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Examining the dynamics of risk, performance, and volatility during COVID-19: Evidence from Moroccan stock market

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Abstract

This study delves into the repercussions of the COVID-19 pandemic on the Moroccan stock market, with a specific focus on the MASI index and sectoral indices. The examination encompasses distinct pre-COVID and during-COVID periods, shedding light on the market's evolution, marked by unique phases and fluctuations. Notably, the MASI index experienced a significant downturn in March 2020, indicative of the pandemic's disruptive impact on investor behavior. Despite this setback, the market showcased remarkable resilience, staging a swift recovery and surpassing pre-crisis levels by the close of 2020. This rebound can be attributed to various factors, including historically low bond yields, the initiation of vaccination campaigns, and the resumption of dividend payouts by the banking sector. Our findings bring forth a nuanced understanding of performance and risk dynamics across individual sectors. Moreover, there is a noteworthy surge in correlations between sectoral returns during the COVID-19 period, limiting diversification options for investors and exposing them to heightened risks. The volatility patterns, analyzed using GARCH models, underscore the dynamic nature of the MASI index, exhibiting stability in the pre-pandemic phase and a transient disturbance during the initial pandemic shock. This study contributes to the existing body of literature on the global financial impact of COVID-19, providing valuable insights into the Moroccan context. The results emphasize the significance of comprehending sector-specific vulnerabilities and market dynamics for both investors and policymakers. In navigating the uncertainties of the post-pandemic era, these insights offer crucial perspectives for market participants to make informed decisions and adapt optimal strategies.

Keywords: COVID-19, GARCH model market, MASI index, Moroccan financial market, Psychological impact, Risk measures, Volatility.
JEL Classification: G32; G10; C60.

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Contents

Contribution of this paper to the literature
This study investigates the COVID-19 pandemic's impact on the Moroccan stock market, particularly the MASI index. Through analysis spanning pre-COVID and during-COVID periods, it illuminates market evolution and resilience, despite a significant downturn in March 2020. Results highlight sector-specific vulnerabilities and market dynamics, providing valuable insights for investors and policymakers.

1. Introduction

In the realm of finance, outbreaks represent extreme events that often defy easy anticipation. The challenge in foreseeing these events lies in the fact that their triggering causes are typically relatively insignificant events or the accumulation of seemingly minor occurrences. Financial crises, in particular, are marked by sudden and pronounced declines in the value of financial assets. Across the landscape of financial history, numerous instances of outbreaks have shaken the general stability of specific financial systems or even the global financial ecosystem. For further exploration of this phenomenon, we recommend delving into works such as Allen and Gale (2007); Claessens and Kose (2013); Eichengreen (2002); Helleiner (2011) and Shiller (2012), and the references therein. Morocco recorded its first confirmed case of coronavirus-2019 (Covid-19) on March 2nd, 2020. Subsequently, on March 11th, the World Health Organization declared Covid-19 a global pandemic. Since this pivotal moment, the repercussions of the outbreak on the daily social life of individuals have been profound. In response to the imperative of curbing the virus's spread, millions of people worldwide have experienced lockdowns and stringent restrictions, leading to a significant slowdown in consumer activity. The resultant economic slowdown, in turn, has reverberated across the global financial system, and Morocco is not exempt from these challenging economic dynamics.

The global ramifications of the Covid-19 health crisis have reverberated across all sectors worldwide. In a study by Baker et al. (2020) this health crisis was identified as the most influential factor impacting the stock market. Additionally, Ashraf (2020) demonstrated a pronounced reaction of stock markets to the heightened risk of Covid-19 infection. This heightened risk adversely affected the performance of various Chinese sectors, particularly in areas such as transport and tourism, as highlighted by Shen, Fu, Pan, Yu, and Chen (2020). Furthermore, Gu, Ying, Zhang, and Tao (2020) conducted an empirical analysis to assess the impact of Covid-19 on the performance of several sectors, utilizing a sample of 34,000 companies. Their findings indicated a substantial 57% reduction in electricity consumption during the first week of the Covid-19 outbreak, illustrating the widespread effects of the crisis on diverse aspects of economic activity. In a separate study, Wang, Zhang, Wang, and Fu (2020) scrutinized the impact of Covid-19 on China's insurance industry. Their investigation revealed that the emergence of Covid-19 had a detrimental effect on the sector's overall performance. Collectively, these studies underscore the extensive repercussions of the Covid-19 crisis, not only on public health but also on global economic sectors and industries. Moreover, the influence of Covid-19 on the performance of the banking sector in Europe was notable primarily during the initial phase. This scenario can be attributed to the multifaceted measures implemented by European governments, as elucidated by Batten, Choudhury, Kinateder, and Wagner (2023). Notably, governments extended financial assistance to uphold the standard of living for citizens. Concurrently, regulatory measures were introduced, ranging from travel restrictions to the closure of both public and private establishments, initially through partial containment measures and subsequently transitioning to total containment strategies. These interventions were devised to mitigate the socio-economic impact of Covid-19. These circumstances wielded a profound influence on business activities, creating upheavals in various markets and sectors, notably impacting the tourism sector. The study conducted by Bouri, Cepni, Gabauer, and Gupta (2021) delved into the response of the New Zealand government to the challenges posed by Covid-19, particularly in the context of secondary sector equity returns, employing a GARCH model. The investigation revealed a fluctuating dynamic correlation among secondary sector stock returns, initially exhibiting negativity and subsequently turning positive in March 2020. This shift underscored an increased interdependence among different secondary sector stocks, with eight secondary sector returns exhibiting a positive and significant impact. Notably, this positive impact extended to the NZ50 (New Zealand Exchange, NZSX 50). However, the study also brought to light that certain government policies, including economic stimulus plans and travel bans, did not exert a discernible influence on the performance of shares in specific sectors such as real estate and healthcare. This nuanced finding suggests that the impact of government interventions varied across sectors, indicating a complex and sector-specific response to the challenges posed by the Covid-19 pandemic.

Theoretically, it is essential to acknowledge that the interdependence among major markets may experience an increase. As demonstrated by Aslam et al. (2020) who studied 56 stock market indices using TVP-VAR variances, positive correlations emerged due to the substantial uncertainty surrounding the onset of the Covid-19 pandemic. Additionally, Bouri et al. (2021) explored the connectivity between various assets, including crude oil, currencies, global equities, gold, and bonds, in relation to Covid-19. Their findings indicated a swift and concerning impact on the performance of these assets.

