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Assessing the Impacts of Financial Stress on the Yield Spreads of Poland, Mexico and South Africa

Summary: This study employs a nonlinear vector autoregression (VAR) model and quantile-based analysis to examine the effects of the financial stress index (FSI) of developed countries and the exchange market pressure index (EMPI) on the USD-denominated yield spreads of Poland, Mexico, and South Africa. It was found by the nonlinear VAR that increases/decreases in the FSI of developed countries and in the EMPI raise/lower the yield spreads in each emerging country. Although different results are obtained among each emerging country, it was highlighted that foreign and domestic financial stress can be incorporated in the monetary policy formulation of the central banks of Poland, Mexico, and South Africa. Quantile analysis also revealed the role of different bond market pressure regimes in emerging countries, while the asymmetrical impacts of FSI and EMPI should be considered by the policymakers.

Keywords: Financial stress, Yield spreads, Quantile-based analysis, Nonlinear VAR.

JEL: E44, F31, F41.

As a result of the expansionary policies implemented by major central banks after the 2008-2009 Global Financial Crisis (GFC), it can be suggested that the correlation of sovereign bond yield dynamics also increased among developed and periphery countries (e.g., Silvo Dajcman 2013). On the other hand, in the presence of increasing interaction between the US interest rates and the interest rates of developing countries (e.g., Mikhail Stolbov 2014), the long-term government bond yield spread, which is the difference between the return rates paid by emerging countries' government bonds and those offered by US government bonds, has become a widely used indicator. In this context, the motivation for the study is to determine the impacts on the USD-denominated bond yield spreads of Poland, Mexico, and South Africa, which are vulnerable to variations in the bond market due to the capital flows from developed countries. More specifically, this study departs from the assumption that domestic and global financial stress measures can have contrary effects of different magnitudes on the bond yield spreads consistent with the studies indicating the role of asymmetry in the transmission of financial stress (e.g., Anastasios Evgenidis and Athanasios Tsagkanos 2017; Dalu Zhang, Meilan Yan, and Andreas Tsopanakis 2018; Georgios N.

Apostolakis, Giannellis Nikolaos, and Athanasios P. Papadopoulos 2019; Oguzhan Ozcelebi 2020).

Although none of the studies found in the scientific literature have focused on the asymmetric effects on bond yield spreads, the asymmetric relationships among the variables are explored by the nonlinear VAR model of Lutz Kilian and Robert J. Vigfusson (2011) and the quantile regression model parallel to Ozcelebi (2020). More specifically, I investigate the role of the asymmetry in the relationship between model variables using impulse response functions (IRFs) and the Mork test based on the censored variable approach of Kilian and Vigfusson (2011). Incorporation of quantile regression models that include variables decomposed into positive and negative changes made it possible to specify whether the asymmetric impacts of foreign and domestic financial stress on the yield spread can vary among different regimes.

1. Literature Review

Depending on the unconventional monetary policy and the macroprudential policies after the GFC, it has been acknowledged that the transmission of financial stress to macroeconomic and financial variables is also valid at the international scale. In one of the studies in this context, Pu Chen and Willi Semmler (2018) employed a multi-regime global VAR model to analyze the spillover effects of financial stress, finding that, in both the high- and the low-stress regime, financial shocks to a country, a big or a small one, can have large and persistent outcomes in the financial markets of other countries. This finding highlights the issue that positive and negative financial stress shocks may have different effects in different regimes. The results of Chen and Semmler (2018) were confirmed by Ozcelebi (2020), who used a quantile regression model, and it was revealed that the effects of the FSI of developed countries on the exchange market of emerging countries will vary under different regimes and will be asymmetric. Additionally, Evgenidis and Tsagkanos (2017) analyzed the asymmetric effects of the international transmission of US financial stress to the eurozone with a threshold VAR approach and revealed that small financial stress shocks, rather than infrequent large ones, could cause large fluctuations in inflation rates. Apostolakis, Nikolaos, and Papadopoulos (2019) enhanced the analysis by considering the exposure of eurozone countries to internal and external shocks. In terms of financial stress, they studied the transmission of asymmetric shocks within the eurozone using the spillover approach of Francis X. Diebold and Kamil Yilmaz (2009, 2012) and a conventional VAR model. Apostolakis, Nikolaos, and Papadopoulos (2019) revealed that internal or external shocks can have asymmetric effects within the eurozone.

Here, it should be noted that the macroeconomic developments after the GFC suggest the transmission of financial stress to the variations in interest rates. More specifically, it can be assumed that both domestic and foreign financial stress had impacts on bond markets. For instance, Juan M. Julio, Ignacio Lozano, and Melo (2013) investigated the reaction of the country risk to the global appetite in their model, in which the fiscal policy stance is determinative of the relevant transmission. More specifically, the authors found that a nonlinear response of Colombian sovereign risk (EMBI-Colombia) is mainly determined by international investors' risk appetite, proxied by the American corporate BAA spread with respect to the 10-year treasury bond. Julio, Lozano, and Melo (2013) also revealed that the relationship between these variables experienced an important structural break in the second half of the 2000s, suggesting that the domestic macroeconomic developments in Colombia have gained ground. The role of the GFC in the J.P. Morgan emerging market bond index global (EMBIG) spreads was also confirmed by Erdal Özmen and Özge Doğanay-Yaşar (2016) by employing a daily panel of 23 developing countries. Both conventional panel estimations and methods dealing with cross-sectional dependence also verified that the EMBIG spreads are determined by credit ratings. On the other hand, the long-range dependence, nonlinearities and structural breaks in the Emerging Market Bond Index (EMBI) of Latin American countries (Argentina, Brazil, Mexico and Venezuela) were considered by Guglielmo M. Caporale, Hector Carcel, and Luis A. Gil-Alana (2018) *via* the fractional integration framework and both parametric and semi-parametric methods. The authors found long-range dependence as well as breaks in the relevant EMBIs.

The effects that will occur on the yield spreads are under the influence of regime changes along with structural breaks, and it can be said that changes occurring in economic conditions can be a determinative factor. At this point, the dollarization level can be recognized as a significant factor for developing countries. In this context, Maria L. M. del Cristo and Marta Gómez-Puig (2017) analyzed the interplay between the evolution of the EMBI and the macroeconomic variables (growth expectations, inflation and external debt-to-exports ratio) in seven Latin American countries within the cointegrated vector framework. More specifically, the study focused on the short-run effects from 2001 to 2009 and found that the EMBI is more stable in dollarized countries. del Cristo and Gómez-Puig (2017) also underlined that investors' confidence might be higher in dollarized countries, where the economic performance is less vulnerable to external shocks, than in non-dollarized ones. According to Mike Kennedy and Angel Palerm (2014), the fluctuations in the global risk measure calculated from several US and EU corporate bond spreads and the US equity-price risk premium led to changes in the EMBI spreads in 18 countries. Their pooled mean group (PMG) estimations also highlighted that the differentiation between emerging countries in terms of EMBI spreads is due to the domestic macroeconomic factors. Furthermore, they revealed that viable fiscal positions, low external debt levels, low political risk and importantly healthy foreign exchange reserves could be determinative factors.

In this context, it has been assumed that financial stress is contagious across financial markets and countries after the GFC, and it has been recognized that the monetary policies of central banks react in a nonlinear way (e.g., Charles Goodhart, Carolina Osorio, and Dimitrios Tsomocos 2009; Frederick Mishkin 2009). In this respect, Jaromir Baxa, Roman Horváth, and Borek Vašíček (2013) examined the evolution of monetary policy interest rates in response to financial instability over the last three decades for the cases of the US, the UK, Australia, Canada and Sweden. More specifically, they investigated the impacts of financial stress by employing the monetary policy rule estimation methodology, which allows for time-varying response coefficients and corrects for endogeneity. The exchange market also has an important weight in the financial stress index used by Baxa, Horváth, and Vašíček (2013), and it was found that central banks often change policy rates, mainly decreasing them in the face of high levels of financial stress. Accordingly, it can be argued that the yield spreads will be under the influence of this process, since US Treasury bills are dependent on the policy rate of the FED. In another study, Massimo Guidolin, Erwin Hansen, and Manuela Pedio (2019) evaluated the transition between financial asset classes and hence financial markets for the US with the time-varying parameter VAR model and revealed that the US subprime crisis can be used as an exogenous shock to measure cross-asset contagion. Thus, the post-GFC period can also be regarded as a period during which the financial instability in terms of the interaction between financial assets increased as a result of the unconventional and macroprudential policy changes.

Assessing the validity of the uncovered interest parity (UIP) condition, which signifies the relationship between the exchange markets and the money markets, in the relevant period could also provide important outcomes for policy makers. In this context, Juan C. Cuestas, Faibo Filipozzi, and Karsten Staehr (2015) indicated that the forecasts deviated from UIP in the GFC when the financial markets were under severe stress when structural breaks were included in the analysis. William D. Craighead, George K. Davis, and Norman C. Miller (2010) also investigated the validity of the UIP condition and obtained more favorable results when the interest differentials (IDs) were large. Moreover, the authors found evidence of instability across samples, which suggested the usage of empirical techniques dealing with nonlinear dynamics. In this vein, Chun Jiang et al. (2013) employed the nonlinear threshold unit root test to examine the non-stationary properties of UIP with the risk premium for ten Central and Eastern European (CEE) countries and provided robust evidence showing that UIP holds true for seven countries. Most recently, Resul Aydemir, Bulent Guloglu, and Ercan Saridogan (2021) investigated the dynamic interactions between exchange rates and the ten-year bond rates of the Fragile Five and found that shocks' positive impacts on expected conditional variances of the variables are largely market-specific and different.

