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Return and volatility transmission between emerging markets and US debt throughout the pandemic crisis

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ABSTRACT

In this study, we investigate the return and volatility spillovers between emerging markets and US government bonds during the Covid-19-triggered pandemic by accounting for the market sentiment captured by the media coverage index. To study the dynamic spillovers, we use a TVP-VAR approach. Our results show a significant increase in the dynamic connectedness between media coverage, emerging market bonds, and US bonds, as well as between the respective volatilities, especially during the early phases of the Covid-19 pandemic, with the highest values observed in March 2020. The emerging market bonds appear to be net transmitters to the system and lead the system; whereas, the US bond market is the net receiver. These results show that, during the pandemic, the US bond market is less vulnerable and more resilient to changes in market sentiment vis-à-vis the fixed-income markets of the developing countries.

1. Introduction

Modeling the dynamic spillovers between financial markets, especially debt markets, is critical for investors and policymakers to plan suitable policy decisions, understand business cycles, and assess diversification benefits for international portfolios (Umar et al., 2019; Gubareva and Umar, 2020). Several factors influence the strength and direction of spillover in the fixed-income markets of developing and developed countries (Ahmad et al., 2018; Umar and Spierdijk, 2017; Kenourgios et al., 2020; Huidrom et al., 2020; Riaz et al., 2020). During the current Covid-19 pandemic, the world has seen not only an unprecedented health crisis across the continents but an economic and financial contagion characterized by social distancing and commercial lockdowns leading to a global economic crunch.

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The ongoing outbreak of virulent disease has produced severe influences on the financial markets and the real economy (Goodell, 2020; Umar and Gubareva, 2021). Sène et al., 2020, show that the yields on the Eurobonds of both emerging and developed markets overreacted on the economic meltdown triggered by Covid-19 in the first half of 2020. They propose that the daily case statistics reported by each country play a leading role in the observed unusual behavior of the bond markets. The liquidity and credit stresses in the emerging bond markets reached their apogees in late March 2020 and credit spreads then lingered to recover to the pre-crisis level due to the occurred repricing of default risk; see (Gubareva, 2021) and Gubareva, 2020. Papadamou et al., 2020, document a negative effect of the pandemic on the stock-bond correlation. They observe a flight-to-quality effect and this occurrence is not country-specific but prevails simultaneously across all countries.

In this context, our paper contributes to the literature by advancing the knowledge of the impact of the Covid-19 pandemic on the fixed-income markets by exploring the dynamics of return and volatility spillovers between the emerging and US bond markets. The market sentiment is captured by the media coverage index. A closely related paper includes Gubareva and Umar, 2020. It investigates the impact of the pandemic on the emerging market bonds using wavelet analysis. Our study differs from Gubareva and Umar, 2020, in the two following aspects. First, we study the spillover between the United States (US) bond market, the emerging bond markets, and the media coverage index (MCI) - not just between the emerging bond markets and the MCI. We include US in the framework, because of its significance in the international financial system and spillover effects to other markets (Cardona et al., 2017; Chulia et al., 2017). The US has severe implications for the emerging markets and global stability, specifically during the Covid-19 pandemic (Aizenman and Itô, 2020). Second, we analyze the impact of coronavirus-induced panic on the volatility of the emerging and US debt markets.

We use a Time-Varying Parameter Vector Auto-Regression (TVP-VAR) model to estimate the spillovers across the US and the emerging bond markets (Koop and Korobilis, 2014; and Antonakakis and Gabauer, 2017). The TVP-VAR is a modification of the Diebold and Yilmaz (2012) connectedness approach. The advantage of the TVP-VAR methodology resides in overcoming the arbitrariness in selecting the size of the rolling-window as in Diebold and Yilmaz (2012), which may lead to over-smoothed parameters while disregarding otherwise important observations (Antonakakis et al., 2018; Korobilis and Yilmaz, 2018). The Diebold and Yilmaz (2012) rolling window may not be appropriate due to the relatively short time series data that is available for Covid-19. Thus, by employing the TVP-VAR approach, we can better quantify the time-varying spillover.

