Hindawi
Complexity
Volume 2022, Article ID 2249581, 14 pages
https://doi.org/10.1155/2022/2249581

Research Article

Do Local and World COVID-19 Media Coverage Drive Stock Markets? Time-Frequency Analysis of BRICS

Ahmed Bossman,[1] **Tamara Teplova**,[2] **and Zaghum Umar**[3]

[1]*Department of Finance, School of Business, University of Cape Coast, Cape Coast, Ghana*
[2]*National Research University Higher School of Economics, Moscow, Russia*
[3]*College of Business Zayed University, P.O. Box 144534, Abu Dhabi, UAE*

Correspondence should be addressed to Ahmed Bossman; ahmed.bossman@outlook.com

Received 18 June 2022; Accepted 22 August 2022; Published 27 September 2022

Academic Editor: Gang Jin Wang

The role of media coverage as a proxy for investor sentiments has led to the assessments of the impact of COVID-19 media coverage on financial markets. To determine how both local and global media coverage affect financial markets differently, we investigate this issue from the perspective of top emerging markets, BRICS (i.e., Brazil, Russia, India, China, and South Africa). With datasets covering January 2020 to March 2022, we employ the wavelet coherence technique on two major subsamples, viz. initial outbreak year sample and the "new normal" era sample. Our findings demonstrate the leading role of BRICS equities in the initial outbreak period, particularly across medium and low frequencies. In the "new normal" era, we find a significant effect of world media coverage on BRICS equities. We discuss the implications of our findings, which are of importance to investors, policymakers, and practitioners.

1. Introduction

In the 21st century, the global financial crisis (GFC) had the most devastating effects on global markets until the emergence of the COVID-19 pandemic. Having occasioned a strange and unprecedented financial market meltdown, the COVID-19 pandemic's effect is noted to exceed the hardships during the era of the GFC [1]. Since its inception, notable financial markets have registered record-breaking losses, with some losses continuing as various strands of the virus emerged.

Accompanied by rigid restrictions such as social distancing, shutting of face-to-face school sessions, ban on international travels, closure of borders and places of worship, etc., measures to combat the spread of the COVID-19 and mitigate the associated hardships on the global economy resulted in a heightened concentration on media information across several outlets. To facilitate acceptance of policy measures against the ravaging impact of the pandemic and boost economic recovery, the pivotal role of media coverage has been underscored. Complexities in capital markets and society have been proxied with data on investor sentiment [2–4]. At the societal level, behavioral factors like public mood and/or investor sentiment are best captured by media data, and this is particularly applicable in the era of a long-lasting pandemic, where diverse capital market reactions have been witnessed regardless of market size, market bloc, or investment class, although the magnitudes of the effect may differ.

Hinged on the abovementioned rationale, we analyze the impact of COVID-19 media coverage on a market bloc containing major five emerging economies whose assets are noted to be instrumental to international portfolios due to their returns predictability and high-yielding characteristics [5, 6]. The economies of Brazil, Russia, India, China, and South Africa (i.e., BRICS) form a vibrant market bloc with lucrative growth prospects. With their substantial contribution to the global economy and their pivotal contribution to international portfolios, examining the effect of COVID-19 media coverage on their equity markets is necessary to

inform market participants of how behavioral factors tend to impact the price-generating mechanism of emerging market equities [6, 7].

Specifically, we examine the co-movement dynamics between media coverage and BRICS equities. Motivated by recent studies under the wavelet framework, we employ the bi-wavelet time-frequency approach, which is capable of revealing the lead-lag interrelationships between media coverage and equity prices across both the time and frequency domains.

The main motivation for the study stems from investors' and broader financial market participants' desire to search for assets with better returns and risk profiles during a systemic crisis such as the COVID-19 pandemic. In particular, the integration of asset markets over recent times coupled with the frequency of financial crises has contributed to the scarcity of such assets. Within this broader framework, the role of investor sentiment on asset returns and particularly the immunity of various assets against such returns is gaining a lot of attention as well. Thus, in this paper, we attempt to study the interrelation of media sentiment driven by the COVID-19 pandemic in five major emerging market economies by accounting for both local and international media coverage. We focus on the BRICS economies owing to their global significance as the major emerging market economies, their global trade share and the attractiveness of their financial markets to potentially offer high mean returns, which contribute to higher risk-adjusted performance for investors from developed markets. To the best of our knowledge, this is the first study to document this interrelation.

We offer specific contributions as follows. First, from an emerging market bloc, we provide the time-frequency dynamics of the lead-lag relationships between COVID-19-related media coverage and equity prices. While the time-domain trajectory of the co-movements between information, investor sentiments, and equity prices is essential, the heterogeneity of financial market participants [8, 9, 10] suggests that revealing the interrelations between these variables along frequency bands, which correspond to trading horizons, is of importance to market participants whose decisions are heterogeneous across the short-, medium-, and long-term trading periods.

Second, we tackle the impact of the pandemic on emerging markets equities from the behavioral viewpoint, which makes our study contribute to the strand of works that examine the behavioral impact of the pandemic on financial markets. It is to be noted that public mood and/or investor sentiments tend to intensify during stressed market conditions, but assessments of the pandemic's impact are fixed. The ubiquity of COVID-19 shocks was clear from the pandemic's onset following the intensity of the repercussions experienced by top-international markets like CAC40, DJIA, and S&P500 and emerging markets such as NSE50 [11]. While much empirical analysis has focused on top listed markets [12–16], the impact of the pandemic on the capital markets of emerging economies is yet to be analyzed in the context of behavioral variables such as public mood and/or sentiment.

Third, we undertake a comparative analysis of the respective effects of local and world media coverage on each of the BRICS equities. Several works have employed different proxies for the COVID-19 pandemic's effect. Amongst them are death counts, the number of confirmed cases, media coverage index, and the pandemic fear index [13, 17]. We add to the class of literature that examines the pandemic's impact using media coverage and we do this for both local and global media coverage. By doing so, we present evidence of both locally and internationally driven public mood and/or investor sentiments' impact on equity markets.

Methodically, relative to other approaches, the wavelet coherence approach has several benefits; hence, its application in this study. First, it can reveal information about variables' joint behavior not only within a single domain of time but also across distinct investment time scales or frequency bands, allowing us to investigate various patterns of BRICS equities and media coverage movements, lead-lag connections, and co-movements. We use wavelet approaches since the co-movements and lead-lag relationships between investor sentiments and equity prices across frequency bands, which represent investment horizons, are so important in this case. Second, strict assumptions like stationarity, linearity, or nonlinearity of the data series, which may be so significant to overlook in other techniques, are not primary to the wavelet technique. As a result, it can be applied to both linearly and nonlinearly distributed series. Third, for both short and long-time series data, the wavelet technique is efficient in deciphering crucial findings. All the aforementioned features portray the wavelet approach as a robust technique for investigating various time series' coherence, which we employ to investigate the causal relationships between variations in local and world COVID-19 media coverage indices (MCI) and BRICS equities.

Through our bi-wavelet analysis, we revealed that the patterns of co-movement between MCI and each of the BRICS equities are generally comparable. In the first year of the COVID-19 pandemic, BRICS markets provided modest protection against COVID-19 shocks, as measured by both local and global MCI at medium and low frequencies, which roughly correlate to monthly and quarterly trading periods. Conversely, we found more complicated co-movement dynamics between media coverage and BRICS stocks in the "new normal" era. We find that global COVID-19 media coverage drives and offers large risks to developing market stocks at medium and low frequencies in the new normal.

The remaining parts of the study are organized as follows. Section 2 describes our datasets and the wavelet technique. We discuss the main results and their implications in Section 3 and conclude in Section 4.

2. Datasets and Methods

2.1. Data and Descriptive Statistics. Our analysis makes use of daily stock indices of BRICS economies and both world media coverage indices (WMCI) and local media coverage indices (LMCI). Our datasets span between January 2020 and March 2022. The datasets on BRICS equities were sourced from Bloomberg, whereas the LMCI and WMCI

were sourced from RavenPack. The MCI from Ravenpack quantifies COVID-19-related media coverage as the proportion of news sources related to the COVID-19 pandemic to total news sources. With a base of 0% and a limit of 100%, higher MCI indices indicate higher levels of news coverage on COVID-19. We account for both local and international media coverage due to the systemic nature of the pandemic. We argue that both local and international sentiments may have an impact on the financial markets; therefore, accounting for both these metrics is important for a better understanding of the impact of various media coverage-driven news sentiments on financial markets. The statistical properties of the sample are summarized in Table 1. Figure 1 shows plots that depict the trajectories of each BRICS equity indices, their corresponding LMCI, and the WMCI. We notice that at the outbreak of the pandemic, all countries experienced a sharp decline in equities. Thus, underscoring the global nature of the pandemic and its systemic effects on the global financial markets. This sharp decline coincides with a sharp increase in the local and local MCI for each country. However, in the following months, we will see different patterns across different markets, accounting for the various waves of the pandemic. For instance, China experienced a sharp decline around 2021 due to a rise in pandemic cases again. However, we point out that the large decline in Russian equities at the end of the sample period may be attributed to the geopolitical crisis rather than the pandemic.