The global dynamic connectivity of these assets, which was relatively stable before Covid-19, experienced significant changes. Notably, bonds assumed the role of the primary shock transmitter during the Covid-19 epidemic, contrasting with the pre-pandemic scenario where the dollar and equity indices held that position. Le, Do, Nguyen, and Sensoy (2021) contributed insights by studying dependency networks of international financial assets in the context of Covid-19. They revealed an asymmetric influence, with right-tail dependencies becoming weaker and less responsive to left-tail ones. Furthermore, they identified US Treasuries and Bitcoin as assets disconnected from others in the dependency networks, portraying them as weak assets for global investors during the Covid-19 period. In a different context, the impact of COVID-19 on stock market volatility was evident in Germany and England, as indicated by GARCH models (Yousef, 2020). The study suggested that Covid-19 significantly increased stock market volatility. Analyzing the behavior of the S&P 1200 Global Shariah and non-Shariah sector indices, Dharani, Hassan, Rabbani, and Huq (2022) affirmed that non-Shariah indices exhibited higher volatility than Shariah indices. This observation aligns with the findings of Takyi and Bentum-Ennin (2021) who demonstrated that falling sectors in African stock markets were significantly more volatile than rising sectors. This article aims to contribute to the existing body of theoretical and empirical literature by examining the impact of Covid-19 on the Moroccan stock market, specifically using the MASI index. The study seeks to provide insights into the performance of the Moroccan stock market before and after the introduction of Covid-19, aligning with broader global trends observed in financial markets.

The primary objective of this paper is to assess the impact of the Covid-19 outbreak on the Moroccan financial market by scrutinizing the behavior of the MASI index. The MASI index, short for the Moroccan All Shares Index, serves as the principal stock index, providing insights into the performance of all companies listed on the Casablanca Stock Exchange. To achieve this goal, we aim to analyze both the value and returns of the MASI index, employing various risk and variability measures. Additionally, our investigation will extend to studying the intra-correlation among the diverse assets that constitute the MASI index. This comprehensive analysis seeks to shed light on the nuanced dynamics of the Moroccan financial market in response to the challenges posed by the Covid-19 outbreak.

The rest of the paper is organized as follows. Section I presents some preliminaries about risk, variability and correlation measures and the used model. Section 3 provides result and discussion. The last section concludes.

2. Preliminary

We consider a probability space $(\Omega, \mathcal{F}, \mathrm{P})$. Let $L^{\infty} := L^{\infty}(\Omega, \mathcal{F}, \mathrm{P})$ be the space of equivalent classes of essentially bounded continuous random variables. We denote X the random outcome of a financial position, and F_X is the cumulative distribution function of X. We begin by providing the definition and some theoretical axioms of risk measures.

Definition 2.1. A risk measure is a functional $\rho: L^{\infty} \rightarrow \mathrm{R}$, which may satisfy the following properties:

- Monotonicity: If $X \leq Y$, then $\rho(X) \leq \rho(Y), \forall X, Y \in L^{\infty}$.
- Translation Invariance: $\rho(X + C) = \rho(X) + C, \forall C \in \mathrm{R}, \forall X \in L^{\infty}$.
- Positive Homogeneity: $\rho(\lambda X) = \lambda \rho(X), \forall \lambda \geq 0, \forall X \in L^{\infty}$.
- Sub-Additivity: $\rho(X + Y) \leq \rho(X) + \rho(Y), \forall X, Y \in L^{\infty}$.
- Convexity: $\rho(\lambda X + (1 - \lambda)Y) \leq \lambda \rho(X) + (1 - \lambda)\rho(Y), \forall X, Y \in L^{\infty}, \forall \lambda \in [0,1]$.
- Law Invariance: If $F_X = F_Y$, then $\rho(X) = \rho(Y), \forall X, Y \in L^{\infty}$.
- Co-monotonic Additivity: $\rho(X + Y) = \rho(X) + \rho(Y)$ for every co-monotonic pair $X, Y \in L^{\infty}$.

The first property, monotonicity, indicates that for a position that generates worse results than the second, its risk is expected to be higher. The second property, translation invariance, informs that if a certain gain is added to the position, the risk is expected to decrease by the same amount. Risk measures that respect both axioms are known as monetary risk measures. The third property, positive homogeneity, indicates that the risk of the position increases with its size. sub-additivity shows that the risk of a combined position is less than or equal to the sum of the risks of the individual assets that make up the portfolio. When a risk measure fulfills monotonicity, translation invariance, positive homogeneity and sub-additivity, it is known as a coherent risk measure in the sense proposed by Artzner, Delbaen, Eber, and Heath (1999). Positive homogeneity and sub-additivity together imply Convexity. For more details, see Föllmer and Schied (2002) and Frittelli and Gianin (2002). The next property, law invariance, points that two positions that have the same distribution have equal risks. The last property, co-monotonic additivity, shows that, for co-monotonic pair of financial positions, the risk of a combined position is equal to the sum of risks of the individual assets that make up the portfolio. For more details regarding the properties above, we refer to Delbaen (2012). The functionals provided below are examples of risk measures.

Value-at-Risk (VaR): This is the most common risk measure in financial industry, and it represents the α-quantile of X. It can be interpreted as the maximum loss expected for a given significance level of risk such that:

$$\mathrm{VaR}_{\alpha}(X) = \inf\{x: F_X(x) \geq \alpha\} = F_X^{-1}(\alpha), \alpha \in [0,1], \forall X \in L^{\infty}.\# \quad (1)$$

- Expected Shortfall (ES): This measure represents the expected value of the losses, since it exceeds the α-quantile of X, that is, the VaR. One can define the ES as follows:

$$ES_{\alpha}(X) = \frac{1}{1-\alpha}\int_{\alpha}^{1} F_X^{-1}(u)du, \alpha \in (0,1], \forall X \in L^{\infty}\# \quad (2)$$

Now we are going to define variability measures and provide some of their properties.