Our results show a significant increase in the dynamic connectedness between the MCI, emerging market (EM) bonds, and the US bonds returns and volatility as the Covid-19 pandemic progressed. Overall, the connectedness was lower before and after the apogee of the Covid-19 crisis, but it was outrageously high during the pandemic meltdown in March 2020. We also find that the EM bond markets are net transmitters to the system and lead the system; however, the US bond market acts as the net receiver from the EM bonds and MCI during the Covid-19 times. These results show that, during the pandemic, the US bond market is less vulnerable and more resilient to changes in market sentiment vis-à-vis the fixed-income markets of the developing countries, implying that US bonds could act as a safe-haven or hedging instrument during periods of global crises and/or systemic events such as the Covid-19.

The remaining part of the article is organized in the following manner. Section 2 presents a detailed literature survey. Section 3 offers a description of the applied econometric framework along with the data employed in the estimations. Section 4 provides the results and discusses their implications. Section 5 lists the most significant conclusions and elaborates on the most valuable insights for the stakeholders.

2. Literature survey

In early 2020, the pandemic strikes the world and results in a tremendous economic downturn. Several studies argue that the damage to the global economy brought about by the current virulent disease surpasses the damage caused by any of the previous pandemics (Goodell, 2020; Spatt, 2020). Zaremba et al., 2020, and Zhang et al., 2020, among many others, show that the financial market risk has substantially increased across the globe in response to the pandemic. Non-conventional financial policy interventions by many governments of developed and developing states have been undertaken to reduce market uncertainty and reestablish investors' confidence. However, governments have been responding to the pandemic individually, in different ways, and without due coordination of policy actions, compromising in this manner the overall efficiency of their efforts.

The damage due to the Covid-19 pandemic is more drastic in emerging markets due to the severely weakened economic conditions, adversely affected growth prospects, and higher policy uncertainty (Djankov and Panizza, 2020). Sène et al. (2020) explore the 48 developing Eurobonds markets and show an overshooting of the yields in response to the daily reports of confirmed cases. They also show that the news of assistance from international public creditors during the crisis period mitigates this pricing risk. Liquidity and credit stress in the emerging markets are also highest during the Covid-19 pandemic (Gubareva, 2020). The liquidity problem has been especially acute in the corporate bond markets; however, it is now relaxed through the intervention of the Federal Reserve (Falato et al., 2020; Haddad et al., 2020; Kargar et al., 2020).

Arellano et al., 2020, study several emerging markets using an epidemiological model combined with a sovereign default model. They propose that lockdown policies during Covid-19 have been beneficial for reducing health devastation but have a significant economic predicament accompanied by an extended debt crisis. The debt crisis in return leads to a more severe health crisis due to relaxed lockdowns implemented by governments to reduce the damaging effects of the debt crisis on the economy.

Studying the emerging market’s Credit Default Swap (CDS) spreads, Daehler et al., 2020, find that the cumulative Covid-19 mortality rate growth is positively associated with the CDS spreads. Their results suggest that the epidemiological deterioration can lower confidence in the sovereign credit markets due to the prospects of prolonged lockdowns and slower GDP growth recovery.

The pandemic resulted in adverse impacts not only regarding bond markets but also regarding all financial markets. To mention, Topcu and Gulal (2020) find an adverse effect of the pandemic on the stock markets of the developing economies; the effect begins to

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diminish after the health and economic crisis apogee in March 2020. The negative impact of the pandemic is extreme in Asia while it is lowest in Europe. The time and size of the government response matter in reducing the pandemic effects. The markets reacted to Covid-19 more repulsively because of the government crisis-containment policies, voluntary social distancing, and limited commercial activity in the countries (Baker et al., 2020).

The Covid-19 also has evidenced an asymmetric effect across markets, industries, and asset classes. Harjoto et al., 2020, show that the number of reported cases and deaths affects the emerging markets while only the number of cases affects the equity markets of the developed economies. Effects of the pandemic vary across industries and the Covid-19 related negative news has been more impactful compared to the positive news (Baek et al., 2020). Sherif (2020) documents a significant negative effect for conventional equities. Furthermore, he also shows that the information technology sector outperforms the markets; however, the conventional stocks, i.e., consumer services, transportation, tourism, and beverages, performed worse during the pandemic. Shen et al., 2020, show that the current pandemic has an adverse influence on the companies performance in China. They find that the negative impact of the pandemic on firm performance is more pronounced when a firm’s investment scale or sales revenue is smaller.