2.2. Methods. We apply the squared wavelet coherence (S-WC) and wavelet phase difference (WCPD) techniques in this study. The use of these wavelet methodologies is consistent with the steps of References [18, 19], as propagated in recent literature [20]. The wavelet transform is utilized to get the S-WC. The approach emerges from a bivariate model hinged on a continuous wavelet transform (CWT) that is capable of revealing varied scale localizations [21].

We start with the Morlet wavelet, which was proposed with the continuous wavelet transform by Morlet et al. [22, 23] and Goupillaud et al. [24]. The Morlet wavelet may be written as follows:

$$\psi(t) = \pi^{-1/4} e^{i\omega_0 t} e^{-t^2/2}. \tag{1}$$

One can see that the Morlet wavelet consists of a complex sine wave within a Gaussian envelope. In line with the existing literature, we employ continuous wavelet transformation.

To generate the CWT of two separate time series, say $a(t)$ and $b(t)$, we follow Reference [18] to generate the S-WC between $a(t)$ and $b(t)$ from their individual CWTs, $W_n^a(u,s)$ and $W_n^b(u,s)$, respectively, as follows:

$$W_n^{ab}(u,s) = W_n^a(u,s)^* W_n^b(u,s), \tag{2}$$

where u denotes location, s represents scale, and the complex conjugation is represented by *. The CWT facilitates differentiation of the regions in the time-frequency domain, embodied by the co-movements between $a(t)$ and $b(t)$, even in the absence of their common strong power. Put differently, at every wavelet scale, the CWT depicts the localized covariance between $a(t)$ and $b(t)$. So, a CWT estimate near 1 suggests that $a(t)$ and $b(t)$ are highly synchronized, whereas a CWT estimate of 0 denotes a lack of significant synchronization.

Following [19], the S-WC, which defines the co-movements between $a(t)$ and $b(t)$ is defined as follows:

$$R^2(u,s) = \frac{S\left(s^{-1}\left|W^{ab}(u,s)\right|^2\right)}{S\left(s^{-1}\left|W^{a}(u,s)\right|^2\right)S\left(s^{-1}\left|W^{b}(u,s)\right|^2\right)}, \tag{3}$$

where s denotes smoothing on the time-frequency scale. The S-WC parameters can be interpreted as a correlation measure in time-frequency space, with a range of values confined between 0 and 1. However, converse to the popular measure of the correlation between two sets of data arrays (i.e., the Pearson coefficient, with a range of values between −1 and 1), the S-WC by default, belongs to the 0 and 1 interval. As a result, it is unable to detect whether the examined return series moves in similar or opposing directions. That is, in distinguishing between negative and positive correlations, the S-WC cannot be relied upon.

To gain additional insights about the co-movement between $a(t)$ and $b(t)$ their lead-lag dynamics, the WCPD is introduced. The WCPD facilitates an efficient distinction between two plausible relations, i.e., negative and positive [18].

The WCPD can be expressed as follows:

$$\Phi_{ab}(u,s) = \tan^{-1}\left(\frac{\mathrm{Im}\left\{S\left(s^{-1}W^{ab}(u,s)\right)\right\}}{\mathrm{Re}\left\{S\left(s^{-1}W^{ab}(u,s)\right)\right\}}\right), \tag{4}$$

where Im(Re) represents imaginary (real) portions of the joint smoothed CWT.

A set of two data arrays with a null phase difference is an example of a perfectly co-moving time series. We adopted a standard visual representation of the data based on heat map panels to represent both S-WC and WCPD. In the S-WC heat maps, deep arrows reflect phase connections between any named two series (any of the BRICS equities and either LMCI or WMCI).

The data arrays act in either in-phase (positive correlation) or anti-phase (negative correlation) mode, portrayed by the left and right directional arrows, respectively. When an arrow points upward or downward, it signifies that $a(t)$ or $b(t)$ is ahead of $b(t)$ or $a(t)$, respectively, by $\pi/2$. Taking note of the guidelines given above facilitates deciphering the message covered by an arrow, regardless of the direction it points.

3. Results

Our empirical results from the S-WC and WCPD-based lead-lag relationships between local and world MCI for each of the BRICS economies are presented in this section. The co-movement patterns from which we infer lead-lag dynamics are presented in scalograms. All horizontal axes

Table 1: Descriptive statistics.

	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Obs.
Panel A: Equities								
Brazil	4668.05	4713.9	5661.2	2879.57	580.57	-0.74	3.22	564
China	1003.54	1034.77	1196.05	756.8	100.25	-0.72	2.48	564
India	8099.96	8310.66	11136.44	4407.46	1842.88	-0.02	1.72	564
Russia	11697.64	11567.19	15275.38	7202.93	1892.41	0.06	1.86	564
South Africa	212658.1	220245.2	260408.4	130686.9	26635.88	-0.54	2.6	564
Panel B: MCI								
Brazil	60.85	66.32	90.4	0	20.39	-1.08	3.7	564
China	61.18	62.35	90.5	0	13.91	-1.32	7.42	564
India	59.29	63.02	83.9	0	15.56	-1.6	6.58	564
Russia	55.2	56.34	86.89	0	15.76	-1.04	5.26	564
South Africa	62.07	66.86	92.81	0	20.08	-1.32	4.54	564
World	65.85	69.75	82.95	0.09	13.94	-2.72	11.97	564

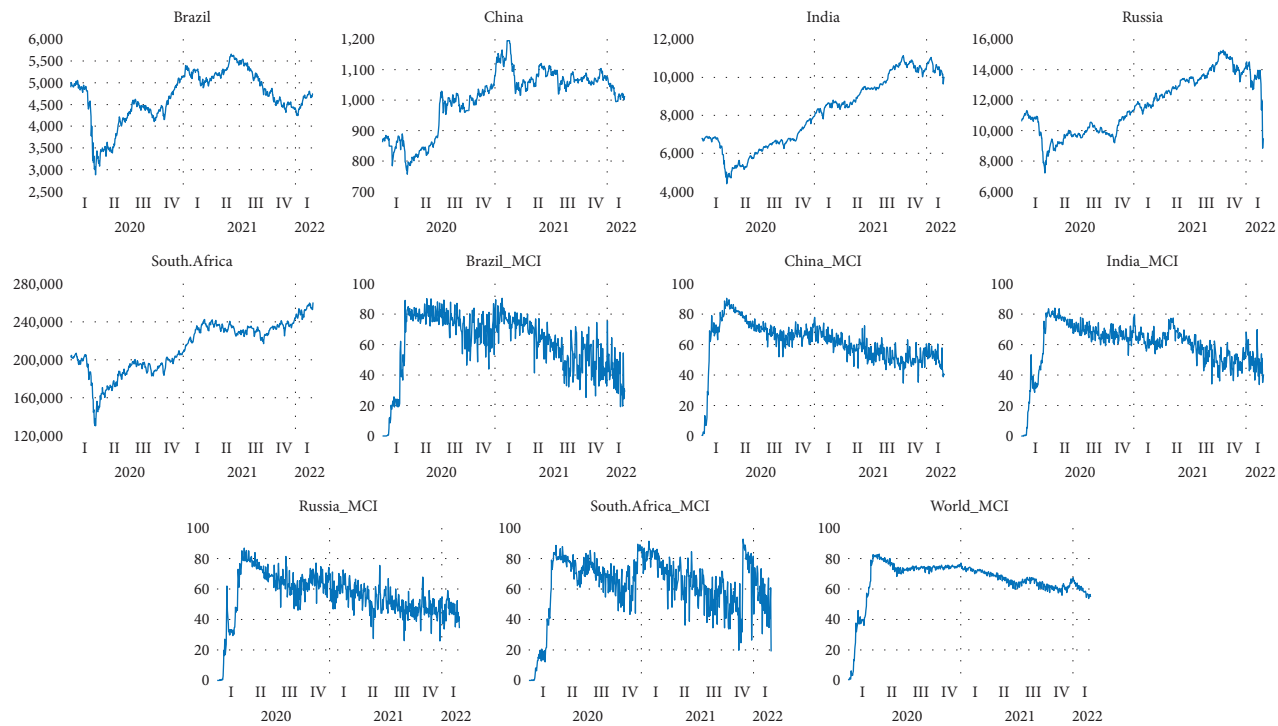

Figure 1: Time series plots.

display the time steps and the vertical axes portray the frequency, measured in days. Each scalogram is accompanied by a color bar, which represents a key for reading the scalogram. Generally, hotter colors, such as yellow and red, communicate high coherence, whereas warmer colors, such as green and blue, communicate low coherence. As detailed in the methods, the phase difference arrows pointing right (→) suggest an in-phase relationship and those pointing left (←) suggest an out-phase relationship. Right and up-diagonal (↗) or left and down-diagonal (↙) arrows indicate that the first variable (local or world MCI) is leading either of the BRICS equities. Right and down-diagonal (↘) or left and up-diagonal (↖) arrows indicate that the second variable (either of BRICS equities) is leading either local or world MCI. We emphasize the phase difference relationships that fall within the cone of influence (COI), which reveals the significant co-movement dynamics between the analyzed pairs.