On the other hand, it can be suggested that the spillover of financial stress can be caused by connectedness or contagion, while it is not necessary distinguish between connectedness and contagion as the underlying cause of spillovers (Wang Chen, Shigeyuki Hamori, and Takuji Kinkyo 2019). In the context of the macroeconomic impacts of financial stress between advanced and emerging economies, Ravi Balakrishnan et al. (2011) revealed that the strength of transmission of financial stress depends on the depth of financial linkages between advanced and emerging economies. Additionally, the fragility of the country in the context of foreign exchange requirement can be assumed to have an effect on the transmission of financial stress. Thus, the stress in the entire global financial system may have significant consequences for 10-year government bond spreads denominated in USD (ys_t), while relevant variable corresponds to the 10-year bond yield of an emerging country minus the 10-year bond yield of the US. The relevant spread is the spread of the USD-denominated bond and a rise or fall in the index refers to an increase or decrease, respectively, in the level of financial stress in an emerging country.

In relation to global financial stress, my study investigated whether financial stress in developed countries, related to their money market funding conditions, can be transmitted substantially to the 10-year government bond spreads in Poland, Mexico, and South Africa. In other words, the financial stress index (fsi_t) incorporates measures related to financial institutions' ability to fund their activities in developed countries. The index assumes that funding markets can freeze if the participants perceive greater counterparty credit risk or liquidity risk corresponding to times of stress. More specifically, the index is computed using the Two-Year EUR/USD Cross-Currency Swap Spread, Two-Year US Swap Spread, Two-Year USD/JPY Cross-Currency Swap Spread, Three-Month EURIBOR-EONIA, Three-Month Japanese LIBOR-OIS, Three-Month LIBOR-OIS, Three-Month LIBOR-OIS, and Three-Month TED Spread. Since the relevant index includes cross-currency swap spreads, it can be accepted that it considers the dynamics of the global exchange market. In this context, this study enhances the analysis by including the role of domestic financial stress in the bond yield spreads. Here, it should be borne in mind that various measures have been used to evaluate the impacts of domestic financial stress throughout the scientific literature. For instance, Balakrishnan et al. (2011) highlighted that exchange market pressure (EMP) is one of five components (the banking sector beta, stock market returns, stock market volatility, sovereign debt spreads and the exchange market pressure index (EMPI)) that the IMF uses to measure financial stress. Although the EMPI does not incorporate the stress in the entire domestic financial system, it can be assumed that, among the domestic financial stress indicators, the EMPI has come to the fore for economies with high foreign financing requirements and debt burdens, like Poland, Mexico and South Africa. The use of the EMPI as a domestic financial stress indicator is also consistent with the financial crisis literature, which has suggested that the speculative attacks in emerging markets, causing variations in the long-term bond rates, are due to the capital outflows depending on the developments in the exchange market. More specifically, it can be accepted that the EMP is at the center of the entire financial system in these countries and that the EMPI reflects the changes in systematic risk in the first place.

More specifically, nonlinear models were used in this study, since it was suggested by Jiang et al. (2013), Cuestas, Filipozzi, and Staehr (2015) and Caporale, Carcel, and Gil-Alana (2018), and that nonlinear models constitute a satisfactory framework in which to explore the relationship between money markets and exchange markets. In this respect, my study differed from the studies incorporating the transmission of financial stress mentioned above, since the asymmetric effects of domestic and global financial stress on the yield spreads were examined considering the interplay between model variables with the nonlinear VAR model. This study, based on the approach of Kilian and Vigfusson (2011), was enhanced by the usage of the quantile regression model parallel to Ozcelebi (2019, 2020). Accordingly, I incorporated the role of regime changes in the relationship between the financial stress of developed countries and the yield spread and between the EMPIs of emerging countries and the yield spread with the quantile regression model. In this vein, my quantile regression model was used to verify the results obtained with the nonlinear VAR model and enhance the analysis in terms of regime changes. Unlike Julio, Lozano, and Ligia A. Melo (2013) and del Cristo and Gómez-Puig (2017), my study specified the regimes using low/medium/high-risk bond market conditions in the emerging countries within quantile analysis and incorporated the issue of asymmetry by including variables related to financial stress decomposed into positive and negative changes in the quantile regression model. The stabilizing/destabilizing effects of financial stress on the bond markets of emerging countries were at the center of my analysis in terms of the yield spreads, while the periods of instability in financial markets were also considered, in parallel to Cuestas, Filipozzi, and Staehr (2015), Craighead, Davis, and Miller (2010) and Guidolin, Hansen, and Pedio (2019). In this respect, the empirical models used in the study contain monthly data covering the period from 2000:01 to 2017:02 due to the availability of data in terms of the EMPI methodology of Ila Patnaik, Joshua Felman, and Ajay Shah (2017).

2. Empirical Model

As for the empirical exercise, the conventional VAR model defined below constitutes the empirical base for our analysis.

$$y_t = a_0 + \sum_{j=1}^{p} A_j\, y_{t-j} + \varepsilon_t, \tag{1}$$

where y_t is a $K \times 1$ vector of variables with $t = 1, \dots, T$ and A_j represents an $M \times M$ matrix of coefficients. Within Equation (1), a_0 and ε_t refer to $M \times 1$ vectors of intercepts and errors, respectively. Additionally, I follow the Kilian and Vigfusson (2011) approach, which departs from the linear and symmetric and asymmetric data generating processes and thus, the censored variable VAR model is computed. The asymmetric VAR model can be defined as follows;

$$y_t = a_0 + \sum_{j=1}^{p} A_j\, y_{t-j} + \varepsilon_t, \tag{2}$$

$$y_t = b_{20} + \sum_{i=1}^{r} b_{21,i} x_{t-i} + \sum_{i=1}^{r} b_{22,i} y_{t-i} + \sum_{i=1}^{r} g_{21,i} x_{t-i}^{+} + \varepsilon_{2,t}, \tag{3}$$

where p and r refer to the lag order of the VAR model. The Equation (2) signifies a linear VAR model examining the effects of x_t on y_t, whereas the Equation (3) incorporates both the effects of x_t and the censored variable of $x_t(x_t^{+})$ on y_t. Within the regression model framework, the data generation process of x_t can both be accepted as asymmetric and symmetric as $x_t = \alpha_1 + \varepsilon_{1,t}$. The substitution of negative values of x_t with zero generates a censored variable x_t^{+} which can be expressed as; $x_t^{+} = \begin{cases} x & x > 0 \\ 0 & x \leq 0 \end{cases}$. Accordingly, the dynamic responses of y_t to positive and negative changes in x_t can be estimated, while b_{10} and b_{20} in (2) and (3) correspond to the vector of intercept and dummy variables, respectively. The coefficients of other model variables are included in b_{12} and b_{22} vectors and g_{21} denotes the vector of the coefficient of the censored variable x_{t-i}^{+}. Finally, $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are the residual vectors of (2) and (3).

In this framework, nonlinear VAR models were estimated for Poland, South Africa and Mexico to determine the effects of positive and negative shocks to the FSI and EMPI on the yield spreads of the above-mentioned countries, and each nonlinear VAR model can be defined as $(fsi_t, ys_t)'$ and $(empi_t, ys_t)'$. Accordingly, the FSI and the EMPI were represented by fsi_t and $empi_t$, while the censored variables fsi_t^{+} and $empi_t^{+}$ were generated by negative values to zero, and it was assumed that only increases have an impact on the other variable of the model *via* the censored variables approach. Additionally, I enhanced the analysis by focusing on the relationships between the EMPI and the yield spread and between the FSI and the yield spread within the linear regression models below.

$$ys_t = \delta_0 + \delta_1 fsi_t + \psi D_t + \omega_t, \tag{4}$$

$$ys_t = \phi_0 + \phi_1 empi_t + \xi D_t + \zeta_t. \tag{5}$$

In terms of the independent variables of the model in Equation (4), fsi_t denotes the FSI of developed countries, taking positive or negative values according to the changes in the level of stress. Equation (5) is also based on the impacts of independent variables on dependent variables, where $empi_t$ refers to the EMPIs of Poland, South Africa and Mexico. Within this framework, a rise/fall in the EMPI indicates that the domestic currency of the country under examination depreciates/appreciates, while the relevant index was derived according to the method of Patnaik, Felman, and Shah (2017). More specifically, the percentage change in the exchange rate and the expected change without the FXI were incorporated and thus the conversion factor ρ in Equation (6) was used to transform the intervention into a measure of the prevented percentage change.