The pandemic also adversely affects mutual funds’ performance. Nonetheless, the mutual funds with high star ratings as well as high sustainability ratings do well even during the pandemic (Pastor and Vorsatz, 2020). It shows the keenness of investors for the funds that pursue sustainability and environmental goals (Albuquerque et al., 2020).

In a cross-market study, covering the fixed-income and equity markets, Papadamou et al. (2020) show a pandemic-triggered flight-to-quality effect. The returns on the two asset classes move in an opposite direction and the bond returns lag the stock returns. The corporations also issued more debt compared to equity as well as to the debt issued in the pre-Covid era (Halling et al., 2020). In a separate study for Iran, Samadi et al., 2020, investigate the cross-impact of gold, oil, foreign exchange (FX), and equity markets during the pandemic. In general, they find very limited comovements among the markets mentioned above. During the Covid-19 times, the gold and FX lead the stock market at the start, but the stock market takes its lead with the progress of the crisis. Salisu et al., 2020, investigate the cross-market impact of stocks and oil markets during the Covid-19 pandemic. They show that both stocks and oil markets may face market-specific as well as cross-market shocks that can be higher initially and prolonged subsequently during the pandemic. The shocks in both markets are due to the uncertainty that prevails within a particular market.

Umar and Gubareva (2020) have used the Coronavirus Panic Index to study the influence of the pandemic on the volatility of major currencies and cryptocurrencies. They find that the Corona Panic index, on one hand, and currencies and cryptocurrencies, on the other hand, show a high level of coherence. In a similar study, Salisu and Vo (2020) use Google searches for health news in the top-20 countries (by the highest number of reported cases or deaths) to investigate health news impacts on equity markets. They show a negatively significant influence of the reported cases on the stock returns and conclude that the number of reported cases represents an important predictor of equity markets performance in the current era of the Covid-19 virulent disease.

The literature has used a diverse range of methodological techniques to study the return and volatility transmission across and between the markets. To mention, Gubareva and Umar, 2020, use squared wavelet coherence and wavelet coherence phase difference technique to explore the transmission mechanisms between the emerging markets. Sene et al. (2020) use a panel vector autoregressive model for studying the sovereign Eurobond yields. Other techniques used are the exponential GARCH model for studying media coverage and financial markets behavior (Haroon and Rizvi, 2020). A number of studies have used the volatility spillover index introduced by Diebold and Yilmaz (2009, 2012), for instance, to investigate asymmetric volatility spillovers between oil and stock markets (Xu et al., 2019), to study energy markets and European emission allowances (Chulià et al., 2017) and to research commodity markets (Barbaglia et al., 2020).

We have used the TVP-VAR model in this study that allows time-varying parameters. It is an improved and extended version of the connectedness measurement developed by Diebold and Yilmaz (2009, 2012, 2014). Antonakakis and Gabauer, 2017, proposed the TVP-VAR methodology. It does not require a rolling window approach and reduces the loss of the number of observations. TVP-VAR is used in several distinct ways in the literature. For instance, the transmission of economic uncertainty (Antonakakis et al., 2018; Jiang et al., 2019; and Gabauer and Gupta, 2018), monetary policy spillover (Antonakakis et al., 2019), crude oil markets (Liu and Gong, 2020), and financial and commodity markets (Adekoya and Oliyide, 2021).

To summarize, the pandemic has proved to be very devastating for the world economic system. Several pieces of research have explored the impact of the pandemic on different aspects of the economies. Our paper adds to this stream of literature by investigating the return and volatility transmission across the emerging and US bond markets and the MCI. Our paper has also used an advanced TVP-VAR methodology, proposed by Antonakakis and Gabauer (2017). In particular, given the short length of time series available on this topic, the TVP-VAR approach enables us to investigate the total as well as bilateral spillover between the pandemic induced sentiment, US bonds and the emerging economies debt markets.