For two subsamples, we focus on the initial outbreak year (i.e., 2020) and the "new normal" (i.e., from February 2021 to 2022). Thus, we analyze each BRIC equity market under two main sample periods.

3.1. Media Coverage and BRICS Equities in the Initial COVID-19 Outbreak Year (2020)

3.1.1. Media Coverage Index and Equities of Brazil in the Initial COVID-19 Outbreak Year. Figure 2 portrays the wavelet coherence plots for the co-movements between the

COVID-19 media coverage index and Brazilian equities in the first outbreak year.

From panel A, which reveals the scalogram for the coherence between Brazil MCI and Brazilian equities, we find that at a high-frequency scale of 2–4 days, between April to June 2020, the positioning arrows (↗) and (↙) signify that local MCI led its co-movement with Brazilian equities. This means that the dynamics of Brazilian equities were driven by MCI in the first few months of the pandemic. This period corroborates the period in which restrictive measures were initiated by several economies to curb the spread of the coronavirus. Intuitively, it is natural to assume that Brazilian equities will respond to local media coverage in the first few trading days of such months. These dynamics, despite changing across the median frequency bands, persisted between March and June 2020 across the 64 daily frequency bands and beyond. Notwithstanding, market dynamics changed after the first week of trade, between the 8–16 and 16–45 frequency bands, around May–June and November 2020. At such frequency bands, Brazilian equities instead led their co-movement with local media coverage. The high predictability of the pricing and return dynamics of emerging market equities may be a factor that influenced this co-movement despite the systemic crisis induced by the COVID-19 pandemic.

Concerning the world media coverage (panel B), interspersed positioning arrows are spotted across 2–8 daily scales, which correspond to the high-frequency bands. Notably, these arrows largely indicate either an antiphase relationship between world MCI and Brazilian equities or a leading role for world MCI. The antiphase relationship is more profound in March and November 2020 along the 2–3 daily scale. The intuition is that Brazilian equities negatively respond to world media coverage of COVID-19-related news. This is reasonable given that the early days of the pandemic resulted in intense negative impacts on several equity markets, and high-frequency bands are likely to experience hasty market dynamics. World MCI led Brazilian equities around June and between September and October 2020 across the 4–8 frequency band. Impliedly, as Brazilian equities lag world MCI, the market dynamics in Brazilian equities are driven by global COVID-19 media coverage. That is, the dynamics in emerging markets may follow from those factors that drive the dynamics of the world economy. Between November and January 2020, the positioning arrows suggest an in-phase relationship between world MCI and Brazilian equities beyond the monthly frequency band (32–45 days). Impliedly, as world COVID-19 media coverage increases, Brazilian equities increase correspondingly. The quest for emerging market assets in turbulent periods may explain this nexus. After investors realize that Brazilian equities may withstand COVID-19 shocks, the rush for Brazilian equities in lower frequency periods may push the price up, and hence, the positive relationship.

3.1.2. Media Coverage Index and Equities of Russia in the Initial COVID-19 Outbreak Year. Figure 3 portrays the wavelet coherence plots for the co-movements between the COVID-19 media coverage index and Russian equities in the first outbreak year.

Panel A of Figure 3 shows the coherence plot between local COVID-19 media coverage and Russian equities. At a high-frequency scale, specifically 2–4 days, the co-movement between Russian equities and local MCI exhibited an antiphase relationship in February, when COVID-19 was yet to be declared a pandemic by the World Health Organization (WHO). This persisted across the 4–5 daily frequency band in the same month with slight indications of Russian equities-driven co-movements, which saw a full manifestation in August 2020 with (↖) and (↘) positioning arrows at high frequencies (2–6 days). Similar dynamics are spotted between December 2020 and January 2021. Similar to Brazilian equities, the predictability of market dynamics of emerging markets assets explains the leading role of these equities. Across the weekly scale (8 daily frequency) in September 2020, straight-up positioning arrows signify that local MCI rather led Russian equities by $\pi/2$ and partly communicate the driving role of local COVID-19 media coverage, whereas the straight-down positioning arrows between the 12–16 daily frequency band in March 2020 communicated the driving role of Russian equities. Beyond these scales, up to a daily frequency of 24 hours, Russian equities remain the lead series ahead of COVID-19-related local media coverage.

Panel B of Figure 3 reveals the co-movement dynamics between world MCI and Russian equities. We find mixed co-movement and lead-lag dynamics between world MCI and Russian equities in the high-frequency bands (2–8 days). The antiphase relationships in February–March 2020 and November 2020 suggested an inverse relationship between media coverage and Russian equities in the early days of the COVID-19 outbreak and possibly, during new variant detection. This explains the leading role of world MCI ahead of Russian equities between July and August 2020 across 2–3 daily frequencies. After world MCI led Russian equities in March 2020 across the fortnightly scale (up to 16 daily cycles), we witness the leading (lagging) role of Russian equities (world MCI) across lower frequency bands.

3.1.3. Media Coverage Index and Equities of India in the Initial COVID-19 Outbreak Year. Figure 4 portrays the wavelet coherence plots for the co-movements between the COVID-19 media coverage index and Indian equities in the first outbreak year.

From the co-movement dynamics revealed by the coherence plot in Panel A of Figure 3, we find that across the high-frequency bands (2–4 daily scale), the market dynamics for Indian equities were driven by local COVID-19 media coverage. This was observable from January to July 2020 and persisted through the 2–16 daily frequencies. Up to 2 weeks of trading, the early days of the COVID-19 pandemic influenced several markets across the globe. Thus, it is unsurprising that the Indian equity market was driven by COVID-19 shocks, proxied by local media coverage. However, given the character of an emerging market like India, equities turned back to lead or drive COVID-19 media

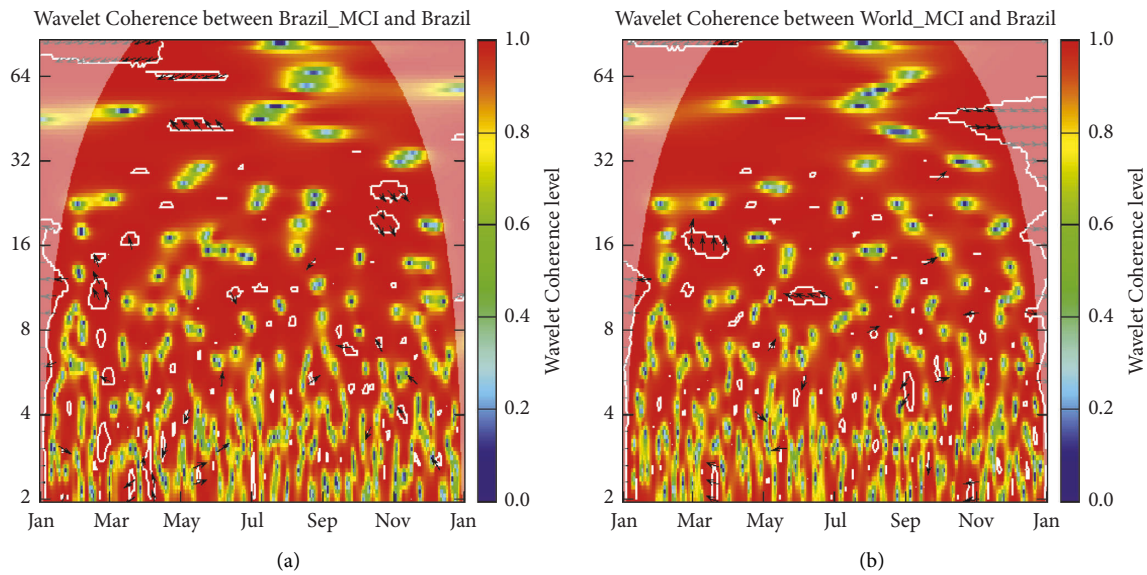

Figure 2: MCI and Brazilian equities in the initial COVID-19 pandemic year. The values on the x axis show the dates and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