Definition 2.2. A variability measure is a functional $\nu: L^{\infty} \rightarrow \mathrm{R}_{+}$that may satisfy the following properties:

- Non-Negativity: $\nu(X) = 0$ for all constant $X \in L^{\infty}$ and $\nu(X) > 0$ for all non-constant $X \in L^{\infty}$.
- Translation Insensitivity: $\nu(X + C) = \nu(X), \forall C \in \mathbf{R}, \forall X \in L^{\infty}$.
- Positive Homogeneity: $\nu(\lambda X) = \lambda \nu(X), \forall \lambda \geq 0, \forall \in L^{\infty}$.
- Sub-Additivity: $\nu(X + Y) \leq \nu(X) + \nu(Y), \forall X, Y \in L^{\infty}$.
- Convexity: $\nu(\lambda X + (1 - \lambda)Y) \leq \lambda \nu(X) + (1 - \lambda)\nu(Y), \forall X, Y \in L^{\infty}, \forall \lambda \in [0,1]$.
- Law Invariance: if $F_X = F_Y$, then $\nu(X) = \nu(Y), \forall X, Y \in L^{\infty}$.
- Co-monotonic Additivity: $\nu(X + Y) = \nu(X) + \nu(Y)$ for every co-monotonic pair $, Y \in L^{\infty}$.

The first property, non-negativity, indicates that any non-constant position have nonnegative variability. The next axiom, Translation Insensitivity, informs that the deviation value does not change if a constant is added. When a variability measure fulfills Non-Negativity and Translation Insensitivity, it is labelled as a proper variability measure. If a proper variability measure fulfills, Positive Homogeneity and Sub-Additivity it is know as a generalized variability measure, in the sense proposed by Rockafellar, Uryasev, and Zabarankin (2006). For more details regarding financial interpretation of these properties, we refer to Rockafellar et al. (2006) and Pflug and Romisch (2007).

We illustrate the variability concept with some examples:

- Variance (VAR):

$$\mathrm{var}(X) = \mathbb{E}[(X - \mathbb{E}[X])^2], \forall X \in L^{\infty}\# \quad (3)$$

- Standard Deviation (SD):

$$SD(X) = \left(\sqrt{\mathbb{E}[(X - \mathbb{E}[X])^2]}\right), \forall X \in L^{\infty} \# \quad (4)$$

2.1. Performance Measures

Regarding the variable X, we will consider the following measures.

$$\text{Sharp ratio } = \frac{\mathbb{E}[X] - r_f}{\sigma(X)}, \quad \text{Treynor ratio } = \frac{\mathbb{E}[X] - r_f}{\beta(X)}. \# \quad (5)$$

Where: $\beta(X)$ and r_f denote, respectively, Beta of variable X and the risk-free rate (refer to Sharpe (1963) and Treynor (1962)).

Skewness (6) and kurtosis (7) are among the most widely examined measures in the field of descriptive statistics across various disciplines, such that,

$$\text{Skewness } (X) = \frac{\mathbb{E}[(X - \mathbb{E}[X])^3]}{\sigma(X)^3} \# \quad (6)$$

$$\text{kurtosis } (X) = \frac{\mathbb{E}[(X - \mathbb{E}[X])^4]}{\sigma(X)^4} \# \quad (7)$$

2.2. GARCH Model

The GARCH model, introduced by Engle (1982) and further developed by Bollerslev (1986) serves as the foundation for our analysis. In this study, we employed the GARCH (1,1) model, recognized for its simplicity and widespread applicability in modeling financial processes. Karmakar (2005) recommended the use of GARCH (1,1) to visualize conditional volatility in stock returns. Consistent with the formulation in Bollerslev (1986) the equation for the conditional variance in the GARCH (1,1) model is expressed as follows:

$$h_t^2 = \omega_0 + \omega_1 \epsilon_{t-1}^2 + \omega_2 h_{t-1}^2 + v_t. \# \quad (8)$$

Where, $\epsilon_t \backsim \mathcal{N}(0, \sigma_t^2)$ is the error obtained from equation (9):

$$X_t = \alpha_0 + \beta_i X_{t-1} + \beta_j \epsilon_{t-1} + \epsilon_t, \# \quad (9)$$

Additionally, ω_1 represents the ARCH coefficient, and ω_2 is the GARCH coefficient, both expected to be non-negative ($\omega_1 \geq 0$ and $\omega_2 \geq 0$). Furthermore, the conditions $\omega_1 + \omega_2 < 1$ and $\omega_0 \geq 0$ are imposed. The sum of ω_1 and ω_2 serves as an indicator of the model's quality. A value close to one for $\omega_1 + \omega_2$ suggests persistence in the considered GARCH model.

3. Results and Discussion

3.1. Data

We aim to analyze the Moroccan All Shares Index (MASI) along with the time series data of individual sector indices on the Casablance [1] Stock Exchange (as shown in Table 2), covering the period from January 2017 to December 2021. This timeframe is segmented into two distinct periods: the pre-COVID period, spanning from January 1, 2017, to March 1, 2020, and the during-COVID period, extending from March 2, 2020, to December 31, 2021. The demarcation of these periods is crucial for understanding the dynamics of Casablanca's sectoral indices, particularly considering that Moroccan authorities reported the first case of COVID-19 on March 2, 2020. The data was retrieved from the Casablanca Stock Exchange website. Moving forward, we denote $\mathrm{X_t}$ as the daily return of each index on day t, calculated using the following formula:

$$X := X_t = \log\left(\frac{P_t}{P_{t-1}}\right) \times 100 \# \quad (10)$$

Where, P_t and P_{t-1} are, respectively, the prices of each index on day t and $t-1$.

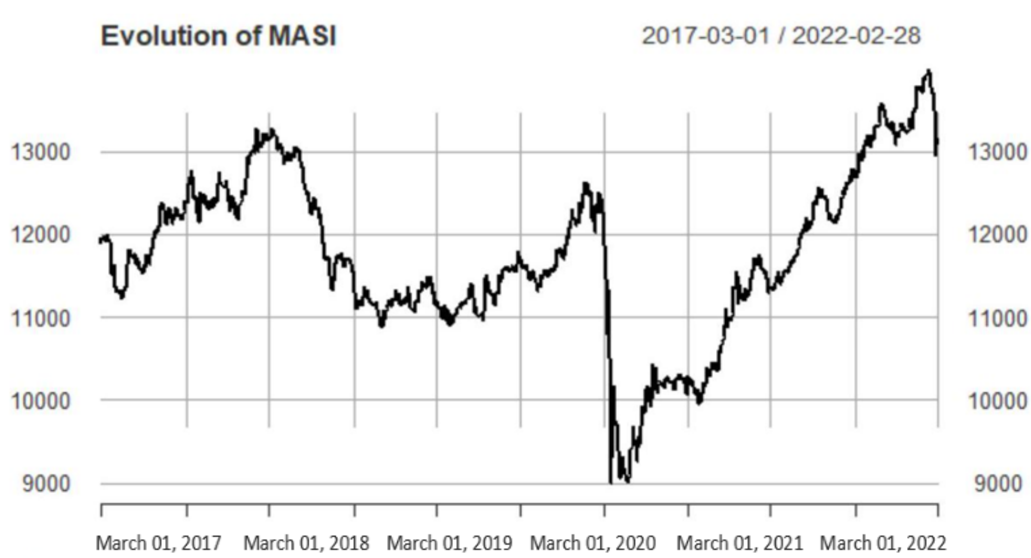

Figure 1. MASI evolution before and during Covid-19.