3. Data and econometric framework

3.1. Data

This research applies the time-varying-parameter vector-autoregressive methodology to study volatility spillover and the dynamic connectedness between the emerging market (EM) bonds, US government bonds, and the pandemic media coverage. We compile a dataset of daily bond indices for the EM High-Yield (EMHY), EM Investment Grade (EMIG), and the US Treasuries. The coronavirus media coverage is taken into account by employing the Ravenpack Media coverage index (MCI). The sample period spans from 01/01/2020 to 01/12/2020. The returns and volatility data are obtained from Bloomberg. We use the 10-day historical volatility for the primary analysis and use 20-day and 30-day historical volatility for robustness tests.
Table 1 presents the samples’ descriptive statistics. We remark that the EM HY index exhibits the highest mean returns while the EM IG exhibits the lowest average volatility. The Ravenpack MCI is a proxy of the coronavirus awareness of investors, representative of the pandemic-driven market sentiment. From Table 1, the average value of MCI is 66.02, meaning that, on average, 66% of all news sources cover the Covid-19 pandemic. Additionally, the EM HY index represents the riskiest assets, as it exhibits the greatest returns and volatility standard deviations followed by the EM IG and US bonds. All return series for both the EM and US bond markets are skewed to the left as highlighted by negative and significant skewness values. All volatility series exhibit positive and significant skewness values, except the IG indices and the MCI series. All return and volatility series for the EM and US bond markets and the MCI result in high kurtosis values, evidencing leptokurtic distributions. For both return and volatility series, the null hypothesis of normality is rejected at the 1% level (see the results of the Jarque-Bera test).

### 3.2. Dynamic connectedness: The time-varying-parameter VAR methodology

To study the time-varying volatility and return transmissions between the emerging markets and the US government debt during the recent Covid-19 health crisis, we employ the time-varying-parameter vector-autoregressive framework introduced by Koop and Korobilis (2014). We combine this original methodology with the dynamic connectedness framework of Diebold and Yilmaz (2014). The dynamic connectedness methodology is based on Kalman filter estimation. In this manner, the variances are not supposed to be constant and may vary over time. The tremendous plus of this methodology resides in overcoming the arbitrary selection of the size of the rolling-window, which may lead to over-smoothed parameters while disregarding otherwise important observations (Antonakakis et al., 2018; Jiang et al., 2019; Gabauer and Gupta, 2018; Antonakakis et al., 2019; Liu and Gong, 2020; Adekoya and Oliyide, 2021; Aharon et al., 2021).

In line with the BIC, we are employing a time-varying-parameter vector-autoregressive framework (1):

\[
Y_t = \Phi_Y Y_{t-1} + u_t, \quad \Omega_{t-1} \sim N(0,S) \tag{1}
\]

\[
\Phi_Y = \Phi_{Y,t-1} + v_t, \quad \Omega_{t-1} \sim N(0,R_t) \tag{2}
\]

where \( Y_t \) is a \((N \times 1)\) vector, \( \Omega_{t-1} \) is the array of data accessible at \( t - 1 \). \( Y_{t-1} \) denotes the \((Np \times 1)\)-lagged array of dependent parameters. \( \Phi_Y \) is the \((N \times Np)\)-matrix of time-varying coefficients, \( u_t \) and \( v_t \) are \((N \times 1)\)-dimensional arrays of error terms. \( S_t \) and \( R_t \) are \((N \times N)\) and \((Np \times Np)\) variance-covariance matrices, respectively, for \( u_t \) and \( v_t \). After estimating the TVP vector-autoregressive model, in the next step, we need to transform the time-varying-parameter vector-autoregressive model to its vector moving averages. The time-varying parameters of the vector moving averages are the basic pillars of the connectedness indices as per Diebold and Yilmaz (2012). It is worth mentioning that the relevant GIRF\(^4\) and GFEVD\(^5\) concepts were introduced by Koop et al. (1996) and Pesaran and Shin (1998).

Therefore, we transform Eq. (1) as follows:

\[
Y_t = \Phi_Y Y_{t-1} + u_t = A_t u_t \tag{3}
\]

where \( A_t = (A_{1,t} A_{2,t} \ldots A_{N,t} ) \) is \((N \times N)\)-dimensional matrix such as \( A_{i,t} = \sum_{k=1}^{p} \Phi_{1,i} A_{i,k} \), if \( i \neq 0 \), and \( I_N \) otherwise. Thus, the GIRF defines the reactions of all parameters to a perturbation in parameter \( i \).