$$empi_t = \%\Delta ex_t + \rho_t I_t. \tag{6}$$

In Equation (6), $\%\Delta ex_t$ represents the percentage change in the exchange rate and I_t denotes the intervention measured in billions of dollars. On the other hand, ρ_t refers to the conversion factor associated with FXI and it can be defined in (7). More specifically, the conversion factor ρ reflects the change in the exchange rate associated with \$1 billion of intervention, and it is used to transform the intervention into a measure of the percentage change that was prevented. Herein, it should be noted that monetary policy authorities may consider various exchange rate regimes; accordingly, fixed and floating exchange rate regimes may be implemented by central banks depending on the changing macroeconomic targets. In this respect, the exchange rate can change in float periods, while the FXI is observed in fixed periods. In this respect, Equation (7) shows the derivation of the conversion factor to compute $empi_t$.

$$\rho_t = \left(\frac{\mathrm{var}(\Delta ex_t)}{\mathrm{var}(I_t)}\right)^{1/2}. \tag{7}$$

ρ_t considers the value when countries move from a fixed exchange rate regime to a floating regime. More specifically, Equation (7) shows the standard deviation of the exchange rate volatility per intervention volatility. For instance, if ρ_t is 5.5%, 1 billion dollars of intervention would yield a 5.5% change in the exchange rate. The dependent variable of the models is the yield spread (ys_t), which indicates the sovereign bond spread. The spread considers the dollar denominated bonds of emerging market governments and US Treasury bills, while an increase/decrease in the spread signifies an improvement/worsening in the financial stress of emerging countries in terms of the bond market. In Equations (4-5), $D_t = (D_{t1}, \ldots, D_{st})'$ represents a vector including s dummy variables; for instance, if observation t belongs to the j^{th} period, $D_{jt} = 1$ and 0 otherwise. Finally, ω_t and ζ_t correspond to a random error term of the model.

At this point, asymmetry appears to be an important factor in empirical models for the identification of the interactions between macroeconomic variables. More specifically, the model below was employed to allow for asymmetry in the relationship between the EMPI and the yield spread and between the FSI and the yield spread. On the other hand, it can be suggested that other macroeconomic and financial factors that matter for the yield spreads of emerging countries can be taken into account. However, in terms of the quantile regression model, I enhanced my analysis on the basis of one independent and dependent variable following Salah A. Nusair and Dennis Olson (2019). Thus, fsi_t and $empi_t$ were decomposed into positive and negative changes as $fsi_t^+ = \max(fsi_t, 0)$, $fsi_t^- = \min(fsi_t, 0)$, $empi_t^+ = \max(empi_t, 0)$ and $empi_t^- = \min(empi_t, 0)$, and those variables were incorporated into Equations (4-5).

$$ys_t = \delta_0 + \delta^+ fsi_t^+ + \delta^- fsi_t^- + \psi D_t + \varpi_t, \tag{8}$$

$$ys_t = \phi_0 + \phi^+ empi_t^+ + \phi^- empi_t^- + \xi D_t + \nu_t. \tag{9}$$

Accordingly, within Equations (8) and (9), I could determine whether positive/negative FSI and EMPI shocks have different impacts on the yield spreads in terms of the direction and magnitude of the coefficients of the relevant variables. The quantile regression models can also be specified in line with the framework employed in (8) and (9); thus, the differences in the impacts of positive/negative shocks to fsi_t and to $empi_t$ on ys_t between low, medium and high-pressure regimes in the bond market can be studied. The quantile regression model is based on the conditional τth quantile of the dependent variable.

$$Q_{y_t}(\tau/x_t) = \alpha(\tau) + x_t'\beta(\tau). \tag{10}$$

In Equation (10), $Q_{y_t}(\tau/x_t)$ corresponds to the conditional τth quantile of the dependent variable y_t, and the intercept term $\alpha(\tau)$ in model (10) is dependent on τ. Additionally, $\beta(\tau)$ denotes the vector of coefficients associated with the τth quantile, while the explanatory variables of the model are included in the vectors x_t'. Thus, the relationships between the model variables can be analyzed *via* the coefficients of the τth quantile of the conditional distribution. The residuals of model (10) were computed with the estimated parameters for the specified quantile as follows: $\hat{\varepsilon}_t(\tau) = y_t - x_t'\hat{\beta}(\tau)$. Standardized residuals also refer to the ratios of the residuals to the degree-of-freedom-corrected sample standard deviation of the residuals. Thus, the approach in (11) can be defined, which refers to a solution to the minimization problem. Following Nusair and Olson (2019), I used the minimization of the weighted deviations from the conditional quantile as below:

$$\min_{\hat{\beta} \in \mathbb{R}^k} \sum_t \rho_t \left(y_t - \alpha(\tau) - x_t'\hat{\beta}(\tau)\right), \tag{11}$$

where ρ_τ is a weighting that can be written for any $\tau \in (0,1)$ as in (12).

$$\rho_t(\upsilon_t) = \begin{cases} \tau\upsilon_t & if \quad \upsilon_t \geq 0 \\ (\tau - 1)\upsilon_t, & if \quad \upsilon_t < 0\text{'} \end{cases} \tag{12}$$

where $\theta_t = q_t - \alpha^\tau - x'_t\beta^\tau$ and quantile regression signifies a weighted model minimizing the sum of residuals. Accordingly, positive/negative residuals have a weight of $\tau/(1-\tau)$. In terms of (10-12), the impacts of the FSI and the EMPI on the yield spread can be analyzed, while the following quantile regression models corresponding to OLS models can be generated:

$$Q_{y_t}(\tau/x_t) = \gamma_0^\tau + \gamma_1^\tau fsi_t + \gamma_2^\tau D_t; \tag{13}$$

$$Q_{y_t}\left(\frac{\tau}{x_t}\right) = \eta_0^\tau + \eta^{\tau+} fsi_t^+ + \eta^{\tau-} fsi_t^- + \eta^\tau D_t; \tag{14}$$

$$Q_{y_t}(\tau/x_t) = \iota_0^\tau + \iota_1^\tau empi_t + \iota_2^\tau D_t; \tag{15}$$

$$Q_{y_t}\left(\frac{\tau}{x_t}\right) = \kappa_0^\tau + \kappa^{\tau+} empi_t^+ + \kappa^{\tau-} empi_t^- + \kappa^\tau D_t. \tag{16}$$

In this context, I employed nine quantiles ($\tau = 0.10, 0.20, \ldots, 0.90$), which correspond to three regimes: low pressure in the exchange market ($\tau = 0.10, 0.20, 0.30$), medium pressure in the exchange market ($\tau = 0.40, 0.50, 0.60$) and high pressure in the exchange market ($\tau = 0.70, 0.80, 0.90$). More specifically, low/high pressure in the bond market shows that changes in the yield spread are in the lowest/highest three quantiles, while medium pressure in the bond market suggests that the factors leading to changes in the EMPIs and in the FSI of developed countries are not highly considerable and/or are rather small in magnitude. Unlike other studies in the scientific literature, the novelty of the paper is that it allowed for low/medium/high pressure in the bond markets of emerging countries and low/high pressure conditions in low/high-risk market conditions, indicating the increase/decrease in the "spread". In this respect, a medium or normal market corresponds to a market that is neither bearish nor bullish, reflecting that the latest changes in the exchange rate were rather small in magnitude.

Accordingly, the aims of this study were threefold: (i) to expose the reactions of the dependent variables in the nonlinear VAR and the quantile regression model; (ii) to determine the existence of asymmetry within the coefficients of the IRFs and the slope-based tests; and (iii) to show whether positive and negative shocks in the financial stress of developed countries and the EMPI of the emerging countries affect the yield spread differently in low/medium/high-pressure regimes. Thus, I contribute to the existing literature by addressing the question of whether the exchange market pressure in selected emerging countries and the financial stress of the developed countries can be recognized as the major source of variations in bond yield spreads and provide suggestions for policymakers. The main hypothesis of this paper concerns whether the changes in the FSI of advanced economies and the EMPIs of emerging countries have a considerable asymmetric impact on the yield spreads and thus lead to stabilizing/destabilizing effects in the money markets and on the funding conditions in the emerging countries under investigation. I also discuss whether the above-mentioned factors change the default risk in Poland, South Africa and Mexico.

More specifically, this paper focuses on emerging countries - namely Poland, Mexico, and South Africa - that have a relatively low reserve/import ratio (below 60%) and a relatively high debt/GDP ratio (above 40%) in comparison with other emerging countries according to the IMF. Accordingly, it is assumed that those countries are more vulnerable to variations in the bond market due to the capital flows from developed countries than other emerging countries. Herein, it should also be noted that the selected countries do not fall into the Wall category in terms of capital control measures, and they implement inflation-targeting regimes without an exchange rate anchor. At this point, it should be borne in mind that considering the increased size and volatility of international capital flows over the last years, as a macroprudential policy, emerging countries can apply capital control measures to a certain extent. More specifically, Milena Kabza and Konrad Kostrzewa (2016) noted that emerging countries, such as Poland, have implemented market-oriented capital controls, for example a sub-set of currency-based measures, in the context of capital flow management measures. However, these implementations have not shown that the country has a closed capital regime according to the IMF classification (Andrês Fernández et al. 2016). The International Monetary Fund (2019) also provided a classification of the monetary policy frameworks and exchange rate arrangements; accordingly, the possibility of different policy frameworks influencing the relationship between the financial stress and the yield spreads is eliminated.