[1] http://www.casablanca-bourse.com

Based on Figure 1, we can see that the MASI index fluctuates in different ways. This erratic fluctuation, generating up and down cycles over shorter or longer periods, can be divided into two major phases. The first phase before the Covid-19 crisis and the second phase during and after the onset of this crisis. Within this framework, we observe in the first phase that the MASI index recorded an increase between the first quarter of 2017 and the first quarter of 2018.This improvement is essentially due to the performance of cyclical sectors, namely: buildings and construction materials and real estate participation and development. During 2019, the MASI index fell before making a small recovery at the start of 2020, this situation may be due to the underperformance of certain sectors compared with that of MASI, by way of example the oil & gas and utilities sectors. In March 2020, we observe a remarkable drop in the MASI index due to the health crisis and the repercussions of containment on the behavior of investors and the economy as a whole. Moreover, we note that the return to equilibrium did not take long and that the MASI index has continued to rise to a significant level, even exceeding the value recorded during the first quarter of 2018. This improvement can be explained by the resilience of certain sectors (agrifood and pharmaceuticals). From the last quarter of 2020 onwards, the rotation in favor of cyclical sectors picked up significantly, against a backdrop of economic optimism and a return to the initial situation of activity as a whole. The progress made in vaccinating against the Covid-19 pandemic, the significant easing of restrictions on mobility and the effective launch of the national economic recovery plan are all factors that will encourage investors to position themselves in cyclical segments in the near future.

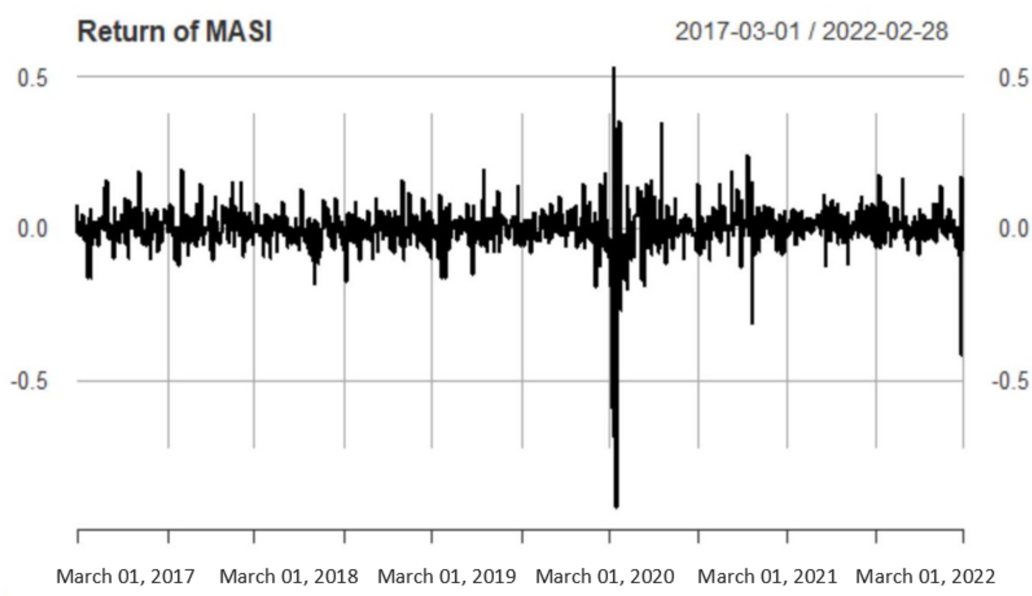

Figure 2. Return of MASI before and during Covid-19.

Based on Figure 2, we can see that MASI index returns fluctuate within a range of 0.5 and -0.5, and that this fluctuation is almost stable between the first quarter of 2017 and the first two months of 2020. In March 2020, MASI yields recorded a remarkable fall, which took only enough time to return to the initial state. This recovery saw an improvement in returns, particularly between the last six months of 2020 and the first quarter of 2021. In fact, the drop in MASI returns can be explained by the uncertainty surrounding the evolution of the Covid-19 pandemic, which at the start of the crisis caused major disruptions to the financial markets, particularly on the Casablanca stock exchange, which recorded significant underperformance and high volatility. In addition, the fall in the MASI index can also be explained by a 50% drop in the property development sector, as well as the banking sector, which lost more than a third of its valuation at the height of the crisis. The recovery of the MASI index after the Covid-19 stock market shock is due to 3 factors that have a positive impact on investors' perception of equities. Firstly, historically low bond yields; secondly, the launch of the vaccination campaign in Morocco and abroad in December; and thirdly, the return to dividend payouts by the banking sector. Finally, the MASI has been on an uptrend since the end of September 2020, reflected in a +10.4% rise to the end of November. As a result, the equities market reduced its annual losses to −9.7%, compared with −26.2% at the height of the stock market crash.

Table 1. Descriptive statistics of MASI during and before COVID-19.

Periods	Mean	SD	Max.	Min.	Kurtuisis	Skewness	Median
Before COVID 19	0.0043	0.5244	1.9549	-1.9641	1.7569	0.0876	0.0022
During COVID 19	0.0129	0.9722	5.3054	-9.2317	27.3963	-2.7079	0.0369

3.2. Market Behaviors before and during COVID-19

3.2.1. Descriptive Statistics

Table 1 shows the descriptive statistics of our study, such as standard deviation (s), Skewness (Skew), kurtosis (Kurt), maximum (Max), median, mean and minimum (Min). In addition, we calculated both the performance and risk of the MASI index before and during the Covid-19 period and the correlation between sectors for both periods (see Tables 2, 3, 4 and 5). The descriptive statistics presented in Table 1 show that the MASI index over the Covid-19 period has high returns, but also high risk and is associated with high kurtosis. In other words, the MASI index during the pandemic period experienced high gains, but these were coupled with high risk which is associated with high kurtosis. In contrast, the MASI index prior to Covid-19 is less risky and less rewarding. Specifically, after the Covid-19 is triggered, the standard deviation and mean of the MASI index become more significant (0.5244; 0.9722 and 0.0043; 0.0129) these observations confirm the impact of Covid-19 on stock index volatility.