The j-to-i directional connectedness is presented via the GFEVD, \( \Psi_{i,j}(J) \). It represents the impact that parameter \( j \) produces on parameter \( i \). The forecasts-error variance may be written as:

\[
\Pi_{i,j}^f(J) = \sum_{j=1}^{J} \sum_{i=1}^{N} \Psi_{i,j}^2 \tag{4}
\]

where \( \Pi_{i,j}^f(J) \) denotes the portion, which is the variance in one parameter exercised over other parameters, \( \Psi_{i,j}^2(J) = S_{i,j}^{-1} A_{i,j} S_{i,j}, \sum_{j=1}^{N} \Pi_{i,j}^f(J) = 1 \), and \( \sum_{j=1}^{N} \Pi_{i,j}^f(J) = N\).

Employing the GFEVD concept, we build a total connectedness index (TCI), which represents the total interconnectedness in the framework. More explicitly, this methodology allows evidencing how a perturbation on one parameter spills over to other parameters and is formulated by:

\[1\] We report the graphs of the timeseries in Appendix A to conserve space.

\[2\] The connectedness framework of Diebold and Diebold and Yilmaz (2012) is widely used in finance literature. (Umar et al., 2021a, 2021b, 2021c; Malik and Umar, 2019, and the references therein)

\[3\] Bayesian information criterion

\[4\] GIRF stands for generalized impulse response function.

\[5\] GFEVD stands for the generalized forecast-error variance decomposition.
We can also compute the opposite connectedness that a parameter $i$ gets from the parameter $j$. Generalizing, we may compute a total connectedness from others, expressed by:

$$H_{g\rightarrow i, t}(J) = \frac{\sum_{i,j=1, i\neq j}^N \Pi_{g, i,j}(J)}{\sum_{j=1}^N \Pi_{g, j,j}(J)} \times 100$$

(6)

Equally, we calculate the directional connectedness that a parameter $i$, after a perturbation, transmits to other parameters. Generalizing, we may compute a total connectedness to others, expressed by:

$$H_{g\rightarrow i, t}(J) = \frac{\sum_{i,j=1, i\neq j}^N \Pi_{g, i,j}(J)}{\sum_{j=1}^N \Pi_{g, j,j}(J)} \times 100$$

(7)

Finally, we can compute a netted connectedness as the connectedness from others minus the connectedness to others, which is but an impact of the parameter $i$ on the variables framework.

$$H_{g\rightarrow i, t}(J) = H_{g\rightarrow i, t}(J) - H_{g\rightarrow i, t}(J)$$

(8)

If $H_{g\rightarrow i, t}(J) > 0$, it signifies that the parameter $i$ impacts the framework more than it is impacted by the framework. Whereas, if $H_{g\rightarrow i, t}(J) < 0$, it signifies that the parameter $i$ is driven by the framework.

Table 1

| Returns | Volatility |
|---------|------------|
| EMHY    | EMIG       | US    | EMHY    | EMIG       | US    | MCI    |
| Mean    | 0.01%      | 0.03%  | 0.03%   | 0.001     | 0.00   | 0.01   | 66.02  |
| Median  | 0.06%      | 0.05%  | 0.03%   | −0.01     | 0.02   | 0.00   | 73.88  |
| Maximum | 2.69%      | 1.71%  | 1.67%   | 13.30     | 7.01   | 6.86   | 82.61  |
| Minimum | −4.68%     | −3.31% | −1.88%  | −8.97     | −8.81  | −5.55  | 0.20   |
| Skewness| −2.39      | −2.89  | −0.26   | 1.42      | −0.46  | 0.68   | −2.06  |
| Kurtosis| 16.09      | 23.14  | 10.05   | 22.41     | 24.80  | 19.15  | 6.28   |
| Jarque-Bera | 1860.41 | 4206.76 | 478.26 | 3689.37 | 4564.62 | 2517.11 | 265.73 |
| Probability | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sum     | 0.02       | 0.06   | 0.07    | 0.34      | 0.72   | 1.97   | 15,184.87 |
| Sum Sq. Dev. | 0.02 | 0.00 | 0.00 | 688.05 | 324.14 | 216.69 | 91,646.10 |
| Observations | 230 | 230 | 230 | 230 | 230 | 230 | 230 |

Fig. 1. Total connectedness measure.
4. Results and discussions

We have segregated our results and discussion into two subsections each encompassing the returns and the volatility of the system’s variables comprising the EM and US bonds, and MCI.