3. Empirical Data and Analysis

3.1 Empirical Data

In this study, I examine the effects of changes in the FSI of developed countries and the EMPIs of Poland, Mexico and South Africa on the 10-year government bond spreads of the relevant emerging countries. Given the availability of data, I use 120 monthly observations for the above-mentioned variables over the period from January 2010 to December 2019. The FSI was extracted from the Office of Financial Research (OFR) database, the EMPIs of Mohit Desai et al. (2017) were extracted from Macro/Finance Group[1], and the 10-year government bond yields were sourced from Thomson and Reuters. More specifically, this study aims to incorporate the relationship between the model variables in the context of the vectors $(fsi_t, ysi_t^{pol})'$, $(fsi_t, ys_t^{mex})'$, $(fsi_t, ys_t^{sa})'$, $(empi_t^{pol}, ys_t^{pol})'$, $(empi_t^{mex}, ys_t^{mex})'$ and $(empi_t^{sa}, ys_t^{sa})'$. Additionally, it can be accepted that the Jarque-Bera normality tests (1980) in Table 1 mean that the null hypothesis of normality can be rejected for the majority of the series at the 5% significance level. This shows that the model variables contain nonlinearities, and the quantile regression analysis in the context of the above-mentioned vectors is robust to non-normal skewness in the estimation.

On the other hand, the optimal specification of a time series model is dependent on the determination of the unit root properties of the model variables. In this respect, I firstly used the traditional unit root analysis, and the results of the augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests in Table 2 suggested that the series, except for $empi_t^{pol}$, $empi_t^{mex}$ and $empi_t^{sa}$, can be accepted as stationary at first differences. Alternative unit root tests support the findings in Table 2; in this respect, the long-run cointegration relationship in terms of the $(fsi_t, ysi_t^{pol})'$, $(fsi_t, ys_t^{mex})'$, $(fsi_t, ys_t^{sa})'$,

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[1] **Macro/Finance Group.** 2017.
https://macrofinance.nipfp.org.in/releases/exchange_market_pressure.html.

$(empi_t^{pol}, ys_t^{pol})'$, $(empi_t^{mex}, ys_t^{mex})'$ and $(empi_t^{sa}, ys_t^{sa})'$ vectors cannot be explored *via* the Johansen cointegration test depending on VAR modeling.

Table 1 Summary Statistics

	$empi_t^{pol}$	$empi_t^{mex}$	$empi_t^{sa}$	ys_t^{pol}	ys_t^{mex}	ys_t^{sa}	fsi_t
Mean	-0.07	-0.01	0.35	1.49	4.23	6.14	-0.10
Median	-0.42	-0.10	-0.02	1.24	4.05	5.99	-0.24
Maximum	14.40	7.30	11.00	3.86	6.28	7.53	1.81
Minimum	-12.51	-6.41	-11.47	0.01	2.71	4.90	-0.69
Std. dev	4.25	2.86	3.80	1.12	0.75	0.68	0.50
Skewness	0.38	0.31	-0.05	0.56	0.58	0.36	1.53
Kurtosis	4.29	3.24	3.13	2.10	2.75	2.07	5.42
Jarque-Bera	11.22	2.15	0.15	10.36	7.10	6.93	76.06
Jarque-Bera probability	0.00	0.34	0.93	0.01	0.03	0.03	0.00

Source: Author's calculations.

Table 2 Traditional Unit Root Analysis Results

Variables	ADF	PP test
fsi_t	-1.71 (9)	-2.01 (2)
Δfsi_t	-4.36 (12)	-6.42 (9)
ys_t^{pol}	-0.73 (0)	-0.86 (4)
Δys_t^{pol}	-9.76 (0)	-9.77 (3)
ys_t^{mex}	-0.69 (4)	-1.88 (15)
Δys_t^{mex}	-8.00 (3)	-15.96 (54)
ys_t^{sa}	-1.82 (0)	-1.90 (3)
Δys_t^{sa}	-10.29 (0)	-10.28 (7)
$empi_t^{pol}$	-6.61 (2)	-9.42 (6)
$empi_t^{mx}$	-9.96 (4)	-8.53 (4)
$empi_t^{sa}$	-9.80 (0)	-9.80 (1)

Notes: The number of lags in the ADF test (in parentheses) is imposed by the Akaike information criterion (AIC), while the bandwidth for the PP test is indicated automatically by the Newey-West bandwidth (in parentheses) using the Bartlett kernel spectral estimation method. The 1%, 5% and 10% critical values for the ADF and PP tests with an intercept term are −3.47, −2.88 and −2.58, respectively.

Source: Author's calculations.

More specifically, the variables included in my empirical exercise were determined according to the unit root test results, while I also used the BDS test proposed by William A. Brock et al. (1996) to inform the variables. As shown in Table 3, it was suggested that the model variables contain nonlinearities, and nonlinear effects can be persistent in the relationship between the considered macroeconomic variables.

Table 3 BDS Test Results

Variables	*p*-values of the BDS test statistics				
	2	3	4	5	6
fsi_t	0.00	0.00	0.00	0.00	0.00
Δfsi_t	0.00	0.00	0.00	0.00	0.00
ys_t^{pol}	0.00	0.00	0.00	0.00	0.00
Δys_t^{pol}	0.00	0.00	0.00	0.00	0.00
ys_t^{mex}	0.00	0.00	0.00	0.00	0.00
Δys_t^{mex}	0.05	0.19	0.55	0.98	0.97
ys_t^{sa}	0.00	0.00	0.00	0.00	0.00
Δys_t^{sa}	0.02	0.10	0.26	0.57	0.99
$empi_t^{pol}$	0.71	0.33	0.03	0.00	0.00
$empi_t^{mx}$	0.68	0.33	0.47	0.52	0.48
$empi_t^{sa}$	0.96	0.90	0.53	0.84	0.61

Notes: The distance value of the test is 0.7. For the details of the BDS test, please see Broock et al. (1996).

Source: Author's calculations.

Table 4 Nonlinear Granger Causality Test Results

Vector	$I_q = I_{p_o}$	$empi_t$ does not cause Δys_t	Δfsi_t does not cause Δys_t
$(empi_t^{pol}, \Delta ys_t^{pol})'$ $(\Delta fsi_t, \Delta ys_t^{pol})'$	1	0.77 (0.21)	0.20 (0.42)
	2	1.73 (0.04)	0.99 (0.15)
	3	1.92 (0.02)	1.01 (0.15)
	4	0.99 (0.15)	1.20 (0.11)
	5	0.83 (0.20)	0.43 (0.33)
	6	0.38 (0.35)	0.13 (0.44)
	7	0.60 (0.27)	0.23 (0.40)
	8	-0.11 (0.54)	0.30 (0.38)
$(empi_t^{mex}, \Delta ys_t^{mex})'$ $(\Delta fsi_t, \Delta ys_t^{mex})'$	1	0.51 (0.30)	0.22 (0.41)
	2	1.14 (0.12)	0.89 (0.18)
	3	0.72 (0.23)	1.29 (0.09)
	4	0.56 (0.28)	1.14 (0.12)
	5	-0.02 (0.51)	1.01 (0.15)
	6	-0.07 (0.52)	1.19 (0.11)
	7	-0.51 (0.69)	1.11 (0.13)
	8	-0.30 (0.61)	1.16 (0.12)
$(empi_t^{sa}, \Delta ys_t^{sa})'$ $(\Delta fsi_t, \Delta ys_t^{sa})'$	1	0.31 (0.37)	0.33 (0.36)
	2	0.49 (0.31)	-0.17 (0.56)
	3	0.005 (0.49)	0.27 (0.38)
	4	-1.24 (0.89)	0.91 (0.18)
	5	-1.42 (0.92)	0.88 (0.18)
	6	-1.01 (0.84)	0.74 (0.22)
	7	-1.12 (0.86)	0.83 (0.20)
	8	-1.23 (0.89)	0.66 (0.25)

Notes: The *p*-values are square bracketed, and $I_q = I_{p_o}$ represents the number of lags in the residual series used in the test, which is from 1 to 8.