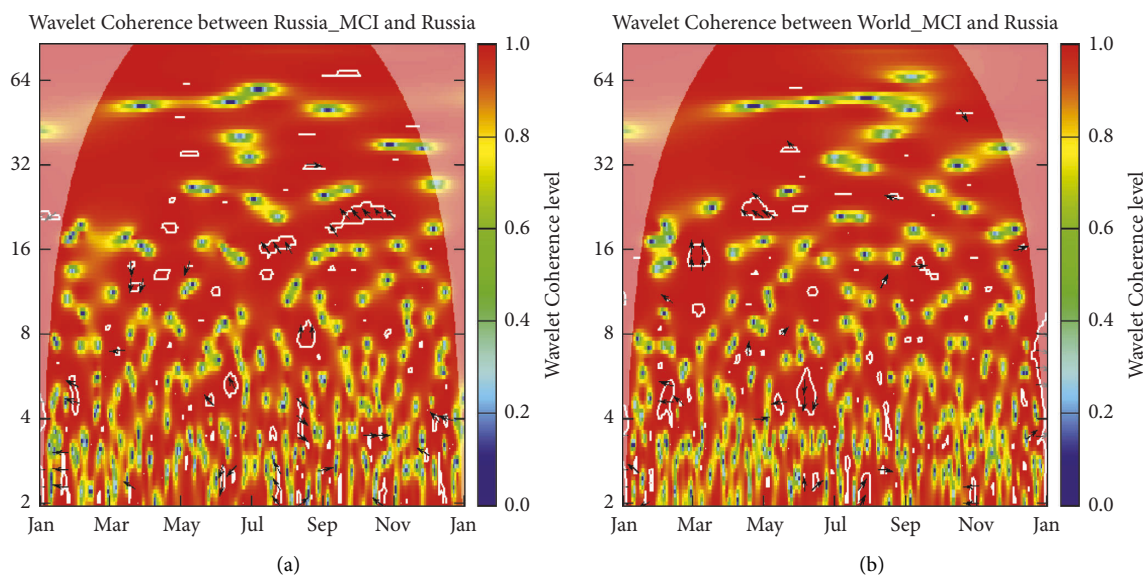

Figure 3: MCI and Russian equities in the initial COVID-19 pandemic year. The values on the x axis show the dates, and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

coverage. This is evidenced by the (↖) and (↘) positioning arrows spotted between August and December 2020 at high frequencies between 2 and 8 daily periodicities. Between the 12 and 16 daily periodicities in September and October 2020, the antiphase positioning arrows imply an inverse connection between local MCI and Indian equities, which may correspond to revisions in policies targeted at containing the spread of the virus and/or the emergence of new variants. Meanwhile, around scale 28–48 daily periodicities, Indian equities led their co-movement with local COVID-19-related media coverage from July through till January 2021. Again, it is unsurprising of this class of equities, as they fall under emerging markets assets.

A careful examination of the co-movement dynamics between the world MCI and Indian equities across the higher frequency bands (2–3 daily periodicities) reveals a leading or driving role of world media coverage of COVID-19-related news. This is seen for March, June, and October 2020. As an emerging market with equities whose dynamics are highly predictable, Indian equities assumed the leading or driving role for its co-movements with world media coverage specifically between 4 and 6 daily periodicities in March, June, and September 2020. The antiphase positioning arrows spotted across medium frequency scales (16–28 daily cycles) in April and May 2020 revealed a negative impact of the COVID-19 pandemic on Indian equities, while the cloud

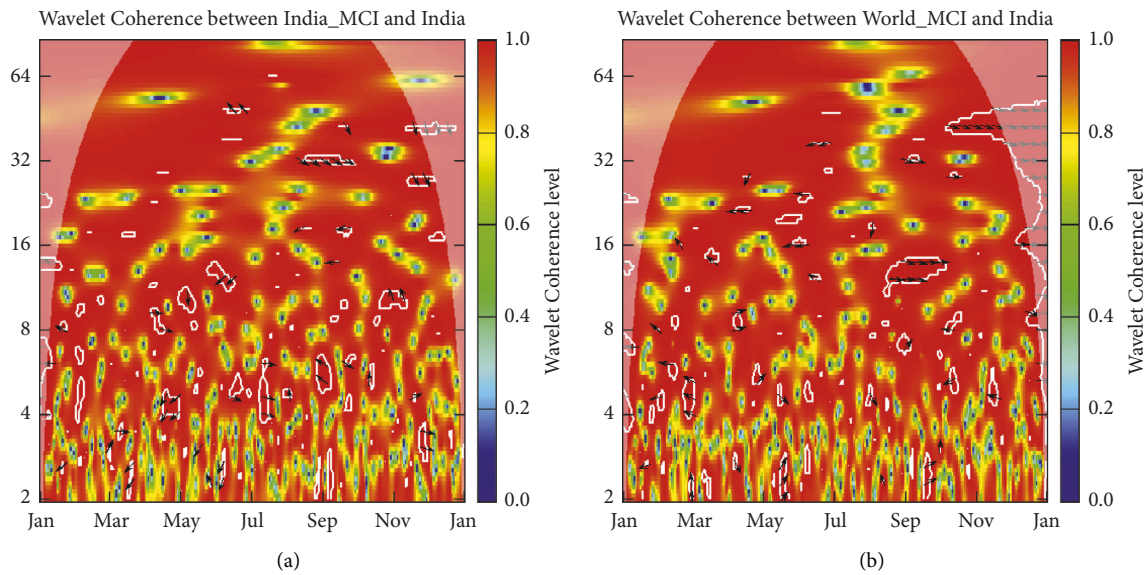

Figure 4: MCI and Indian equities in the initial COVID-19 pandemic year. The values on the x axis show the dates, and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

of positioning arrows spotted between September and October 2020 suggests positive co-movements between Indian equities and world MCI; this persists across high and low-frequency bands (i.e., between 4 and 52 daily periodicities) from November 2020 to January 2021. Thus, as the market gets saturated with global COVID-19 media coverage, fundamental dynamics tend to emerge across the lower frequencies. Thus, COVID-19 shocks hardly reduced Indian equity prices during such periods.

3.1.4. Media Coverage Index and Equities of China in the Initial COVID-19 Outbreak Year. Figure 5 portrays the wavelet coherence plots for the co-movements between the COVID-19 media coverage index and Chinese equities in the first outbreak year.

The co-movement dynamics between local media coverage and Chinese equities (panel A of Figure 5) indicate a positive coherence between media coverage and equities from China across high and medium frequencies in January 2020, specifically at 3–14 daily cycles. Between the 2–3 frequency band, in the early days of February 2020 and between 3 and 14 daily cycles in March–June 2020, Chinese equities led their co-movements with COVID-19 media coverage. This is shown by the (↘) and (↖) positioning arrows. The lucrative character of Chinese equities, as a subset of top-emerging market equities, results in these dynamics despite the shocks from the COVID-19 pandemic. This may be a result of their smart and timely measures rolled out to conquer the pandemic, which they were the main source of. Their strategies put in place to curb the pandemic might have outpaced the impact of the shocks from the pandemic through media coverage. Local media coverage is seen to occupy the leading role at 1.5–3 daily cycles in the early days of August 2020, but this was overturned in late (early) August (September) of the year 2020. The antiphase relationships noticeable between November and December 2020 implied a negative impact of COVID-19 shocks on Chinese equities at high frequencies (2–4 daily periodicities). Notwithstanding, Chinese equities outpaced local media coverage at medium frequencies (7–10) daily cycles in December 2020.

The co-movement dynamics between world media coverage and Chinese equities are portrayed in panel B of Figure 5. From the coherence plot, the lead-lag nexus between world MCI and Chinese equities does not differ significantly from that of local MCI and Chinese equities in panel A. The positive impact of media coverage on Chinese equities is revealed at low to medium frequencies (3–14 daily cycles) in January 2020. World MCI takes a lead role in March 2020, when the coronavirus was declared a pandemic by WHO. This persists at high frequencies (2-daily periodicities) in July and October 2020. The cloud of left and up-diagonal (↖) positioning arrows across 14–18 daily scales communicates that Chinese equities drive their co-movements with COVID-19 media coverage. As the year 2020 ends, similar to other BRICS markets, Chinese equities are positively impacted by world media coverage of COVID-19-related news. As indicated by the right-pointing (→) positioning arrows, low, medium, and high-frequency bands, world COVID-19 shocks may pose no detrimental effect on Chinese equities.

3.1.5. Media Coverage Index and Equities of South Africa in the Initial COVID-19 Outbreak Year. Figure 6 portrays the wavelet coherence plots for the co-movements between the COVID-19 media coverage index and South African equities in the first outbreak year.