In addition, it should be noted that, during the Covid-19 period, the Skewness coefficient is different from 0 and the kurtosis coefficient is greater than 3. In addition, the median differs from the mean for both periods. Similarly, for the pre-pandemic period, all but the kurtosis coefficient is below 3. In addition, we noticed that the majority of correlation coefficients between yields increased after the appearance of Covid-19, as shown in (Tables 4 and 5).

3.2.2. Volatility of the Market

Examining Figure 3 in detail, we observe a period of remarkable stability in the volatility of MASI index returns leading up to the emergence of the pandemic. The pre-pandemic phase is characterized by a consistent and predictable pattern in the volatility of the MASI index. However, with the onset of the pandemic, a transient disturbance is noticeable, affecting the volatility for a relatively short duration. Intriguingly, after this initial perturbation, the volatility tends to revert to the earlier observed levels, resembling the conditions prevailing before the onset of the health crisis. This nuanced analysis underscores the dynamic nature of the MASI index, with its volatility demonstrating resilience and a tendency to return to established patterns even in the face of significant external disruptions such as the pandemic.

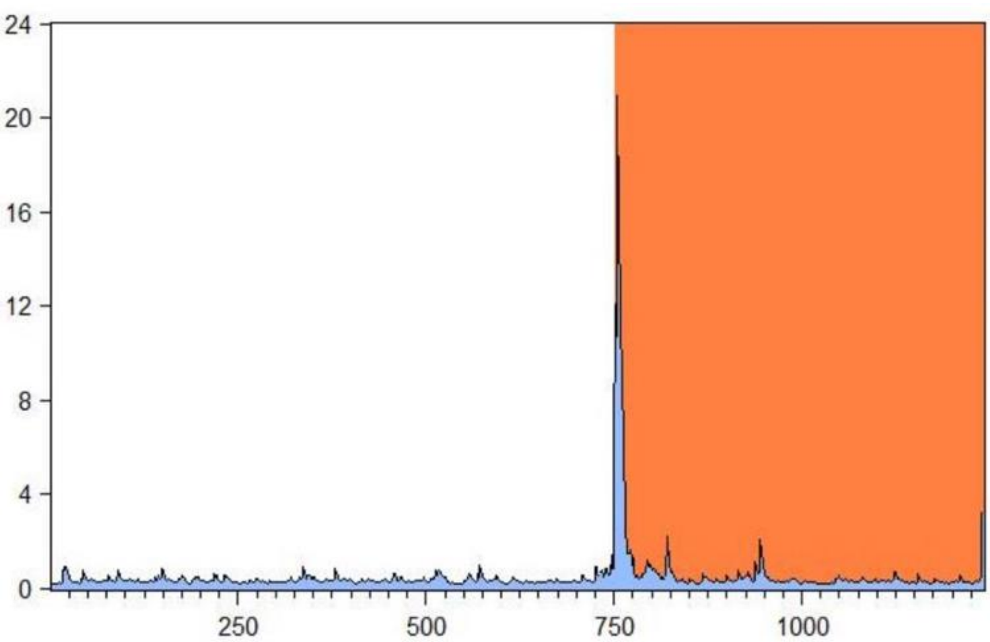

Figure 3. Volatility of MASI overall the period.

3.3. Risk and Performance of Sectors before and during COVID-19.

In this subsection, we are examining the risk and performance of sectors both before and during Covid-19 to provide a clear understanding of the sectors that have significantly influenced the behavior of MASI.

Table 2. Symbole and sectors.

Symbol	Sector	Symbol	Sector
s1	Utilities	s12	Pharmaceutical industry index
s2	Electricity index	s13	OIL AND GAZ
s3	Mining index	s14	Materiels logiciels & services informatiques
s4	Food producers & processors index	s15	Forestry & paper
s5	Insurance index	s16	Beverages
s6	Telecommunications index	s17	Transportation services index
s7	Banks index	s18	Holding companies
s8	Distributors index	s19	Construction & building materials
s9	Real estate participation and promotion	s20	Leisures and hotels
s10	Chemicals index	s21	Investment companies & other finance
s11	Transport index	s22	Engineering & equipment industrial goods

Table 3. Risk and performance of sectors before COVID-19.

Sector	Mean	Sharp ratio	Treynor	SD	BETA	ES	Kurtuisis	Skewness	Median
s1	-0.0251	-0.0120	-0.0429	2.0881	0.5863	-0.0564	4.9959	-0.1763	0.0000
s2	0.0257	0.0166	0.0401	1.5508	0.6412	-0.0354	1.9279	-0.1366	0.0000
s3	-0.0257	-0.0179	-0.0358	1.4425	0.7191	-0.0372	4.8238	-0.5473	0.0000
s4	0.0339	0.0343	0.0437	0.9894	0.7755	-0.0228	1.7378	-0.0871	0.0282
s5	0.0062	0.0041	0.0065	1.5134	0.9485	-0.0399	5.8713	-0.6022	0.0148
s6	0.0050	0.0059	0.0054	0.8514	0.9317	-0.0204	18.1679	-0.9177	0.0000
s7	0.0109	0.0166	0.0120	0.6590	0.9143	-0.0131	1.1556	0.3411	0.0042
s8	0.0543	0.0411	0.0827	1.3212	0.6566	-0.0320	6.6402	-0.2081	0.0074
s9	-0.2247	-0.1196	-0.1907	1.8791	1.1782	-0.0504	4.0149	-0.3204	-0.1067
s10	0.0484	0.0181	0.0459	2.6707	1.0539	-0.0603	2.0051	0.0579	0.0000
s11	0.0381	0.0241	1.8744	1.5790	0.0203	-0.0399	7.9466	0.2733	0.0000
s12	0.0025	0.0021	0.0414	1.1796	0.0605	-0.0321	8.5675	0.2500	0.0000
s13	0.0285	0.0166	0.0317	1.7203	0.8993	-0.0436	4.0329	-0.0967	0.0000
s14	0.1190	0.0964	0.2336	1.2342	0.5093	-0.0265	3.7132	0.4127	0.0285
s15	-0.0879	-0.0245	-0.1805	3.5798	0.4867	-0.0810	16.4514	-1.2407	0.0000
s16	0.0224	0.0153	0.0394	1.4629	0.5674	-0.0398	6.6817	-0.1662	0.0000
s17	0.0683	0.0539	0.0708	1.2683	0.9646	-0.0274	11.9240	-0.1938	0.0000
s18	0.0363	0.0187	0.0550	1.9432	0.6600	-0.0481	4.5201	-0.0870	0.0000