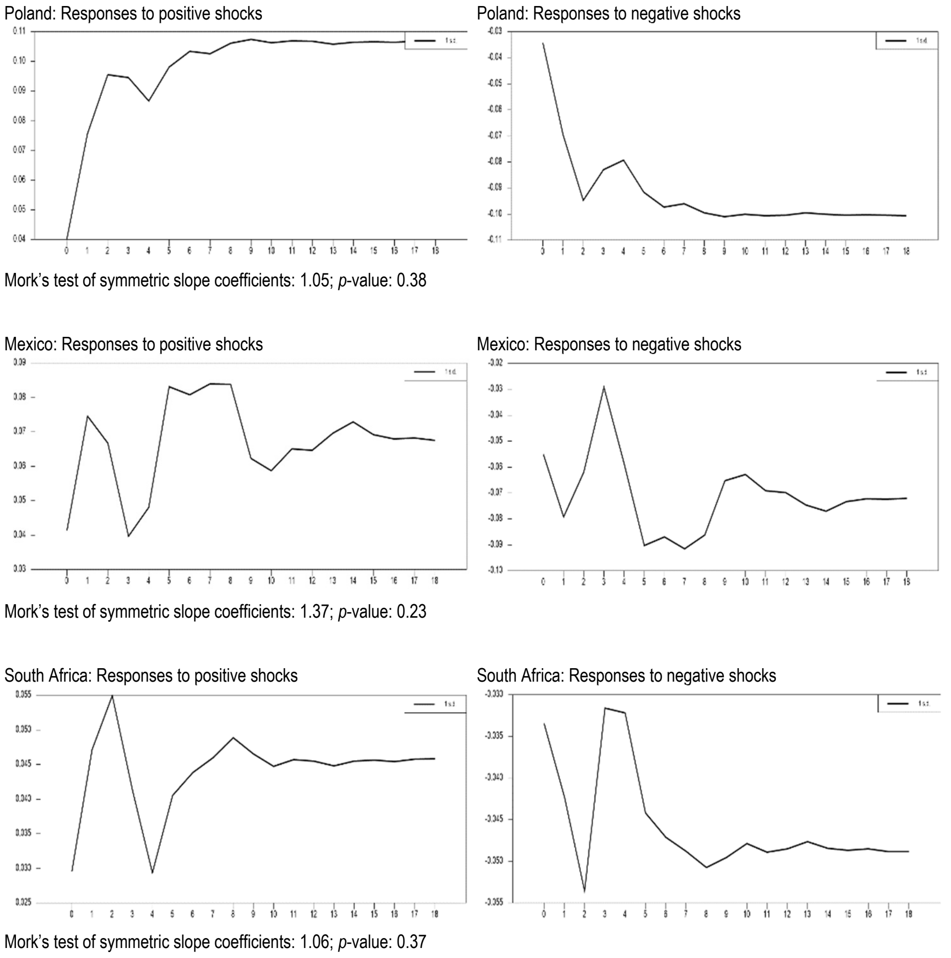
Source: Author's calculations.

Accordingly, it can be assumed that the linear causality test lacks power against nonlinear relationships, while I employed the nonparametric test of Cees Diks and Valentyn Panchenko (2006) in Table 4 to ascertain that the VAR framework is not suitable for examining the causality relationship between the variables under investigation. In this vein, the relevant test was applied to the residuals obtained from a VAR model on the basis of the $(\Delta fsi_t, \Delta ysi_t^{pol})'$, $(\Delta fsi_t, \Delta ys_t^{mex})'$, $(\Delta fsi_t, \Delta ys_t^{sa})'$, $(empi_t^{pol}, \Delta ys_t^{pol})'$, $(empi_t^{mex}, \Delta ys_t^{mex})'$ and $(empi_t^{sa}, \Delta ys_t^{sa})'$ vectors, where the lag lengths of each model were imposed by the AIC as 5, 5, 5, 1, 1 and 1, respectively. I also set the lag order as $I_q = I_{p_o} = 1, \ldots, 8$ and the bandwidth as $\varepsilon = 1.5$ following Diks and Panchenko (2006) and Nusair and Olson (2019).

3.2 Nonlinear VAR Model Results

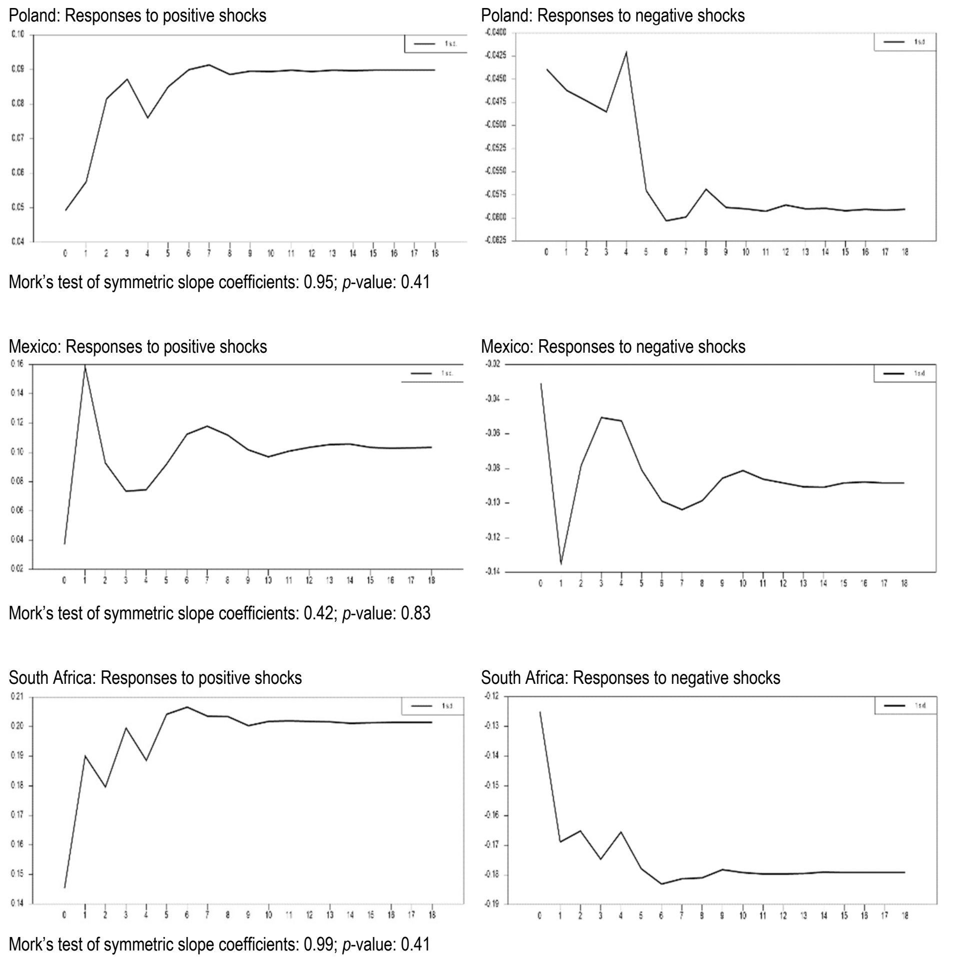
Despite the BDS and the nonlinear Granger causality test results indicating that the relationship between the FSI and the yield spread and the relationship between the EMPI and the yield spread can be subject to asymmetric effects. For this purpose, I used the nonlinear VAR model as an empirical framework and evaluated asymmetric relationships with IRFs and the Mork test based on the nonlinear VAR model of Kilian and Vigfusson (2011). The results of the impulse response analysis are shown in Figure 1, and the magnitude and direction of the IRFs' coefficients suggest that shocks in the FSI and shocks in the EMPI can have considerable effects on the yield spreads. In this respect, the impulse response analysis revealed that, as a result of positive/negative shocks in the FSI of developed countries, the yield spread will increase/decrease and thus the probability of a currency crisis in these countries will be strengthened/weakened due to the increase in the bond yields of Poland, Mexico and South Africa. Herein, it should be noted that the IRFs of the nonlinear VAR models are estimated based on the modified RATS code in line with Kilian and Vigfusson (2011). This relevant study did not produce confidence intervals for impulse responses. Although it is impossible to determine whether the effects of the financial stress index and the EMPI on bond spreads are statistically significant, the purpose of the exercise is to show the presence of asymmetry and check it *via* slope-based tests.

More specifically, due to the rise in the FSI, it can be assumed that investors' demand for safe-haven assets (e.g. 10-year US treasury bills) may increase, bearing in mind the fact that the financial turmoil in advanced economies triggered severe financial stress in emerging markets during the GFC. In other words, it can be argued that the interest in developing country bonds will decrease/increase and the interest in US bonds will increase/decrease as a result of a rise/fall in financial stress in developed countries. Thus, the international transmission effect of financial stress on macroeconomic and financial variables was suggested, parallel to Kennedy and Palerm (2014), Evgenidis and Tsagkanos (2017), Chen and Semmler (2018) and Apostolakis, Nikolaos, and Papadopoulos (2019). Regarding the relationship between the EMPI and the yield spread, the nonlinear VAR model's IRFs in Figure 2 showed that positive/negative shocks in the EMPI of the emerging countries under investigation led to an increase/decrease in the yield spreads. In terms of the sign and magnitude of the coefficients of the IRFs, this finding suggests that the increase in the domestic financial stress of Poland, Mexico, and South Africa may cause a debt crisis. Here, it should be noted that this finding of the impulse response analysis implies that the UIP condition may be valid, while the relationship between the variables mentioned above needs to be confirmed under different regimes. On the other hand, the impulse response analysis results support the results of the nonlinear causality test, whereas the results of the slope-based Mork test indicate that the relationship may be symmetric due to the p-values being higher than 0.05.



Source: Author's calculations.

Figure 1 Responses of the Yield Spread to Positive and Negative Shocks to the FSI (One Standard Deviation)



Source: Author's calculations.