4.1. Dynamic returns spillover

We start our analysis with the system of variables encompassing the returns of the EM and US bonds, and the MCI. Fig. 1 depicts the dynamics of total connectedness of the entire system of variables over the sample period. We notice sizable variation in the connectedness of the system over the sample period, thus underscoring the importance of employing a time-varying framework to thoroughly analyze the connectedness of the system. We observe a spike in the overall connectedness of the system during March 2020 that coincides with the announcement of the Covid-19 pandemic by the World Health Organization (WHO) and the lockdowns announced around the world. However, subsequently, we notice a consistent downturn in the overall connectedness with values ranging between 25% and 29%. These values highlight a high connectedness level between the EM bonds, the US government bond, and the coronavirus media coverage index during the health crisis outbreak and the initial post-crisis recovery. Thus, in the event of a systemic crisis such as the Covid-19, the diversification and hedging attributes (as well as the safe haven attributes) of the EM and US bonds tend to decrease by a great degree. These high connectedness levels may provide valuable insights for researchers, market participants, and regulators, as the EM HY, EM IG, and the US bonds are highly sensitive to news related to the recent Covid-19 health crisis.

While the above analysis allows us to see the total connectedness of all the variables in the system, it is important to identify the role of each variable in the overall connectedness of the system. Equally important is to identify the net transmitter and net receiver of spillover in the system. Therefore, we extend our analysis and report the spillover ‘To’, ‘From’ and ‘Net’ between a particular variable (listed in rows) and all the other variables in the system in the first, second and third columns of Fig. 2, respectively. Here again, we can notice that all variables in the system show significant time-varying transmission patterns, underscoring the importance of employing a time-varying framework to analyze the connectedness. Furthermore, all the variables exhibit a spike during March 2020 that coincides with the peak when the peak of Covid-19 related fear and precedes lockdowns in many countries around the world.

The first column of Fig. 2 shows that the EMHY and EMIG bonds exhibit the highest spillover ‘To’ all the other variables, with a peak value of approximately 18% in March 2020 for both variables. Subsequently, we notice a steady decrease in spillover percentage with values ranging between 12%–14% for each of these variables. The spillover ‘To’ other variables exhibited by US bonds and MCI is weaker compared to EMHY and EMIG but sizeable, signifying their relevance in the system of variables. The second column of Fig. 2 shows that both EMIG and the US bonds receive the highest spillover ‘From’ all other variables in the system with value of approximately 13%, followed by EMHY with a value of approximately 12%, during March 2020. Subsequently, the spillover is around 11% for both EMIG and EMHY, and around 6% for US bonds. The spillover received ‘From’ other variables for MCI is small in magnitude.

In order to identify the net transmitter and net receiver of spillover, we look at the last column titled ‘Net’ of Fig. 2. Here, we notice that EMHY, EMIG and MCI are the net transmitters of spillover, whereas, the US government bonds are the net receiver of spillover. In the period following the health crisis, the transmission patterns from the emerging market bonds (EMHY and EMIG) to other variables decline and maintain stable levels ranging from 12% to 14%. These results reveal that the EMHY, EMIG bonds and MCI are the net transmitter of returns spillovers to the US bonds and that the connectedness between the EM bonds and other variables increases during the outbreak of the health crisis. These findings are important as they can serve as an early warning mechanism for transmission of spillover from EM bonds to US bonds. Furthermore, the time-varying nature of spillover over the sample period highlights the importance of designing active investment and hedging strategies even for the traditional safe haven assets such as US bonds during periods of extreme uncertainty. Thus, these findings may give new insights for investors about investment opportunities in EM debt and may be useful for investors seeking hedging opportunities and diversification benefits from EM corporate and sovereign issues.

4.2. Dynamic spillover volatility

We expand our analysis and discuss the results of volatility connectedness between fixed income market and the MCI in this section. Understanding the dynamic volatility spillover mechanism between the EM debt, US government debt, and the coronavirus media coverage index may be helpful for investors who seek to mitigate financial risks and want to benefit from diversification opportunities.