From panel A of Figure 6, the co-movement dynamics between local media coverage and South African equities are displayed. The positioning arrows at high frequencies (2–3

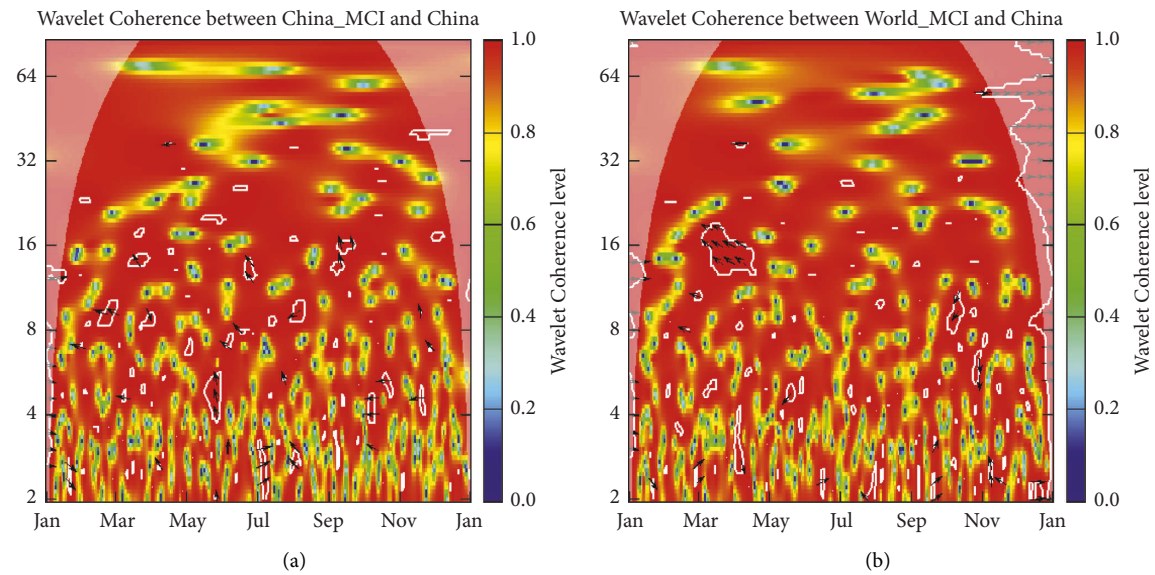

Figure 5: MCI and Chinese equities in the initial COVID-19 pandemic year. The values on the x axis show the dates, and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

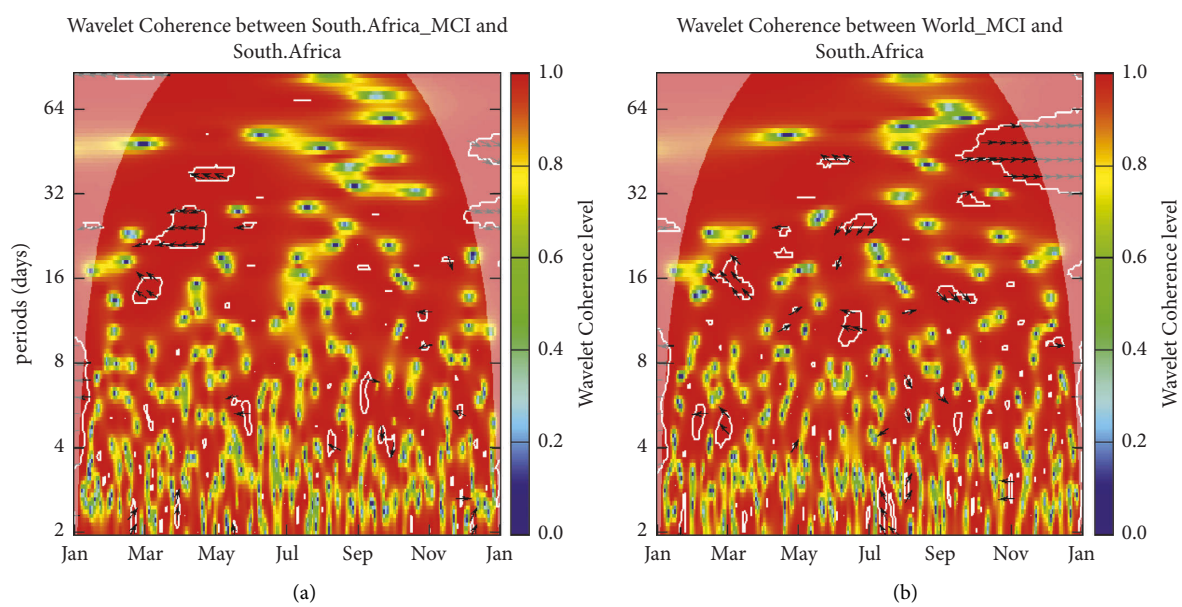

Figure 6: MCI and South African equities in the initial COVID-19 pandemic year. The values on the x axis show the dates, and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

daily periodicities) in the early months (between March and May) of the pandemic shows that media coverage influenced the equity market dynamics in South Africa. This persisted across 20–32 daily cycles within the same period. However, across the 12–16 and beyond the 32-daily cycles, South African equities led their co-movements with local media coverage. South Africa is a member of the African continent, which was the last to record a case of COVID-19. Yet, local media coverage of the pandemic had a detrimental impact on their equities. However, being a part of the top emerging markets globally and the lead market for the African continent, its lucrative character made it overturn the negative impact posed by COVID-19 shocks in the first few months. Indicatively, despite interspersed phase difference arrows, South African equities take on the driving role after December 2020, although this may not be captured by the COI.

Turning to the world media coverage and South African equities' co-movement dynamics, which are revealed by the coherence plot in panel B of Figure 6, similar dynamics from the local MCI hold for the world MCI. However, the leading role of South African equities is clearly shown in this case.

The mix of positioning arrows at high frequencies (2–4 daily cycles) partly communicates the hasty market events exhibited by international market participants in the presence of COVID-19 safety protocols and containment measures. Aside from the leading role of world MCI across 12–14 and 24–26 daily periodicities between May and July 2020, the remaining positioning arrows largely communicate the lead position of South African equities at medium frequencies from March to October 2020. Between 32 and 64 daily cycles, the right-pointing (→) positioning arrows indicate a positive relationship between world media coverage, as a proxy for COVID-19 shocks, and South African equities. This observation is consistent among other BRICS economies and, hence, unsurprising.

3.2. Media Coverage and BRICS Equities in the "New Normal" (2021–2022). We now analyze each BRICS equity market's co-movement dynamics with local and global media coverage in the "new normal" era. We expect that dynamics in various BRICS equity markets will bounce back to normal after they may become saturated with COVID-19 media coverage, either local or global. The individual BRICS markets are analyzed as follows.

3.2.1. Media Coverage Index and Equities of Brazil in the "New Normal". Figure 7 reveals the wavelet coherence plots for the co-movements between the COVID-19 media coverage index and Brazilian equities in the new normal era.

As depicted in Figure 7 A, in the "new normal" era, local media coverage tends to generally drive Brazilian equities across high frequencies (2–8 daily periodicities). Positioning arrows are more of (↙) and (↗), suggesting that the dynamics in the Brazilian equity market are influenced by local media coverage of COVID-19-related news. As recovery tends to be slower, market participants carefully monitor the pandemic through news outlets, and this may influence the pricing of stocks. At low frequencies (around 100 daily cycles) in the early parts of 2021, Brazilian equities took the lead position, but this has been inconsistent in subsequent periods.

When the world media coverage is considered (panel B of Figure 7), we spot Brazilian equities in the lead position in the early days of 2021 between the 16–32 frequency band and in the latter part of 2021 around 8–12 daily cycles. Except for these periods, all other positioning arrows suggest that world media coverage drives Brazilian equities. An inconsistent positive nexus between world MCI and Brazilian equities are found around 6-daily periodicities in the early days of 2022. It is worth mentioning that the resulting positioning arrows for the "new normal" era show the complex behavior of financial markets and the power of social media coverage.

3.2.2. Media Coverage Index and Equities of Russia in the "New Normal". Figure 8 displays the wavelet coherence plots for the co-movements between the COVID-19 media coverage index and Russian equities in the "new normal" era.

In the "new normal," the positioning arrows from the coherence plot between local media coverage and Russian equities show a split in the lead-lag positions. Local MCI leads Russian equities at intermittent wavelet scales in the first half of 2021. Across the frequency bands 16–20 and approximately 64–72 of mid-2021, Russian equities lead their relations with local MCI. This is also envisaged at a high-frequency band (2–3 daily cycles) in the early part of 2022. Meanwhile, Russian equities take a lag position around 12-daily cycles.