Figure 2 Responses of the Yield Spread to Positive and Negative Shocks to the EMPI (One Standard Deviation)

Because this study also examined the asymmetric impacts by considering the role of alternative regimes, the quantile regression model was employed following Nusair and Olson (2019). In this respect, I performed a quantile unit root test (Table 5) in addition to the traditional unit root tests. The quantile unit root test considered the null hypothesis that $H_0: a(\tau) = 1$ for the grid of 9 quantiles to T=[0.10;0.90], and thus, Table 3 shows the t-statistics of the null hypothesis and the critical values of the test. The results of quantile autoregression unit root analysis with five reported quantiles is in line with those in Table 5. More specifically, fsi_t, ys_t^{pol}, ys_t^{mex} and ys_t^{sa} can be accepted as non-stationary at the 5% significance level, whereas $empi_t^{pol}$, $empi_t^{mx}$ and $empi_t^{sa}$ are stationary for all the quantiles of the conditional distribution.

Accordingly, it can be suggested that the quantile unit root test results support the findings of the traditional unit root tests.

Table 5 Quantile Autoregression Unit Root Analysis

	τ								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
fsi_t	-5.61 (-2.53)	-7.56 (-2.61)	-5.71 (-2.62)	-5.15 (-2.71)	-1.89 (-2.70)	-0.63 (-2.72)	1.16 (-2.79)	1.47 (-2.73)	2.08 (-2.57)
Δfsi_t	-1.59 (-2.55)	-4.30 (-2.47)	-5.61 (-2.40)	-9.70 (-2.58)	-11.28 (-2.52)	-10.80 (-2.47)	-10.10 (-2.47)	-6.04 (-2.48)	-1.63 -2.15)
ys_t^{pol}	-1.41 (-2.12)	-2.70 (-2.56)	-1.96 (-2.73)	-1.89 (-2.64)	-0.91 (-2.56)	-0.17 (-2.73)	0.48 (-2.75)	0.79 (-2.56)	0.44 (-2.60)
Δys_t^{pol}	-6.25 (-2.50)	-6.43 (-2.39)	-7.48 (-2.55)	-5.92 (-2.38)	-5.76 (-2.52)	-6.89 (-2.62)	-6.93 (-2.74)	-6.36 (-2.61)	-3.45 (-2.60)
ys_t^{mex}	-0.60 (-2.12)	-0.84 (-2.12)	-1.32 (-2.29)	-1.57 (-2.29)	-2.45 (-2.38)	-2.01 (-2.42)	-1.14 (-2.36)	-1.50 (-2.46)	-0.82 (-2.54)
Δys_t^{mex}	-5.96 (-2.23)	-8.02 (-2.15)	-13.39 (-2.30)	-14.20 (-2.29)	-12.42 (-2.37)	-10.94 (-2.40)	-9.57 (-2.38)	-6.49 (-2.25)	-2.93 (-2.49)
ys_t^{sa}	0.21 (-2.63)	-0.11 (-2.51)	-0.35 (-2.64)	-0.82 (-2.63)	-1.18 (-2.63)	-2.08 (-2.42)	-2.34 (-2.58)	-1.23 (-2.39)	-0.80 (-2.39)
Δys_t^{sa}	-5.02 (-2.58)	-9.97 (-2.55)	-10.35 (-2.58)	-8.78 (-2.51)	-8.28 (-2.52)	-6.98 (-2.46)	-7.30 (-2.50)	-4.89 (-2.29)	-3.45 (-2.23)
$empi_t^{pol}$	-2.90 (-2.52)	-5.50 (-2.62)	-7.95 (-2.63)	-10.25 (-2.61)	-8.95 (-2.61)	-6.82 (-2.52)	-5.62 (-2.56)	-5.10 (-2.38)	-1.92 (-2.19)
$empi_t^{mx}$	-4.28 (-2.37)	-4.15 (-2.38)	-6.53 (-2.61)	-8.10 (-2.74)	-9.57 (-2.70)	-8.70 (-2.67)	-4.30 (-2.76)	-3.13 (-2.71)	-1.90 (-2.41)
$empi_t^{sa}$	-3.03 (-2.43)	-5.94 (-2.50)	-8.56 (-2.66)	-7.75 (-2.72)	-6.89 (-2.82)	-6.30 (-2.66)	-5.91 (-2.61)	-4.99 (-2.36)	-4.48 (-2.40)

Notes: Critical values corresponding the 5% significance level are in parentheses.

Source: Author's calculations.

Herein, it should be noted that the relationship between the FSI (Δfsi_t) and the yield spread (Δys_t) and the relationship between the EMPI ($empi_t$) and the yield spread (Δys_t) may be under the influence of structural breaks. Thus, I incorporated Jushan Bai and Pierre Perron's (1998, 2003) multiple structural breaks, allowing for a maximum of 5 breaks with a trimming parameter of 0.15. The relevant test considered the null hypothesis of l+1 vs. l sequentially determined structural break, and multiple break dates were found in terms of the above-mentioned relationships. However, it can also be assumed that the significance of structural breaks can change throughout the distribution of the yield spread for each country, in line with Nusair and Olson (2019). Accordingly, a dummy variable ($dummy$) was used to capture the effects of the FED's termination of the quantitative easing policy with the value 1 for the period 2010:01-2014:09 and 0 otherwise.

3.3 Quantile Regression Model Results

With the quantile regression model, the effects of an EMPI increase ($empi_t^+$) in emerging countries on the yield spread of emerging countries were assessed under different pressure regimes in the bond market, as indicated in Table 6. Accordingly, it was found that an increase in the EMPI of emerging countries causes an increase in the yield spread of emerging countries during periods of high pressure in the bond markets. At the significance level of 5%, it was suggested that the effect on the yield spreads has become statistically significant after the 0.6 quantile for all countries. However, in the case of Poland, it was found that $empi_t^+$ also leads to an increase in the yield spread in lower quantiles at the significance level of 10%, corresponding to the regimes with lower bond market pressure. The quantile regression model results indicated that, as a result of the increasing pressure on the exchange market, the demand for Zloty-denominated assets had decreased and capital outflows from the country had occurred. This finding suggests that Poland's bond market is overly sensitive to variations in the exchange market due to the country's higher level of foreign debt in GDP (around 60% according to the CIA World Factbook) compared to Mexico and South Africa. In this respect, it can also be interpreted as indicating that the relationship between the exchange market and the bond market is more effective than those in South Africa and Mexico, whereas this situation can be considered as a risk factor for Poland in terms of financial stability.

On the other hand, it can be inferred that increases in exchange market pressure cause capital outflows from Mexico and South Africa only under higher bond market pressure regimes. Nevertheless, considering the positive coefficients, my findings showed that an EMPI increase in emerging countries can lead to a rise in the likelihood of a debt crisis in the relevant countries by causing an increase in their bond spread. Furthermore, it was suggested that the rising financial stress in emerging countries may negatively affect the macroeconomic expectations and thus even trigger a financial crisis. More specifically, it was implied that the likelihood of increasing financial stress in emerging countries' exchange markets triggering a debt crisis in Poland, Mexico and South Africa is related to the financial instability in the context of the bond market. The results of the quantile regression model also showed that the effects of decreases in emerging countries' EMPI ($empi_t^-$) on emerging countries' yield spreads are statistically significant in lower quantiles in Poland. In this respect, it was revealed that decreases in Poland's financial stress in terms of the exchange market had an impact on the yield spreads during periods of low pressure. At the significance level of 1%, it was indicated that the bond yields with respect to the US decreased in Poland. This finding can be interpreted as indicating that the low financial stress in the exchange markets in the emerging country increased the interest in the assets of the countries, corresponding to a rise in the demand for assets denominated in Zloty causing an improvement in the macroeconomic and financial stability of Poland. The relevant finding is partly in line with that of Cuestas, Filipozzi, and Staehr (2015), who indicated that there are deviations from UIP under severe financial stress, and it can be argued that economic growth can revive since it was found that interest rates were falling in the relevant countries.