Sector	Mean	Sharp ratio	Treynor	SD	BETA	ES	Kurtuisis	Skewness	Median
s19	-0.0186	-0.0128	-0.0104	1.4532	1.7796	-0.0349	3.9416	-0.3035	-0.0024
s20	0.0393	0.0159	0.0524	2.4691	0.7500	-0.0573	3.5126	0.0540	0.0000
s21	0.0144	0.0138	0.0586	1.0450	0.2456	-0.0269	4.0997	-0.3356	0.0000
s22	-0.2555	-0.1194	-2.7630	2.1400	0.0925	-0.0587	2.4390	-0.5620	0.0000

Table 4. Risk and performance of sectors before COVID-19.

Sector	Mean	Sharp ratio	Treynor	SD	BETA	ES	Kurtuisis	Skewness	Median
s1	-0.0946	-0.0502	-0.1833	1.8830	0.5158	-0.0485	4.2792	-0.7283	0.0000
s2	0.0415	0.0285	0.0595	1.4557	0.6967	-0.0352	5.8351	-0.6683	0.0000
s3	0.0837	0.0548	0.0985	1.5266	0.8505	-0.0362	5.1828	-0.8736	0.1337
s4	0.0194	0.0168	0.0215	1.1543	0.9053	-0.0287	10.7454	-1.1681	0.0037
s5	0.0284	0.0276	0.0447	1.0259	0.6344	-0.0280	13.6971	-1.7441	0.0292
s6	-0.0238	-0.0227	-0.0270	1.0505	0.8837	-0.0271	22.0853	-1.7643	0.0000
s7	-0.0030	-0.0025	-0.0026	1.2038	1.1718	-0.0320	18.5008	-1.9715	0.0467
s8	0.0709	0.0585	0.0980	1.2128	0.7233	-0.0313	5.2935	-0.4778	0.0225
s9	0.0365	0.0178	0.0324	2.0589	1.1271	-0.0457	2.2348	-0.2220	-0.0502
s10	0.0918	0.0478	0.1315	1.9211	0.6982	-0.0462	2.7727	-0.8604	0.0009
s11	-0.0463	-0.0268	-0.0704	1.7251	0.6578	-0.0440	3.5792	-0.5171	0.0000
s12	0.2634	0.2250	7.1513	1.1707	0.0368	-0.0264	3.1975	0.2836	0.0000
s13	0.0496	0.0381	0.0736	1.3043	0.6745	-0.0335	4.3899	-0.9455	0.0118
s14	0.0850	0.0624	0.0910	1.3610	0.9339	-0.0343	13.6121	-1.8828	0.0265
s15	0.0623	0.0241	0.1733	2.5823	0.3596	-0.0557	0.5190	-0.3999	0.0000
s16	-0.0009	-0.0007	-0.0013	1.4071	0.7149	-0.0390	10.1749	-1.0470	0.0000
s17	0.0535	0.0332	0.0423	1.6121	1.2634	-0.0431	10.1957	-1.4877	0.0181
s18	-0.0424	-0.0213	-0.0441	1.9883	0.9622	-0.0504	3.5601	-0.8350	0.0000
s19	0.0111	0.0079	0.0092	1.4141	1.2009	-0.0385	8.9419	-1.4279	0.0429
s20	-0.0881	-0.0403	-0.1666	2.1835	0.5285	-0.0491	2.1127	-0.4207	0.0000
s21	-0.0179	-0.0184	-0.0525	0.9721	0.3401	-0.0233	4.5795	-0.7213	0.0000
s22	0.2580	0.1159	0.7850	2.2253	0.3286	-0.0451	0.2002	-0.0370	0.0000

The tabulated data (Table 3,4) provides a comprehensive insight into the diverse repercussions of the COVID-19 pandemic on various sectors, unveiling a clear dichotomy through performance measures. Evidently, eleven sectors (s1, s4, s6, s7, s11, s14, s16, s17, s18, s20, s21) grappled with adverse effects, typified by s1's substantial decline in mean from -0.0251 to -0.0946, Sharp ratio from -0.0120 to -0.0502, and Treynor ratio from -0.0429 to -0.1833. Conversely, an opposing trend emerged among eleven other sectors (s2, s3, s5, s8, s9, s10, s12, s13, s15, s19, s22), showcasing positive effects attributed to the pandemic. For instance, s2 demonstrated an upswing in mean from 0.0257 to 0.0415, Sharp ratio from 0.0166 to 0.0285, and Treynor ratio from 0.0401 to 0.0595. An alternative perspective, considering risk measures, elucidates the pandemic's influence on sectoral risk profiles. Positive impacts are discernible across 11 sectors (s1, s2, s3, s6, s7, s9, s11, s14, s17, s18, s19), as exemplified by s1's marked reduction in standard deviation from 2.0881 to 1.8830, a decrease in beta from 0.5863 to 0.5158, and a shift in expected shortfall from -0.0564 to -0.0485. In contrast, 11 sectors (s4, s5, s8, s10, s12, s13, s15, s16, s20, s21, s22) experience adverse risk dynamics, illustrated by s5's substantial increase in standard deviation from 1.0259 to 1.5134, a rise in beta from 0.4344 to 0.9485, and an escalation of expected shortfall from -0.0280 to -0.0399. These nuanced observations underscore the sector-specific impacts of the COVID-19 pandemic on financial performance, highlighting both positive and negative dimensions across the diverse spectrum of sectors.