Turning to the world MCI, Russian equities responded negatively to world COVID-19 media coverage in the first quarter of 2021. In the second quarter of 2021, Russian equities (world MCI) lagged (led) world COVID-19 media coverage (Russian equities). In the "new normal" era, indications of the leading role of Russian equities manifest in the 16–32 frequency band in the third quarter of 2021. After this period, the leading role of world MCI is found dominant across medium- and low-frequency bands in 2021-ending and the beginning of 2022.

3.2.3. Media Coverage Index and Equities of India in the "New Normal". Figure 9 depicts the wavelet coherence plots for the co-movements between the COVID-19 media coverage index and Indian equities in the "new normal" era.

Distinct from Brazilian and Russian equities, Indian equities generally drive local MCI across different frequency bands in the "new normal" era, as depicted by Figure 9's panel A. This is more glaring in the mid- and late-2021 period in the medium- and low-frequency bands. Across high frequencies (2–3 daily cycles) around the second quarter of 2021 and late 2021, right-pointing (→) positioning arrows indicate positive co-movements between local MCI and Indian equities. Meanwhile, local MCI led Indian equities between the 8–16 frequency band in late 2021.

In terms of world MCI, the coherence plot (panel B of Figure 9) shows mixed co-movement patterns between media coverage and Indian equities. However, the general observation points to some world MCI-led co-movements or negative co-movements in 2021, indicating the fact that the global impact of the COVID-19 pandemic is yet to fully materialize among some economies. However, across low frequencies (above 64 daily cycles), Indian equities lead world MCI, suggesting that approaching the long-term of the pandemic, Indian equities are likely to instead drive world media coverage. This is also noticeable across the 3–5 frequency band in the early part of 2022.

3.2.4. Media Coverage Index and Equities of China in the "New Normal". Figure 10 shows the wavelet coherence plots for the co-movements between the COVID-19 media coverage index and Chinese equities in the "new normal" era.

The mixed coherence phase difference arrows found for other BRICS markets are no different from China. From panel A of Figure 10, we find that the coherence between local media coverage and Chinese equities yields interspersed positioning arrows in high and medium frequencies,

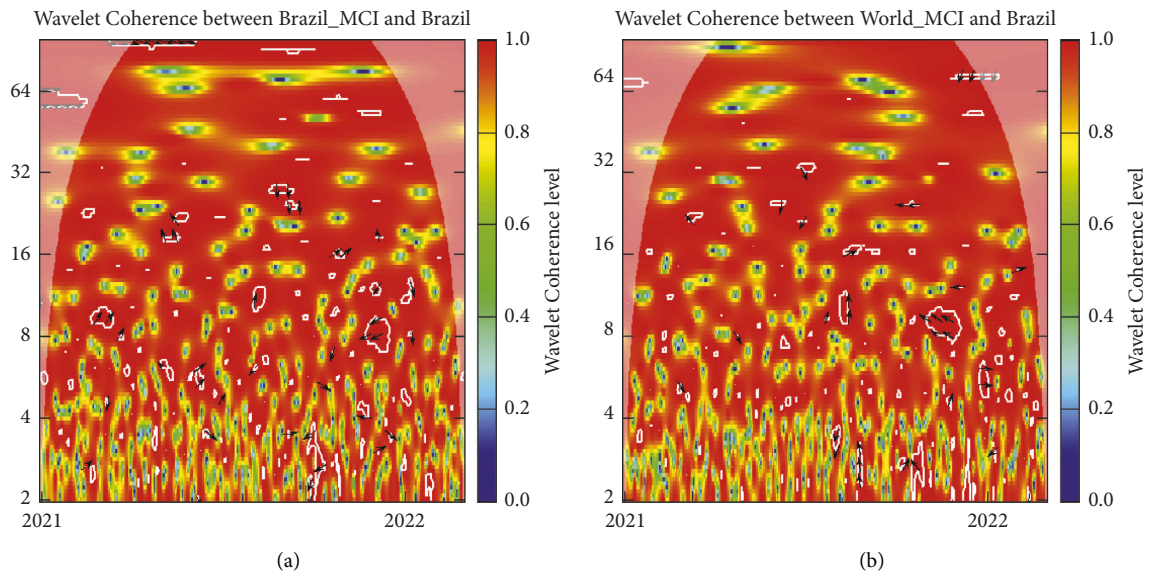

Figure 7: MCI and Brazilian equities in "new normal." The values on the x axis show the dates, and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

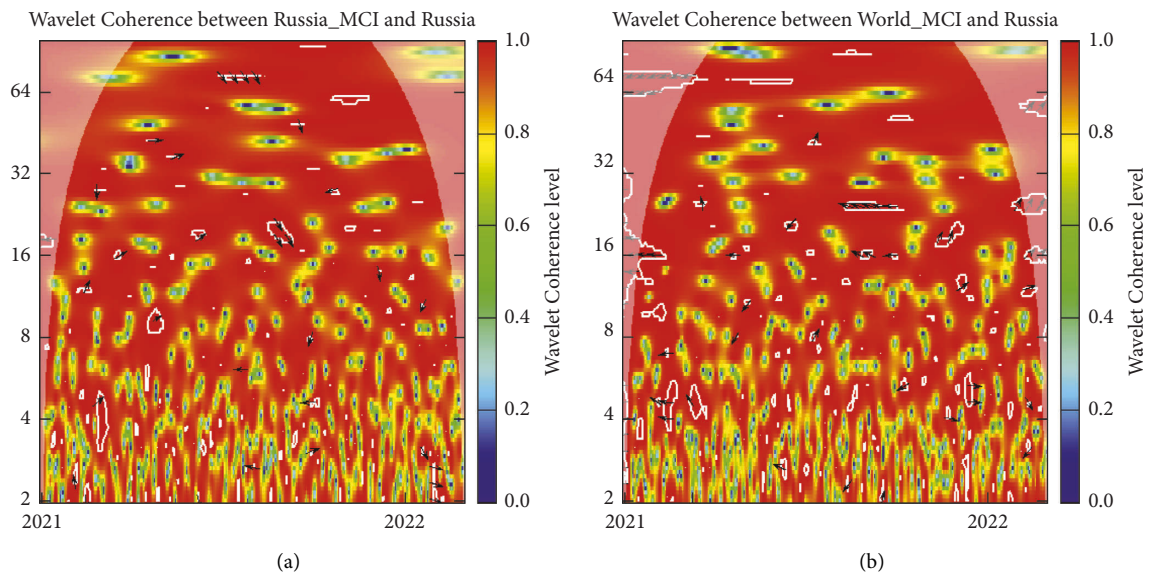

Figure 8: MCI and Russian equities in "new normal." The values on the x axis show the dates, and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

revealing a mix of lead-lag relationships, particularly across the 2–32 frequency band. Thus, it is not clear which of the series consistently leads or lags the other. The lead-lag dynamics are clear at low frequencies (beyond 64 daily periodicities). Across this period in 2021, the leading role of local media coverage of COVID-19 is noticeable.

Whilst Chinese equities fail to consistently drive local media coverage in the "new normal" era, we find that they stand a chance of driving world media coverage in the long term. This is evidenced by the (↘) positioning arrows found between the 32–64 daily cycles in late (early) 2021 (2022). This was also observed during the weekly scale (8-day periodicities) in mid-2021. Whilst Chinese equities were leading world MCI in the first quarter of 2021, across the 3–5 daily frequency band, the co-movements were rather negative nearing the last quarter of 2022 around the same frequency band and the medium frequency band (28–32 daily cycles in mid-2021), as shown by the (←) positioning arrows. These observations reiterate the financial market complexities introduced by the COVID-19 pandemic.

3.2.5. Media Coverage Index and Equities of South Africa in the "New Normal". Figure 11 reveals the wavelet coherence plots for the co-movements between the COVID-19 media coverage index and South African equities in the "new normal" era.