Table 6 Estimation Results for the Quantile Regression Model on the Basis of the Effects of the EMPI

	Low bond market pressure regime (Poland)			Normal bond market pressure regime (Poland)			High bond market pressure regime (Poland)		
Variables	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
$empi_t^+$	0.04	0.06	0.07	0.05	0.05	0.04	0.04	0.04	0.02
	(0.56)	(0.06)	(0.00)	(0.07)	(0.01)	(0.06)	(0.01)	(0.01)	(0.15)
$empi_t^-$	-0.99	-1.85	-1.83	-1.81	-1.07	-0.49	-0.80	-1.32	-0.82
	(0.36)	(0.00)	(0.00)	(0.00)	(0.09)	(0.45)	(0.25)	(0.30)	(0.45)
$Dummy$	1.15	1.19	1.22	1.20	1.59	1.55	1.61	1.70	2.08
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Cons$	0.06	0.15	0.27	0.56	0.67	1.10	1.15	1.17	1.31
	(0.88)	(0.55)	(0.23)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Low bond market pressure regime (Mexico)			**Normal bond market pressure regime (Mexico)**			**High bond market pressure regime (Mexico)**		
Variables	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
$empi_t^+$	0.04	0.02	0.03	0.03	0.04	0.03	0.04	0.03	0.03
	(0.10)	(0.38)	(0.35)	(0.36)	(0.06)	(0.21)	(0.00)	(0.01)	(0.03)
$empi_t^-$	-0.74	-0.84	-0.79	-0.37	-0.18	-0.66	-0.45	0.03	0.15
	(0.24)	(0.16)	(0.20)	(0.55)	(0.76)	(0.27)	(0.45)	(0.95)	(0.72)
$Dummy$	-0.27	-0.29	-0.46	-0.27	-0.14	-0.15	-0.40	-0.29	-0.69
	(0.07)	(0.04)	(0.00)	(0.07)	(0.36)	(0.33)	(0.04)	(0.09)	(0.02)
$Cons$	3.49	3.64	3.85	3.87	3.87	3.97	4.33	4.40	4.90
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Low bond market pressure regime (South Africa)			**Normal bond market pressure regime (South Africa)**			**High bond market pressure regime (South Africa)**		
Variables	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
$empi_t^+$	0.01	0.00	0.01	0.02	0.03	0.05	0.04	0.03	0.03
	(0.55)	(0.99)	(0.75)	(0.67)	(0.27)	(0.01)	(0.02)	(0.04)	(0.01)
$empi_t^-$	0.21	0.52	0.11	-0.24	-0.66	-1.32	-0.88	-0.58	-0.66
	(0.75)	(0.42)	(0.89)	(0.83)	(0.44)	(0.06)	(0.26)	(0.48)	(0.36)
$Dummy$	-0.55	-0.83	-0.79	-1.01	-1.14	-1.10	-1.50	-1.41	-1.44
	(0.06)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Cons$	5.34	5.88	5.97	6.18	6.35	6.34	6.90	7.04	7.14
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: *p*-values are in parentheses.

Source: Author's calculations.

In the cases of Mexico and South Africa, the quantile regression model results indicated that decreases in the EMPI do not affect the yield spread, revealing that decreasing stress in the exchange market is not a considerable factor in changing the interest in assets denominated in pesos and rands. Therefore, it can be argued that those country's foreign financing requirement problem does not improve, and investors' interest does not increase as a result of decreases in the EMPI. Here, it can be argued that the volatility of the pesos and rand due to the risks of economic growth and declining global competitiveness, which in turn cause a downgrade of South Africa's international debt to junk bond status, could be recognized as a factor that eliminates the impacts of the decrease in the EMPI on yield spreads. The finding that $empi_t^-$ has no significant effect on yield spreads in the high bond market pressure regimes implied that the ratio of debt to GDP is considered more than the reserve/import ratio by the economic agents in the relevant regime. More specifically, it was revealed that net capital inflows to emerging countries corresponding to a decrease in the EMPIs do not influence the bond market dynamics during all regimes. The quantile regression model results also showed that increases in the EMPI do not affect the yield spread of South Africa in a significant number of low and normal bond market pressure regimes, suggesting that increasing stress in the exchange market does not lead to a fall in the demand for assets denominated in rands. Since it was found that the EMPI does not cause significant impacts on the long-term bond yields, it can be revealed that that there is not a high level of interaction between the exchange market and the bond market in South Africa. This finding indicates that the financial system of the country is not sufficiently developed, while it also implies that a currency crisis cannot trigger a debt crisis in periods of relatively low domestic financial stress and increase the default risk of the country.

Considering the spillover effects of monetary policy after the GFC, it can also be assumed that the changes in the liquidity conditions in developed countries can influence the bond markets of emerging countries. More specifically, since the rise/fall in the FSI indicates that the financial stress in the developed country has increased/decreased and that the liquidity has been shrinking/abundant, it can be suggested that the bond market will be negatively/positively affected in the context of the international transmission mechanism and that the financial instability will change in emerging countries. In terms of the outcomes of the changes in the financial stress of developed countries, the quantile regression models indicated that a significant degree of interplay may exist between the funding conditions of developed markets and the bond yields of emerging countries. In this respect, Table 7 suggests that the decreasing financial stress in developed countries reflected by Δfsi_t^- will decrease the demand for government bonds of Poland and Mexico and that capital outflows from these two countries will occur as a result of the improved expectations for the financial markets of developed countries. In the context of the positive and statistically significant coefficients, it can be argued that funds flow from the relevant emerging countries' assets to developed countries' assets, particularly to those of the US. However, the decrease in financial stress in developed countries do not affect yield spreads in South Africa. This finding reveals that the country may not be positively affected by the improvement of monetary conditions in developed countries. In other words, it can be argued that decreasing financial stress in developed countries cannot have a positive effect on their economy and contribute to their financial stability through the international transmission mechanism when the demand for long-term government bonds is low. This result reveals that country-specific factors will be more dominant on the yield spreads.

Table 7 Estimation Results for the Quantile Regression Model on the Basis of the Effects of the FSI

	Low bond market pressure regime (Poland)			Normal bond market pressure regime (Poland)			High bond market pressure regime (Poland)		
Variables	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
fsi_t^+	1.13	0.92	2.96	3.65	3.34	2.60	2.54	1.48	0.35
	(0.15)	(0.35)	(0.07)	(0.00)	(0.00)	(0.03)	(0.04)	(0.22)	(0.73)
fsi_t^-	4.87	5.38	4.85	4.40	3.79	3.11	2.76	1.43	0.67
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.15)	(0.46)
$Dummy$	0.96	0.81	0.97	1.12	1.24	1.42	1.42	1.76	2.10
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Cons$	0.18	0.46	0.54	0.60	0.77	0.90	1.07	1.21	1.37
	(0.19)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Low bond market pressure regime (Mexico)			**Normal bond market pressure regime (Mexico)**			**High bond market pressure regime (Mexico)**		
Variables	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
fsi_t^+	0.89	0.62	0.82	0.99	0.64	0.98	0.64	0.13	-0.50
	(0.00)	(0.06)	(0.02)	(0.03)	(0.11)	(0.14)	(0.32)	(0.83)	(0.21)
fsi_t^-	1.42	1.69	1.58	1.65	1.23	1.48	0.98	0.70	0.13
	(0.02)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.06)	(0.24)	(0.79)
$Dummy$	-0.39	-0.34	-0.45	-0.48	-0.38	-0.36	-0.46	-0.37	-0.57
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.06)	(0.06)
$Cons$	3.56	3.68	3.84	3.93	3.98	4.03	4.28	4.42	4.89
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Low bond market pressure regime (South Africa)			**Normal bond market pressure regime (South Africa)**			**High bond market pressure regime (South Africa)**		
Variables	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
fsi_t^+	0.31	0.95	0.77	1.15	0.94	0.48	0.30	-0.01	-0.37
	(0.06)	(0.02)	(0.03)	(0.01)	(0.02)	(0.06)	(0.06)	(0.09)	(0.06)
fsi_t^-	1.21	1.39	0.59	0.36	0.25	-0.34	0.03	0.31	0.13
	(0.38)	(0.06)	(0.59)	(0.74)	(0.80)	(0.76)	(0.96)	(0.61)	(0.81)
$Dummy$	-0.71	-0.98	-0.98	-1.04	-1.16	-1.28	-1.57	-1.60	-1.63
	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$Cons$	5.29	5.85	6.04	6.16	6.37	6.69	7.16	7.32	7.51
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: *p*-values are in parentheses.

Source: Author's calculations.

Herein, it should also be borne in mind that the rise in financial stress in developed countries strengthens the likelihood of a global financial crisis. The results of the quantile regression model support this finding and indicate that Δfsi_t^+ will lead to an increase in yield spreads in all bond market pressure regimes in South Africa. Since the period (2010:01-2019:12) taken into account in the quantile regression model includes the time when the FED stopped quantitative easing, it can be suggested that the increase in financial stress of developed countries affected the debt service of South Africa negatively. More specifically, it can be inferred that investors transferred their funds from South Africa's assets to relatively more safe-haven assets (such as the US 10-year bonds) when the likelihood of a global financial crisis was considerable and thus the spread of the yield increased. However, it was revealed that the demand for assets denominated in Mexican Pesos would not be strongly affected by the increase in financial stress in developing countries since the majority of the coefficients of the Δfsi_t^+ are statistically insignificant at the significance level of 5%. Thus, it can be argued that the Mexican economy's position as the eleventh largest in the world by purchasing power parity and the unprecedented macroeconomic stability with low inflation and interest rates make the country resistant to external financial stress shocks. However, structural issues, such as low productivity, high inequality and a large informal sector employing over half of the workforce, and uncertainty surrounding the future of the NAFTA are factors that may make the country vulnerable to domestic and global financial stress shocks in the coming years.

