all emerging countries. Especially, the nexus

between the CDS spreads and the FX rates are quite clear at all quantiles excluding some middle quantiles and the highest quantile. Naturally, country-based outcomes differ slightly. Hence, it can be concluded that the CDS spreads (FX rates) are significant for the FX rates (CDS spreads).

The nonlinear empirical outcomes validate the hypotheses that take place in the research objectives as:

1 there is a bidirectional nexus between the CDS spreads and the FX rates

2 an increase in the CDS spreads (FX rates) causes an increase in the FX rates (CDS spreads)

3 the nexus between the CDS spreads and the FX rates is at the causality

4 there is a nexus between the CDS spreads and the FX rates almost all quantiles excluding middle quantiles and the highest quantile for some countries, whereas country-based outcomes change a bit.

The outcomes gathered from the nonlinear approaches are consistent with the outcomes of the present studies (e.g., Grammatikos and Vermeulen, 2012; Ertuğrul and Öztürk, 2013; Fontana and Scheicher, 2016; Hassan et al., 2017; Augustin et al., 2020; Kartal, 2020, 2022; Bernoth and Herwartz, 2021; Kartal et al., 2022a, 2022b) and pre-expectations.

In line with the outcomes of the empirical analysis, decision-makers in the emerging countries should consider both the CDS spreads and the FX rates at the same time in the development and implementation of policies. Hence, they can benefit from the stability in these indicators if adverse developments in terms of these indicators can be prevented.

By considering the empirical results that highlight mainly the bidirectional nexus between the CDS spreads and the FX rates, we can propose some policy recommendations. Firstly, emerging countries can focus on factors that affect country risk by taking into that the CDS spreads reflect the riskiness of countries. In this context, the implementation of structural reforms can be an option and main priority for such countries so that country risks can be decreased. With the implementation of the structural reform including economic and political, progress in decreasing country risk can be achieved. Also, such a process can contribute to both decreasing FX rates and making them stable.

Besides, countries can deal with the FX rates. By balancing the current account and foreign trade deficit, countries can limit the foreign currency outflows. Moreover, foreign currency inflows can be increased by stimulating the FX earning activities like export, tourism (especially via international tourists), portfolio inflows and direct investments. By doing so, countries can increase foreign currency inflows and have stable FX rates. Naturally, stability in FX rates can contribute to the decreasing country risk of the countries.

Also, it should be considered that the nexus between the CDS spreads and the FX rates changes at different quantiles. For this reason, applying a straight-line approach in managing policies related to the CDS spreads and the FX rates cannot be appropriate. In other cases, significant findings of the study can be ignored by emerging countries in policy developing and applying processes, which may result in adverse effects.

The policies, some of which are presented above, show that it is required to deal with both the CDS spreads and the FX rates at the same time due to the bidirectional

characteristic of the nexus. Meanwhile, emerging countries can consider other indicators including global, macroeconomic, financial as well as political issues so that more successful policies can be developed and applied concerning the CDS spreads and FX rates. Considering the economic, financial, and political structure of the countries is highly crucial. That is why because these determine the border of the decision-makers in developing and implementing policies. Naturally, all policies should be carried out on time without causing any delay. Otherwise, precautions can cause adverse effects rather than beneficial.

To sum up, decision-makers can use more high-frequency data (i.e., hourly data) and can develop more policies by benefiting from all macroeconomic and financial information that is not publicly available. Moreover, countries can position the CDS spreads and the FX rates as macro-prudential issues, manage them at a very high level in the management of countries and harmoniously apply policies so that occurrence of adverse effects can be prevented.

5 Conclusions

This study examines the causal nexus between CDS spreads and FX rates in the leading emerging countries. In this context, Brazil, Indonesia, Mexico, Russia, South Africa, and Turkey are included because they are outlier countries in terms of CDS spreads. According to the best knowledge, although they have a significant share in the world economy, the nexus between the CDS spreads and the FX rates have not been comprehensively examined for emerging countries taking place in BRICST, E7, MINT, and Fragile Five countries by applying novel nonlinear approaches as the WC, GCQ and QQR. Moreover, the QR is performed for the robustness checks of the QQR results. Hence, a comparative examination is made to investigate the nexus between CDS spreads and FX rates.

The results mainly show that there is bidirectional nexus between the CDS spreads and the FX rates, the nexus exists in almost all quantiles excluding middle quantiles and the highest quantile for some countries, and the results are consistent and robust. The results prove that both the CDS spreads and the FX rates are significant for each other. Also, the results gathered are consistent with the current literature. By taking the empirical results into account, some policy recommendations are proposed like positioning the CDS spreads and the FX rates as a macro-prudential concern, treating these variables together in policy development and implementation processes, and focusing on decreasing country risk via structural reforms and the increasing FX earning activities. Also, consideration of economic realities and structures of countries is highly recommended because they are different for each country although they are all emerging countries and take place in the same peer groups. Hence, the study contributes to decision-makers in the development and implementation of policies to achieve macroeconomic and financial stability through the indicators as the CDS spreads and FX rates by benefiting from the selected emerging countries.

The main contribution of this study is that this study is a pioneering study that investigates CDS spreads and FX rates nexus for a bundle of six emerging countries such as Brazil, Indonesia, Mexico, Russia, South Africa and Turkey. Hence, this study investigates leading emerging countries because they have negative outlier conditions in terms of the progress of the CDS spreads. Also, this study uses very large high-frequency

(i.e., daily) data and applies novel nonlinear econometric methods. Thus, this study provides evidence from the time, frequency and quantile-based examinations. On the other hand, this study has some limitations as focusing on the six leading emerging countries. However, other emerging countries and also developed countries can be included in new studies. Moreover, machine learning algorithms can be used for empirical examinations in future studies.

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The authors certify that they have no affiliations with or involvement in any organisation or entity with any financial interest (such as honoraria, educational grants, participation in speakers' bureaus, membership, employment, consultancies, stock ownership, or other equity interest, and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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The authors have contributed equally to this work. All authors read and approved the final manuscript.

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