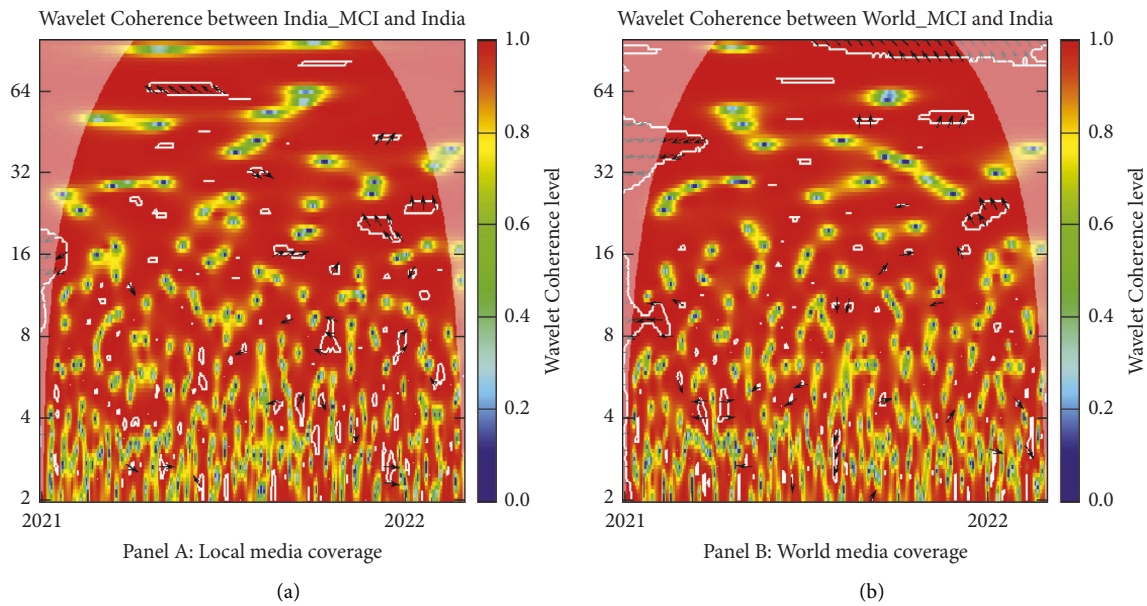

Figure 9: MCI and Indian equities in "new normal." The values on the x axis show the dates, and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

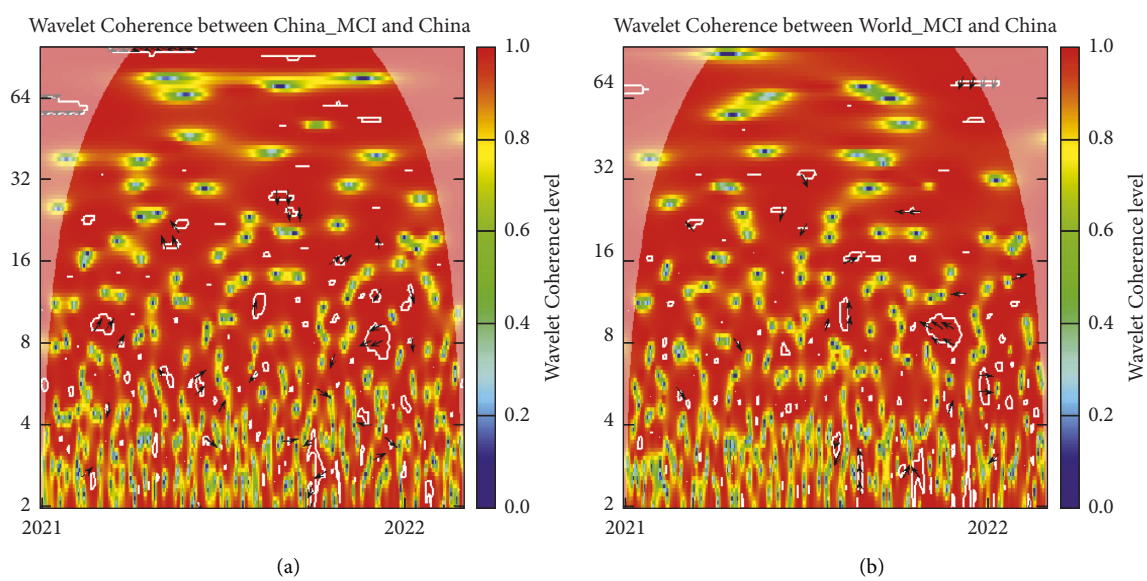

Figure 10: MCI and Chinese equities in "new normal". The values on the x axis show the dates, and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

In the case of South Africa, we find that the coherence between local media coverage and South African equities (see panel A of Figure 11) was driven by local media coverage in the first quarter of 2021 between the 2–4 daily frequency band. Around the mid-2021, across the same frequency band, South African equities assumed the lead position. This was also noticeable between the 4–6 daily periodicities. These were followed by downward positioning arrows (↓), signifying that South African equities led local media coverage by $\pi/2$ at the 3-daily frequency band. With (↗), (↙) and (↑) positioning arrows, the leading role of local media coverage was noticeable across the medium frequency band (8–32 daily cycles) in the "new normal" era, particularly in, the 2021 and early 2022. Across low-frequency band (58–80 daily cycles), from the middle to the end of 2021, we find left-pointing (←) positioning arrows, showing negative co-movements between local media coverage and South African equities.

When we incorporate world media coverage, we find a negative and world MCI-driven impact of media coverage on South African equities at the high-frequency band (2-daily cycles) in the early period of 2021. In the last quarter of

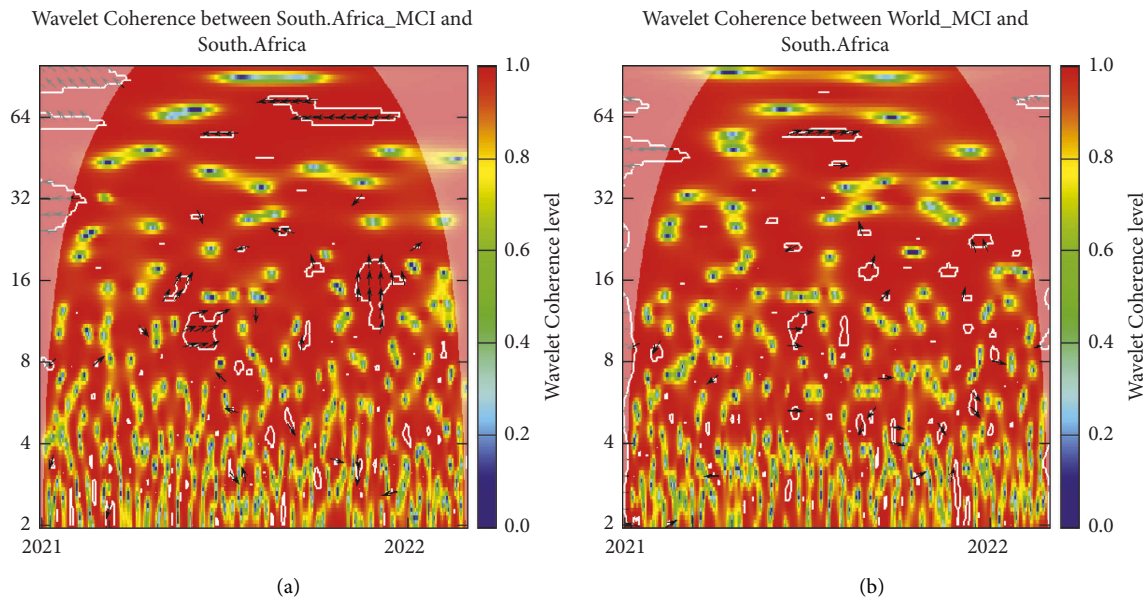

Figure 11: MCI and South African equities in "new normal." The values on the x axis show the dates, and the values on the y axis show the frequency (in days). (a) Panel A: Local media coverage. (b) Panel B: World media coverage.

2021, across the 4–8 frequency band, South African equities drive their co-movement with world media coverage. This is similar to the observation in respect of local media coverage. However, in the "new normal," across the medium frequency band, South African equities show a positive response to world media coverage in mid-2021. South African equities then assume a lagging role nearing the 54-daily frequency band in mid-2021, with a slight potential of leading world media coverage around the 28-daily frequency band in early 2022.

Similar to all BRICS markets, the "new normal" reveals a much more complex interrelation and lead-lag dynamics between media coverage indices, be it local or world, and equity markets.

3.3. Results' Implications. Our findings reveal some practical intuitions for market participants and policymakers. First, our findings indicate that COVID-19-related shocks, proxied by media coverage indices, co-move with equity markets not only in the time domain but also in the frequency domain. The significant co-movement in the time-frequency space indicates that when formulating policy at a given period, the frequency domain, which represents trading horizons in a given timeframe, needs to be incorporated. This is to ensure that significant market dynamics between COVID-19 shocks and financial markets are rightly synchronized in the process of crafting policy actions. Our observation of significant time and frequency domain co-movements between media coverage and equities corroborates the existing literature that reveals time- and frequency-dependent dynamics between media coverage and financial assets [25].

Second, to market participants, we note that given the length of time the pandemic has lasted, media coverage serves as a proxy for public mood and/or investor sentiments at the societal level, thus extending the literature strand on analyzing the capital markets' complexities with media data [2, 3]. Our findings evidence the complexities in the BRICS equity markets. This is shown by the mixed and inconsistent co-movement dynamics between media coverage and each of the BRICS equities at high frequencies (up to weekly trading cycles). Impliedly, during crisis periods, investors (and regulators alike) should be wary of short-lived and inconsistent market dynamics that may render decisions ineffective.