In this study, the question of whether the FSI of developed countries and the EMPIs of Poland, Mexico and South Africa will lead to asymmetric effects on the yield spreads was evaluated using the quantile regression model's coefficients as well as the quantile slope equality test and the symmetric quantiles test. At this point, it should be noted that the quantile regression model estimation with nine reported quantiles on the basis of the effects of the EMPI and FSI are in line with those in Tables 6 and 7. In terms of the quantile regression model dealing with the relationship between the EMPI and the yield spread, the quantile slop equality test, shown in Table 8, indicated that at the significance level of 1%, the coefficients do not differ across quantile values. On the other hand, the symmetric quantiles test indicated that increases and decreases in the FSI can have symmetric effects on the yield spreads in all the cases, and this is not consistent with the quantile regression model results in terms of the sign and magnitude of coefficients of the variables. Moreover, this finding is not in line with the analysis performed using the nonlinear VAR model, suggesting that the impacts of the FSI on the yield spreads can change and become asymmetric in the pres-

Table 8 Symmetric Quantiles and Quantile Slope Equality Test Results (Asymmetric Model)

Model specification	Country	Symmetric quantiles test chi-sq. statistic	Quantile slope equality test chi-sq. statistic
	Poland	11.98 (0.74)	29.00 (0.22)
$\Delta ys_t = f(cons, empi_t^+, empi_t^-, dummy)$	Mexico	18.17 (0.28)	28.66 (0.23)
	South Africa	7.79 (0.95)	26.58 (0.32)
Model specification	Country	Symmetric quantiles test	Quantile slope equality test
	Poland	12.80 (0.68)	37.05 (0.04)
$\Delta ys_t = f(cons, \Delta fsi_t^+, \Delta fsi_t^-, dummy)$	Mexico	14.77 (0.52)	27.42 (0.28)
	South Africa	17.99 (0.32)	24.59 (0.42)

Notes: Both tests are based on the estimated equation quantile tau=0.5, while the number of test quantiles is 10 in the relevant tests. *p*-values are in parentheses.

Source: Author's calculations.

ence of different bond market pressure regimes. Nevertheless, the role of a regime change in the relevant relationship was highlighted, while similar findings were found to be valid for the effects of each country's EMPI on the yield spread. More specifically, the results of the quantile slope equality test indicated that the slope parameters are equal across the various quantiles, and there is no robust evidence of departures from symmetry from the symmetric quantiles test.

In contrast to the findings of the nonlinear VAR model's IRFs, it was indicated through the quantile regression model that the effects of the FSI on the yield spreads can be asymmetric under different bond market pressure regimes. This finding underlines the determinative role of regimes in this relationship and more specifically suggests that the developments that determine the financial stability of each emerging country can change the transmission effect of developed countries' financial stress on emerging countries' bond market, parallel to Julio, Lozano, and Melo (2013). Additionally, it was emphasized that increasing financial stress in developed countries can accelerate the capital outflows from emerging countries and increase the risk of a debt crisis in emerging countries. This finding confirms that, as a result of the increasing financial stress in developed countries, the long-term government bonds of Poland, Mexico and South Africa cannot become an investment alternative. On the other hand, the quantile regression model indicated that, under different regimes, increasing/decreasing financial stress in emerging countries in terms of the exchange market, reflected by $empi_t^+/empi_t^-$, can raise/lower the likelihood of a debt crisis in the emerging countries under investigation; thus, the importance of country-specific factors was exposed, in line with Kennedy and Palerm (2014) and del Cristo and Gómez-Puig (2017).

4. Conclusions

In this study, the impacts of global and domestic financial stress on the yield spreads in emerging countries were examined; hence, possible asymmetric effects of the FSI of developed countries and the EMPIs of Poland, Mexico and South Africa were discussed with alternative quantitative approaches. In this respect, the BDS test of Broock et al. (1996) revealed that the relationships between the above-mentioned variables can be evaluated using nonlinear models. It was also confirmed through the nonparametric causality test of Diks and Panchenko (2006) that the VAR model framework can constitute a base for the detection of the nonlinear relationship between the FSI and the yield spreads and between the EMPI and the yield spreads. The results of Diks and Panchenko's (2006) causality test suggested that the yield spreads can be explained by the global and domestic financial stress in the context of nonlinear models and quantile-based analysis. Considering the results of the nonparametric causality test, I employed the nonlinear VAR model of Kilian and Vigfusson (2011), and I investigated the direction of the impact of the FSI of developed countries and the EMPIs on the yield spreads using the nonlinear VAR model's IRFs. In this context, I found that increases/decreases in the FSI will increase/decrease the yield spreads in each emerging country. Similarly, the IRFs revealed that positive/negative shocks in the EMPIs will lead to a rise/fall in the yield spread. In terms of the shocks in the FSI and the EMPI, the effects on the yield spreads were accepted as symmetric, and this inference was supported by the slope-based Mork test.

This study also followed the assumption that the transition effect of global and domestic financial stress on the yield spreads is dependent on the macroeconomic and financial conditions and that regime changes might affect the relationship. In this respect, the quantile regression model incorporating the variables of the FSIs of developed countries and the EMPIs of Poland, Mexico and South Africa, decomposed into positive and negative changes, was estimated and the asymmetric effects on yield spreads under low/normal/high-bond market pressure regimes were analyzed for each emerging country. The quantile regression model showed that a rise in the FSIs of developed countries may cause an increase in the yield spreads of Poland, Mexico, and South Africa and may affect the debt management of those countries negatively and disrupt the financial stability, increasing their default risk. This effect was found to be valid for all the bond market pressure regimes in South Africa, and it was suggested that the macroeconomic and financial changes in the country have no significant role on the effects of developed countries' financial stress. In the case of Mexico, the above-mentioned effect was weakly detected in all the pressure regimes, and this finding supports the existence of the recent period of macroeconomic and financial stability in the Mexican economy. More specifically, since the global financial stress indicator used in the study is also related to the likelihood of a global financial crisis, my results revealed that investors seeking safe-haven assets may sell the 10-year bonds of Poland, Mexico and South Africa and buy the 10-year bonds of the US. Since it was found that default risk in Poland, Mexico, and South Africa may increase as a result of the increase in the FSIs of developed countries, it is suggested that the relevant countries reduce their foreign currency financing requirements by implementing policies that increase international competitiveness.

On the other hand, it was found that declines in the FSI increase the yield spread of Poland and Mexico nearly under all bond market pressure regimes, revealing that decreasing financial stress in developed countries will increase the demand for the assets of all other developed countries due to the improved expectations for these markets. Accordingly, it was revealed that the demand for the Zloty and Peso-denominated assets will decrease, and the long-term bond yield of those countries will increase. More specifically, decreasing financial stress in developed countries will have negative effects on the debt management in Poland and Mexico and increase the default risk of the two countries irrespective of the presence of macroeconomic and financial stability in these two countries. Thus, I suggest that Poland and Mexico may implement policies that increase the return on assets denominated in their local currencies. At this point, the high interest rate policy can be implemented in the short-term, while the long-term macroeconomic stability needs to be strengthened. In the case of South Africa, the relevant quantile regression model exposed that a decrease in financial stress in developed countries do not influence the demand for the bonds of the country. In other words, this finding reveals that the country is not significantly susceptible to capital inflows, which may derive from the improvement in funding conditions in developing countries. However, it can be said that country-specific factors determining financial stress may prevail.

In terms of the effects of domestic financial stress on the yield spreads, the quantile regression model showed that a rising EMPI, which corresponds to the depreciation of the domestic currency, causes negative effects on the bond market of emerging countries, and thus the yield spread may increase. This effect was valid in periods of higher bond market pressure regimes in Mexico and South Africa, whereas the effect in Poland was not subject to the influence of regime changes. This finding indicates that the Polish economy was sensitive to domestic financial stress shocks arising from the exchange market due to its higher share of foreign debt in GDP with respect to Mexico and South Africa in the sample period. More specifically, the possibility of domestic macroeconomic and financial developments triggering a debt crisis in the country is considerable. Thus, it is revealed that polices reducing the current account deficit or increasing the current account surplus are crucial to decrease the foreign debt of Poland. However, the positive effects of the falling EMPI on the yield spreads were persistent in the periods of low bond market pressure in Poland. The findings of the quantile regression model indicated that the UIP rule was partially valid, while they underlined that regime changes in the context of bond market pressure can significantly change the interaction between the exchange market and the money market. In the cases of Mexico and South Africa, it was revealed that, in a low bond market pressure regime, which can be considered as a period of financial stability, even a falling EMPI will not raise the demand for the bonds of the countries. Accordingly, the quantile regression model results support the recent development of the South African economy, limiting the economic growth and decreasing the global competitiveness level and particularly the downgrading of South Africa's international debt to junk bond status.

Furthermore, the quantile regression model estimations showed that the effects of global and domestic financial stress on the yield spreads under low/medium/high bond market pressure regimes will be asymmetric. Thus, this study highlighted that regime changes due to macroeconomic and financial developments will significantly influence the relationships between financial stress and yield spreads in Poland, Mexico, and South Africa. More specifically, it is suggested that the conditions in the bond market, in other words, the factors affecting the pressure in the market, should be closely monitored by the central banks of Poland, Mexico, and South Africa, while the FSI-augmented Taylor rule can be adopted. In this vein, the significant limitation of this study is that mixed frequency models were not used since macroeconomic variables affecting the relationships discussed in the study such as external debt, balance of payments and the international investment position are in quarterly or yearly basis. I suggest that future research should examine the effects of the above-mentioned factors using quantile-based mixed frequency models.

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