Fig. 3 depicts the total connectedness of the system comprising the MCI and the 10-day historical volatilities of EMHY, EMIG and US bonds. We can see that the overall exhibited patterns are similar to the evolution of the returns’ connectedness patterns depicted in Fig. 1. We notice that the total volatility connectedness is time varying. The average levels of volatility spillovers (ranging from 26% to 28%) are registered at the beginning of the year 2020 (January and February), with a big spike in spillover in March (more than 40%). Similarly to our return analysis in the previous section, we proceed to examine the contribution of spillover from each variable in the overall connectedness of the system by accounting for the spillovers ‘To’, ‘From’ and ‘Net’ depicted in first, second and third columns of Fig. 4, respectively.

We start by discussing the spillover contributed by each variable ‘To’ all the other variables in the system. Similar to our results in previous section, we notice that the EMHY and EMIG bonds exhibit the highest contribution of spillover ‘To’ all other variables in the system with highest contribution of approximately 19% during March 2020. In the aftermath of the apogee of the global meltdown, the contribution of spillovers from the EM debt ‘To’ others ranges between 12% to 13%. Here again, we note that the spillover contribution of US bonds to all other variables in the system is relatively low compared to those of the EM debt but is still sizable with a peak around
Fig. 2. To, from, and net dynamic spillover of the system (returns).
of contribution of 5% during March 2020. Lastly, the volatility contribution to all other variables exhibited by the MCI is lowest during the whole sample period. It appears from the above analysis that the magnitudes of volatility spillovers from the EM debt are high that indicates the high integration of the EM debt market with the international debt markets.

Next, we study the spillover received by each variable ‘From’ all other variables in system, depicted in the second column of Fig. 4. Overall, the presented plots show that all variables receive volatility shock transmission from others, but the magnitudes of dynamic volatility transmission vary across the variables. Interestingly, the US bonds receives the highest spillover of approximately 17% from all variables in the system at the peak of crisis during March 2020. However, it ranges between 4 and 8% in the following periods. These findings show that the US government bond market is more exposed to volatility shocks transmission from other variables in the framework compared to the EM debt. The EMHY and EMIG receives a highest spillover contribution of approximately 12.5% and 13%, respectively, during March 2020. After that, the volatility spillovers slightly decrease but maintain relatively high levels for the rest of the sample period. The MCI receives the lowest volatility spillovers from other variables, with a highest value of 5%.

Finally, we analyze the last column of Fig. 4 titled ‘Net’ to identify the net transmitter/receiver of spillover in the system. We notice that EMHY and EMIG are the highest transmitter of spillover throughout the sample period, with a highest value of 7%, for each of them, around March 2020. In addition, we notice that MCI is also a net transmitter. Here again, we notice that US bonds are net receiver of spillover, with a spike in spillover received during March 2020. We can conclude from the plots that the EM HY, EM IG, and the MCI act as the net transmitter of spillover to other variables. On the contrary, the US bonds act as the net receiver, getting volatility from other variables along the overall span of the analysis.

The volatility connectedness analysis in this section highlight that the EM debt is highly integrated with the US bond market and that both markets are very sensitive to the news related to the coronavirus pandemic outbreak. Moreover, this result suggests that the hedging and diversification benefit from the EM bond market decrease remarkably during the period of crisis. This knowledge may help portfolio investors regarding optimal asset allocation decisions and more accurate hedging strategies.

4.3. Robustness tests

To further strengthen our analysis, we conduct a number of robustness tests and report our results in this section.

We start our robustness analysis by choosing an alternative proxy of Covid-19 induced uncertainty. Haroon and Rizvi (2020) and Albulescu (2020) argue that the Ravenpack’s Panic Index (PI) is a suitable proxy for the Covid-19 induced fear and volatility. Following these studies, we re-estimate the volatility connectedness system by replacing the MCI with Ravenpack’s Panic Index (PI) in our TVP-VAR model. Fig. 5 presents results for the total and ‘Net’ connectedness of the system comprising PI and the 10-day historical volatility of EMHY, EMIG and US bonds. The first graph ‘Total’ shows the total connectedness of the system and confirms our earlier conclusion of sizable time-varying connectedness with a peak around March 2020. The results are comparable to our primary findings in Section 4.2 for the MCI, EM HY, EM IG, and US.