3.4. Correlation between Sectors

Moreover, the data presented in Tables 5 and 6 demonstrates a noteworthy surge in the correlation of returns amid the COVID-19 period. Prior to the onset of the pandemic, the correlation coefficient remained below 30%. However, during the COVID-19 period, the correlation coefficient among certain sectors soared, reaching as high as 72%. This substantial increase in correlation suggests a heightened level of interdependence among sectors during the pandemic. As a consequence, investors encountered a scenario with fewer opportunities for effective diversification, exposing them to elevated levels of risk. The surge in correlation during this period underscores the challenges faced by investors in maintaining a diversified portfolio, further emphasizing the intricate and interconnected dynamics prevalent in the financial landscape during the COVID-19 crisis.

Table 5. Correlation between sectors before COVID 19.

Sector	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11
s1	1.000	-0.078	0.070	0.074	0.097	0.067	0.001	0.145	0.058	-0.016	0.016
s2	-0.078	1.000	0.035	0.078	0.098	0.123	0.141	0.016	0.033	0.059	0.026
s3	0.070	0.035	1.000	0.078	0.078	0.081	0.160	0.086	0.105	0.079	0.028
s4	0.074	0.078	0.078	1.000	0.108	0.097	0.229	0.148	0.144	0.125	0.017
s5	0.097	0.098	0.078	0.108	1.000	0.115	0.089	0.107	0.093	0.008	-0.003
s6	0.067	0.123	0.081	0.097	0.115	1.000	0.295	0.075	0.155	0.084	-0.019
s7	0.001	0.141	0.160	0.229	0.089	0.295	1.000	0.078	0.141	0.136	-0.032
s8	0.145	0.016	0.086	0.148	0.107	0.075	0.078	1.000	0.132	0.030	-0.026
s9	0.058	0.033	0.105	0.144	0.093	0.155	0.141	0.132	1.000	0.121	0.056
s10	-0.016	0.059	0.079	0.125	0.008	0.084	0.136	0.030	0.121	1.000	0.072
s11	0.016	0.026	0.028	0.017	-0.003	-0.019	-0.032	-0.026	0.056	0.072	1.000
s12	-0.006	0.048	0.009	0.037	-0.036	-0.017	0.022	0.003	0.029	0.046	0.109
s13	0.169	0.036	0.121	0.173	0.058	0.049	0.075	0.147	0.128	0.100	-0.027
s14	0.118	0.050	0.115	0.028	0.110	0.110	0.091	0.080	0.109	0.046	0.061
s15	0.062	0.013	0.019	0.037	0.060	0.023	0.018	0.017	0.090	0.088	0.004
s16	0.075	0.034	0.030	0.070	0.107	0.056	0.077	0.055	0.025	0.066	0.068
s17	0.121	0.021	0.111	0.256	0.049	0.218	0.213	0.132	0.142	0.124	-0.009

Sector	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11
s18	0.074	0.035	0.123	0.093	0.144	0.094	0.042	0.149	0.126	0.055	0.021
s19	0.074	0.066	0.078	0.169	0.160	0.159	0.235	0.122	0.121	0.089	0.015
s20	-0.011	-0.020	0.080	0.108	0.041	0.063	0.096	0.032	0.089	0.077	0.075
s21	0.099	-0.023	0.096	0.150	0.045	-0.031	0.077	0.042	0.088	0.048	0.045
s22	0.013	-0.085	0.109	0.012	0.020	-0.005	0.008	0.025	0.048	0.036	0.016
Sector	s12	s13	s14	s15	s16	s17	s18	s19	s20	s21	s22
s1	-0.006	0.169	0.118	0.062	0.075	0.121	0.074	0.074	-0.011	0.099	0.013
s2	0.048	0.036	0.050	0.013	0.034	0.021	0.035	0.066	-0.020	-0.023	-0.085
s3	0.009	0.121	0.115	0.019	0.030	0.111	0.123	0.078	0.080	0.096	0.109
s4	0.037	0.173	0.028	0.037	0.070	0.256	0.093	0.169	0.108	0.150	0.012
s5	-0.036	0.058	0.110	0.060	0.107	0.049	0.144	0.160	0.041	0.045	0.020
s6	-0.017	0.049	0.110	0.023	0.056	0.218	0.094	0.159	0.063	-0.031	-0.005
s7	0.022	0.075	0.091	0.018	0.077	0.213	0.042	0.235	0.096	0.077	0.008
s8	0.003	0.147	0.080	0.017	0.055	0.132	0.149	0.122	0.032	0.042	0.025
s9	0.029	0.128	0.109	0.090	0.025	0.142	0.126	0.121	0.089	0.088	0.048
s10	0.046	0.100	0.046	0.088	0.066	0.124	0.055	0.089	0.077	0.048	0.036
s11	0.109	-0.027	0.061	0.004	0.068	-0.009	0.021	0.015	0.075	0.045	0.016
s12	1.000	-0.052	0.010	0.005	-0.020	-0.003	0.004	0.029	-0.035	0.032	-0.057
s13	-0.052	1.000	0.078	0.039	0.143	0.172	0.105	0.073	0.061	0.084	0.023
s14	0.010	0.078	1.000	0.050	0.156	0.069	0.079	0.126	0.056	0.058	0.100
s15	0.005	0.039	0.050	1.000	0.044	-0.005	-0.024	0.055	-0.024	-0.056	-0.004
s16	-0.020	0.143	0.156	0.044	1.000	0.108	-0.015	0.106	0.041	0.049	0.058
s17	-0.003	0.172	0.069	-0.005	0.108	1.000	0.048	0.175	0.123	0.047	0.000
s18	0.004	0.105	0.079	-0.024	-0.015	0.048	1.000	0.086	0.112	0.111	0.100
s19	0.029	0.073	0.126	0.055	0.106	0.175	0.086	1.000	0.095	0.049	-0.007
s20	-0.035	0.061	0.056	-0.024	0.041	0.123	0.112	0.095	1.000	0.029	0.057
s21	0.032	0.084	0.058	-0.056	0.049	0.047	0.111	0.049	0.029	1.000	0.108
s22	-0.057	0.023	0.100	-0.004	0.058	0.000	0.100	-0.007	0.057	0.108	1.000

Table 6. Correlation between sectors during COVID 19.