Third, comparing the market dynamics in the initial COVID-19 pandemic year to those in the "new normal" era, for all BRICS markets, we identify significant changes in the co-movements between how local and world media coverage indices interact with emerging market equities. Aside from paving the way for additional research on this subject, the disparities in market dynamics suggest that timely rebalancing of international portfolios is necessary given that the new norm brings to investors more complex dynamics and intense effects of COVID-19 shocks on financial assets. BRICS equities are part of the top emerging markets equities that offer substantial risk-reduction benefits to investors from developed markets [5–7]. Therefore, as the "new normal" period has caused a change in investor sentiments, a careful selection of emerging market equities, particularly highly integrated ones like BRICS, is recommended to reduce overall portfolio risks.

Lastly, our findings underscore the significance of both global and local media coverage in determining equity markets' price-generating dynamics. However, the complex co-movement dynamics between world media coverage and

BRICS equities stress the pivotal role of global factors in driving financial markets [26]. Indicatively, we note that when market participants focus solely on local media coverage, some decisions may be compromised given that when world media coverage is incorporated, the dynamics in equity markets change significantly. Hence, as markets have evolved to the "new normal," investors, policymakers, and regulators should not uphold local sentiment factors more than global factors.

4. Conclusions

We examined the time-frequency co-movement patterns between COVID-19 media coverage and equities from the BRICS market bloc, which contains Brazil, Russia, India, China, and South Africa. We employed daily equity indices and both world media coverage indices (WMCI) and local media coverage indices (LMCI). Our datasets span between January 2020 and March 2022. Under the wavelet coherence methodology, we comparatively assessed the co-movement dynamics between LMCI and WMCI, and each of the BRICS equity markets.

Due to the high integration between BRICS markets, we found that the co-movement patterns between media coverage and each of the BRICS equities are largely comparable. In the initial year of the COVID-19 outbreak, our results indicated that BRICS markets provided some shield against COVID-19 shocks, proxied by both local and world media coverage across medium and low frequencies, which largely corresponds to monthly and quarterly trading periods. In the "new normal" era, our findings revealed more complex co-movement dynamics between media coverage and BRICS equities. In particular, we find that global COVID-19 media coverage drives and poses high risks to emerging market equities across medium and low frequencies.

From our findings, we conclude that focusing on local sentiment factors alone will insufficiently explain financial markets' complexities. As a result, the essence of synchronizing local and global sentiment factors is pivotal to portfolio management in the "new normal" era. Policymakers should not disregard global factors when devising new measures for economic and trading operations in the "new normal" era. In addition to a timely rebalancing of portfolios, investors should carefully select assets from emerging markets or other market blocs that may be highly integrated.

Future works should examine the role of world media coverage in other advanced economies or market blocs. In addition, any asymmetric and nonlinear dynamics could be investigated, as well as a distinction between the direct and indirect impact of the COVID-19 pandemic. This suggestion comes from an anonymous referee.

Data Availability

All data on BRICS equities were sourced from the Bloomberg database. Media coverage data were provided by RavenPack.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The article was supported by the Russian Science Foundation, under Project no 22-18-00276, https://rscf.ru/project/22-18-00276/.

References

[1] P. Quinsee, "Global equity views Asset class views," 2021, https://am.jpmorgan.com/us/en/asset-management/adv/insights/portfolio-insights/asset-class-views/equity/.

[2] J. Bukovina, "Social media big data and capital markets - an overview," *Journal of Behavioral and Experimental Finance*, vol. 11, pp. 18–26, 2016.

[3] M. L. Tseng, "Using social media and qualitative and quantitative information scales to benchmark corporate sustainability," *Journal of Cleaner Production*, vol. 142, pp. 727–738, 2017.

[4] L. R. Gavish, M. Qadan, and J. Yagil, "Net buyers of attention-grabbing stocks? Who exactly are they?" *The Journal of Behavioral Finance*, vol. 22, no. 1, pp. 26–45, 2021.

[5] B. G. Buchanan, P. C. English, and R. Gordon, "Emerging market benefits, investability and the rule of law," *Emerging Markets Review*, vol. 12, no. 1, pp. 47–60, 2011.

[6] W. Mensi, S. Hammoudeh, and S. H. Kang, "Risk spillovers and portfolio management between developed and BRICS stock markets," *The North American Journal of Economics and Finance*, vol. 41, pp. 133–155, 2017.

[7] P. Panda, S. Vasudevan, and B. Panda, "Dynamic connectedness among BRICS and major countries stock markets," *Journal of Public Affairs*, vol. 21, no. 3, 2021.

[8] E. A. Nunoo, P. O. Junior, A. M. Adam, and A. Bossman, "Assessing the safe haven properties of oil in African stock markets amid the COVID-19 pandemic: a quantile regression analysis," *Quantitative Finance and Economics*, vol. 6, no. 2, pp. 244–269, 2022.

[9] M. Qadan and M. Jacob, "The value premium and investors' appetite for risk," *International Review of Economics & Finance*, vol. 82, 2022.

[10] M. Qadan and M. Zoua'bi, "Financial attention and the demand for information," *Journal of Behavioral and Experimental Economics*, vol. 82, Article ID 101450, 2019.

[11] A. S. Kumar and S. R. Padakandla, "Testing the safe-haven properties of gold and bitcoin in the backdrop of COVID-19: a wavelet quantile correlation approach," *Finance Research Letters*, vol. 47, Article ID 102707, 2022.

[12] M. Arif, M. A. Naeem, M. Hasan, M. S. Alawi, and F. T. Hesary, "Pandemic crisis versus global financial crisis: are Islamic stocks a safe-haven for G7 markets ?" *Economic Research-Ekonomska Istraživanja*, vol. 35, pp. 1–21, 2021.

[13] E. C. M. Hui and K. K. K. Chan, "How does Covid-19 affect global equity markets?" *Financial Innovation*, vol. 8, no. 1, pp. 25–19, 2022.

[14] M. Youssef, K. Mokni, and A. N. Ajmi, "Dynamic connectedness between stock markets in the presence of the COVID-19 pandemic: does economic policy uncertainty matter?" *Financial Innovation*, vol. 7, no. 1, pp. 13–27, 2021.

[15] F. Zeren and A. Hizarci, "The impact of COVID-19 coronavirus on stock markets: evidence from selected countries,"

Muhasebe ve Finans İncelemeleri Dergisi, vol. 3, no. 1, pp. 78–84, 2020.

[16] D. Zhang, M. Hu, and Q. Ji, "Financial markets under the global pandemic of COVID-19," *Finance Research Letters*, vol. 36, Article ID 101528, 2020.

[17] S. M. Hashmi, B. H. Chang, and L. Rong, "Asymmetric effect of COVID-19 pandemic on E7 stock indices: evidence from quantile-on-quantile regression approach," *Research in International Business and Finance*, vol. 58, Article ID 101485, 2021.

[18] C. Torrence and G. P. Compo, "A practical guide to wavelet analysis," *Bulletin of the American Meteorological Society*, vol. 79, no. 1, pp. 61–78, 1998.

[19] C. Torrence and P. J. Webster, "Interdecadal changes in the ENSO-Monsoon system," *Journal of Climate*, vol. 12, no. 8, pp. 2679–2690, 1999.

[20] A. Bossman, A. M. Adam, P. Owusu Junior, and S. K. Agyei, "Assessing interdependence and contagion effects on the bond yield and stock returns nexus in Sub-Saharan Africa: evidence from wavelet analysis," *Scientific African*, vol. 16, 2022.

[21] A. Rua and L. C. Nunes, "International comovement of stock market returns: a wavelet analysis," *Journal of Empirical Finance*, vol. 16, no. 4, pp. 632–639, 2009.

[22] J. Morlet, G. Arens, E. Fourgeau, and D. Glard, "Wave propagation and sampling theory – Part I: complex signal and scattering in multilayered media," *Geophysics*, vol. 47, no. 2, pp. 203–221, 1982.

[23] J. Morlet, G. Arens, E. Fourgeau, and D. Giard, "Wave propagation and sampling theory – Part II: sampling theory and complex waves," *Geophysics*, vol. 47, no. 2, pp. 222–236, 1982.

[24] P. Goupillaud, A. Grossmann, and J. Morlet, "Cycle-octave and related transforms in seismic signal analysis," *Geoexploration*, vol. 23, no. 1, pp. 85–102, 1984.

[25] Z. Umar, M. Gubareva, and T. Sokolova, "The impact of the Covid-19 related media coverage upon the five major developing markets," *PLoS One*, vol. 16, no. 7, p. 28, 2021.

[26] C. D. Gaina and D. Philippas, "Local versus global factors weighing on stock market returns during the COVID-19 pandemic," *Finance Research Letters*, vol. 46, Article ID 102270, 2022.