In order to check that our results are robust to the choice of volatility measure, we use alternative measures of volatility, i.e., 20, and 30-day volatility to estimate the volatility connectedness. Figs. 6 and 7 present the estimates for the 20-day and 30-day volatility measures, respectively. The results remain consistent across different volatility measures. For instance, the total connectedness has been highest during March 2020, and then it has shown a decreasing trend towards the end of 2020. The EMHY debt has been the net receiver during March 2020, and then as the net transmitter from April to September 2020. It acts as net receiver of the shocks from the

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6 We are thankful to an anonymous referee for this suggestion.
Fig. 4. To, from, and net dynamic spillover of the system (volatility).
system. The EMIG debt has been net transmitter throughout the sample period except during January and February, whereas the US governmental debt has been net receiver during the whole period. The PI has been the net transmitter for all three sampled volatility measures at the initial phase of the pandemic. After the apogee of the Covid-19 crisis in March 2020, it turns into the net receiver. Overall, the results are robust to different measures of volatility.

5. Conclusion

This study contributes to the advanced knowledge of the Covid-19 pandemic and its impact on the dynamic connectedness of the Emerging Market High Yield and Investment Grade bonds and the US Treasuries. We study the spillovers of bond returns and volatility, employing the time-varying-parameter vector-autoregressive methodology. Our approach substantially advances the connectedness method proposed by Diebold and Yilmaz (2014). Moreover, a tremendous plus of this methodology resides in overcoming the arbitrariness in selecting the size of the rolling-window, which may lead to over-smoothed parameters while disregarding otherwise
important observations.

We use the pandemic media coverage index (MCI) as a proxy of the investor’s sentiment during the coronavirus pandemic. Our results show that the dynamic connectedness between the EM bond, US bond, and the MCI returns and volatility has increased significantly with the escalation of the pandemic outbreak. Our results evidence positive and significant spillovers of returns and volatility from each parameter to the system during the whole sample period with an unprecedented upsurge during the onset of the pandemic. We also document that the returns and volatility spillovers from the MCI to the EM and US bond markets are relatively low during the whole period, but they increase remarkably during the escalation of the pandemic in the first quarter of 2020. This result highlights that the EM debt is highly integrated with the US bond market and that both markets are very sensitive to the increasing flow of news related to the coronavirus pandemic outbreak. Moreover, our findings indicate that the hedging and diversification benefit from the EM bond market decrease remarkably during the period of crisis. This knowledge may help portfolio investors regarding optimal asset allocation decisions and more accurate hedging strategies. However, the dynamic connectedness between the MCI and the bond markets declines after the apogee of the Covid-19 crisis in March 2020 and from then onward remains at low levels. This result indicates that during recovery from systemic crises, investors may benefit from the diversification attributes, hedging properties,
and safe-haven aspects of the EM and US fixed-income assets.

Regarding the EM and US bond markets, we observe different spillovers of returns and volatility from (to) the analyzed bond markets. We observe that the dynamic spillovers of returns and volatility from the EM HY and EM IG to the US bonds are more pronounced than those from the US bonds to the system. In addition, we observe that the EM HY and the EM IG transmit more returns and volatility spillovers to the system than they receive. These findings highlight that the EM bond markets are more sensitive to the Covid-19 media coverage than the US governmental debt. Moreover, we find that the US government bonds receive return and volatility spillovers from the EM bonds and the MCI more than they transmit, especially during the announcement of the coronavirus pandemic in March 2020. This indicates a relative resilience of the US Treasuries volatility to the influence of the volatility in the MCI, representing the relative weight of news sources providing the coronavirus-related content. From the net total connectedness index, we find that the EM HY, EM IG, and the MCI are the net transmitters of spillover of both returns and volatility, whereas US Treasuries are the net receivers during the overall sample period. This finding implies that the EM HY and EM IG markets may behave as an amplifier of riskiness along with systemic events such as Covid-19.

Wrapping-up, the results from this study provide valuable insights, which could be applied by portfolio managers, market

Fig. 7. Total connectedness of the PI (Panic Index) and 30-day volatility.
regulators, and investors' community involved in investing in the US and EM bond instruments. Our findings may help investors and portfolio managers in building cross-ratings and cross-geography hedging strategies to mitigate risk in periods of market downturns. The outcomes of this study may also be useful for policymakers in designing policy solutions targeting financial stability and safeguarding the market against adverse market moves, known as wrong-way risk.

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Appendix A. Appendix

![Fig. A1. Return series and MCI.](image-url)
Fig. A2. Volatility series and PI.

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