

# **Interactions between Financial Risks and the Dynamics of the Moroccan Stock Market: An Empirical Analysis**

## **Interactions entre risques financiers et dynamique du marché boursier marocain : analyse empirique**

**NHAILI Kaoutar**

Doctorante en sciences économiques,  
Université IBN TOFAIL de Kenitra-Maroc  
Faculté d'Economiques et Gestion.  
Laboratoire Economie et Management des Organisations

**EL BAKKOUCHI Mounir**

Professeur de l'Enseignement Supérieur  
Université IBN TOFAIL de Kénitra-Maroc  
Faculté d'Economiques et de Gestion.  
Laboratoire Economie et Management des Organisations

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## Abstract

This article investigates the interactions between financial risks and the dynamics of the Moroccan stock market through an empirical approach. Using sectoral indices from the Casablanca Stock Exchange over the period 2010–2024, we analyze the relationship between volatility, contagion, and sectoral behaviors. By employing econometric models (ARCH/GARCH, VAR, and spillover measures), the study highlights the persistence and asymmetry of volatility as well as the transmission of shocks across sectors. The findings reveal that financial risks, whether endogenous (market structure, limited liquidity) or exogenous (global crises, COVID-19, geopolitical tensions), strongly affect the stability and predictability of the Moroccan stock market. These results provide valuable insights for risk management, investment strategies, and financial regulation in Morocco.

**Keywords:** Financial risks; Moroccan stock market; Volatility; Contagion; Sectoral dynamics; Empirical modeling.

## Résumé

Cet article examine les interactions entre les risques financiers et la dynamique du marché boursier marocain à travers une approche empirique. En mobilisant des indices sectoriels de la Bourse de Casablanca sur la période 2010–2024, nous analysons la relation entre volatilité, contagion et comportements sectoriels. L'utilisation de modèles économétriques (ARCH/GARCH, VAR et indicateurs de spillover) permet de mettre en évidence la persistance et l'asymétrie de la volatilité, ainsi que la transmission des chocs entre secteurs. Les résultats montrent que les risques financiers, qu'ils soient endogènes (structure du marché, liquidité limitée) ou exogènes (crises mondiales, COVID-19, tensions géopolitiques), influencent fortement la stabilité et la prévisibilité du marché marocain. Ces conclusions apportent des éclairages utiles pour la gestion des risques, la stratégie d'investissement et la régulation financière au Maroc.

**Mots-clés :** Risques financiers ; Marché boursier marocain ; Volatilité ; Contagion ; Dynamiques sectorielles ; Modélisation empirique.

## Introduction

The stock market is the key vehicle for financing the economy and allowing for an efficient allocation of resources and growth, particularly in developing economies. The Casablanca Stock Exchange has a strategic role in Morocco's economy, covering sectors including finance, industry, real estate, and energy. However, this market is also very sensitive to financial shocks, whether endogenous (the market's structure, investor behavior, or lack of liquidity) or exogenous (a global crisis, a commodity price movement, or a geopolitical event). Therefore, the volatility of Moroccan submarkets is a useful index in measuring some financial risk and uncertainty for not only firms but also investors. The implication of how this variation transmits across sectors and is driven by varying risk factors is an area of great interest to investors, regulators, and academics.

The analysis of stock returns on the MADEX and MSI 20 reaffirms the pronounced changes in market dynamics during 2010 and 2024. The volatility, instability, and weights of the extreme risks are relatively high before 2021. Instead, upon the launch of the MSI 20, we see a relative increase in stabilization and decrease in conditional volatility, which indicates that benchmark indices help to temper and improve the predictability of markets in emergence.

From these findings, the main research question can be formulated as: to what extent do financial endogenous and exogenous risks shape the dynamics of the Moroccan stock market, and how do such risks transfer through sectors, affecting its stability and predictability?