Sector	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11
s1	1.000	0.084	0.187	0.223	0.205	0.189	0.225	0.220	0.179	0.168	0.061
s2	0.084	1.000	0.323	0.350	0.304	0.381	0.403	0.257	0.226	0.241	0.172
s3	0.187	0.323	1.000	0.386	0.301	0.408	0.489	0.283	0.293	0.188	0.282
s4	0.223	0.350	0.386	1.000	0.443	0.567	0.675	0.435	0.426	0.319	0.253
s5	0.205	0.304	0.301	0.443	1.000	0.482	0.529	0.380	0.275	0.287	0.251
s6	0.189	0.381	0.408	0.567	0.482	1.000	0.717	0.403	0.401	0.290	0.273
s7	0.225	0.403	0.489	0.675	0.529	0.717	1.000	0.524	0.488	0.302	0.351
s8	0.220	0.257	0.283	0.435	0.380	0.403	0.524	1.000	0.324	0.251	0.178
s9	0.179	0.226	0.293	0.426	0.275	0.401	0.488	0.324	1.000	0.278	0.282
s10	0.168	0.241	0.188	0.319	0.287	0.290	0.302	0.251	0.278	1.000	0.096
s11	0.061	0.172	0.282	0.253	0.251	0.273	0.351	0.178	0.282	0.096	1.000
s12	0.009	0.004	0.007	0.029	-0.016	0.027	0.009	0.049	0.021	-0.052	0.002
s13	0.150	0.209	0.279	0.372	0.361	0.315	0.440	0.323	0.244	0.184	0.235
s14	0.258	0.282	0.390	0.529	0.439	0.507	0.586	0.443	0.414	0.305	0.308
s15	0.110	0.113	0.061	0.131	0.163	0.123	0.104	0.093	0.203	0.155	0.025
s16	0.202	0.231	0.292	0.397	0.297	0.340	0.466	0.368	0.272	0.247	0.255
s17	0.267	0.400	0.428	0.582	0.425	0.641	0.682	0.411	0.420	0.239	0.265
s18	0.192	0.243	0.262	0.346	0.313	0.357	0.442	0.240	0.243	0.249	0.185
s19	0.187	0.323	0.419	0.593	0.459	0.586	0.721	0.438	0.420	0.235	0.309
s20	0.131	0.126	0.157	0.211	0.194	0.170	0.190	0.111	0.217	0.174	0.191
s21	0.111	0.140	0.222	0.266	0.227	0.247	0.316	0.188	0.199	0.164	0.131
s22	0.058	0.088	0.095	0.100	0.123	0.081	0.136	0.067	0.053	0.043	-0.005
Sector	s12	s13	s14	s15	s16	s17	s18	s19	s20	s21	s22
s1	0.009	0.150	0.258	0.110	0.202	0.267	0.192	0.187	0.131	0.111	0.058
s2	0.004	0.209	0.282	0.113	0.231	0.400	0.243	0.323	0.126	0.140	0.088
s3	0.007	0.279	0.390	0.061	0.292	0.428	0.262	0.419	0.157	0.222	0.095
s4	0.029	0.372	0.529	0.131	0.397	0.582	0.346	0.593	0.211	0.266	0.100
s5	-0.016	0.361	0.439	0.163	0.297	0.425	0.313	0.459	0.194	0.227	0.123
s6	0.027	0.315	0.507	0.123	0.340	0.641	0.357	0.586	0.170	0.247	0.081
s7	0.009	0.440	0.586	0.104	0.466	0.682	0.442	0.721	0.190	0.316	0.136
s8	0.049	0.323	0.443	0.093	0.368	0.411	0.240	0.438	0.111	0.188	0.067
s9	0.021	0.244	0.414	0.203	0.272	0.420	0.243	0.420	0.217	0.199	0.053
s10	-0.052	0.184	0.305	0.155	0.247	0.239	0.249	0.235	0.174	0.164	0.043
s11	0.002	0.235	0.308	0.025	0.255	0.265	0.185	0.309	0.191	0.131	-0.005
s12	1.000	-0.018	0.016	-0.060	0.016	0.024	-0.013	0.035	0.029	-0.005	-0.002
s13	-0.018	1.000	0.396	0.095	0.275	0.317	0.233	0.395	0.159	0.186	0.149
s14	0.016	0.396	1.000	0.113	0.388	0.516	0.383	0.534	0.209	0.271	0.067
s15	-0.060	0.095	0.113	1.000	0.077	0.064	0.050	0.083	0.115	0.126	0.191
s16	0.016	0.275	0.388	0.077	1.000	0.332	0.250	0.362	0.221	0.250	0.058
s17	0.024	0.317	0.516	0.064	0.332	1.000	0.391	0.593	0.140	0.254	0.112
s18	-0.013	0.233	0.383	0.050	0.250	0.391	1.000	0.376	0.089	0.182	0.031
s19	0.035	0.395	0.534	0.083	0.362	0.593	0.376	1.000	0.212	0.261	0.127
s20	0.029	0.159	0.209	0.115	0.221	0.140	0.089	0.212	1.000	0.121	0.071
s21	-0.005	0.186	0.271	0.126	0.250	0.254	0.182	0.261	0.121	1.000	0.113
s22	-0.002	0.149	0.067	0.191	0.058	0.112	0.031	0.127	0.071	0.113	1.000

4. Conclusion

In conclusion, our investigation into the impact of COVID-19 on the Moroccan stock market, focusing on the MASI index and sectoral indices, reveals nuanced dynamics and sector specific vulnerabilities. The delineation of the pre-COVID and during-COVID periods provides a comprehensive understanding of the market's evolution, marked by distinctive phases and fluctuations. Analyzing the MASI index, we observed a significant drop in March 2020, reflective of the pandemic's disruptive influence on investor behavior and economic activities. Nevertheless, the market displayed resilience, swiftly recovering and even surpassing pre-crisis levels by the end of 2020. This remarkable rebound can be attributed to various factors, including historically low bond yields, the initiation of vaccination campaigns, and the resumption of dividend payouts by the banking sector. Examining individual sectors, our findings exhibit a dichotomy in performance and risk. Also, we found a significant increase in correlations between sectoral returns during the COVID-19 period. The interconnectedness among sectors heightened, limiting diversification choices for investors and exposing them to increased risks. Moreover, the analysis of volatility patterns emphasizes the MASI index's dynamic nature, showcasing stability in the pre-pandemic phase and a transient disturbance during the initial pandemic shock. Our study contributes to the theoretical and empirical literature on the global financial impact of COVID-19, offering insights into the Moroccan context. The findings underscore the importance of understanding sector-specific vulnerabilities and market dynamics for investors and policymakers. As the world continues to navigate the uncertainties of the post-pandemic era, these insights provide valuable perspectives for market participants to make informed decisions and adapt strategies in an ever-evolving financial landscape.

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