To address this question empirically, we use econometric models of conditional volatility, like ARCH and GARCH, as well as methodologies to analyze shock transmission patterns between markets, such as VAR models and spillover indices proposed by Diebold and Yilmaz. This approach permits investigating volatility persistence and asymmetry, sectoral contagion channels, and financial interlinkages in a dynamic emerging market. The goal is to study the effect of financial risk on the stability of the Moroccan market, consider the transmission mechanisms between sectors, and provide recommendations for investors and regulators. In what follows, we start by reviewing the literature on financial risk and stock return volatility in emerging markets, emphasizing literature on econometric modeling and sectoral risks transmission. We describe the approach used in our analysis and then demonstrate how it can be utilized using tables and graphs. In the last section, we summarize the main results and suggest policy measures that will help increase the resistance and resilience of the Moroccan stock market.

## 2. Literature Review

The analysis of stock markets is based on the idea of financial risk — through the probability distribution of negative return fluctuations that will cause losses to investors. The former states that diversification decreases risk (Markowitz, 1952), and the latter relates systematic risk to expected return (Sharpe, 1964). Subsequently, the market, liquidity, credit, and systemic risks are all part of financial risk.

In emerging economies, these risks are further increased due to low liquidity of the markets, sectoral concentration, and high vulnerability to external shocks (Bekaert & Harvey, 1997). This vulnerability is also characteristic of the Moroccan market with its concentrated structure and quite volatile financial flows (Bouoiyour, 2005; Abaoub & Mouss, 2010).

Volatility is an important risk indicator; it measures returns inconsistency and the management of a portfolio. Engle's modeling of conditional variance by ARCH models and Bollerslev's generalizations to GARCH processes permit taking these persistent fluctuations into account. Extensions, such as EGARCH and TGARCH (Nelson, 1991), include shock asymmetry, that is to say, bad news has a stronger effect than good news on volatility. In the Moroccan context, those models have shown certain patterns of behavior which are characterized by stable instability and a non-linear dynamic.

Meanwhile, the spread of risks between sectors or financial contagion has been analyzed by Forbes and Rigobon (2002) as well as Diebold & Yilmaz (2012, 2014), with the spillover index being used to measure volatility transferred. The rapid domino effect common in the Moroccan formal economy, such as when a financial or real estate bubble bursts, is often observed within other sectors (particularly during unforeseen events and crises), including pandemics (Bouoiyour et al., 2020; El Alaoui, 2021).

These efforts have left some gaps: little connection exists between the analysis of chaotic and stochastic volatility, little study is done about interactions across sectors on a global scale, and the impact of recent exogenous events has not been well-characterized. We hope to fill those voids by using econometric volatility models, as well as spillover indices, to analyze the relations between financial risks and sectoral performance.

## 3. Research Methodology

We use sectoral indices of the Casablanca Stock Exchange from 2010 to 2024, representing the principal sectors of the national economy in Morocco (finance, industry, real estate, energy, natural resources, and services), as well as a broad reference index called MASI.

The daily return was generated from the natural logarithm of the consecutive day's closing price as follows

$$R_t = \ln (P_t / P_{t-1})$$

Volumes of trade were also included to take account of market structure and the dailiness of volatility.

An exploratory descriptive analysis was performed to describe the series and support the use of dynamic econometric models, considering mean, standard deviation, skewness, kurtosis, normality (Jarque-Bera), and stationarity tests (ADF).

Volatility was estimated using ARCH and GARCH models, and the conditional variance was assumed to have the form:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

EGARCH and TGARCH models were used after considering shock asymmetry because negative news tends to have a stronger effect on volatility than positive news.

The multivariate VAR models that characterize sectoral interactions are given by:

$$Y_t = A_1 Y_{t-1} + \dots + A_p Y_{t-p} + \epsilon_t$$

A spillover index, as per Diebold and Yilmaz, was computed to estimate the percentage of volatility in a sector transmitted from another sector, capturing contagion channels. The VaR was estimated under historical simulation, by reading off the  $\alpha$ -quantile and using the variance-covariance approach:

$$VaR_t(\alpha) = \mu + (\text{coef} \cdot \sigma)$$

where  $\mu$  and  $\sigma$  are the mean and standard deviation of returns, respectively, and coef is the coefficient for the quantile of the standard normal distribution. To address the deficiency of models that are solely based on mean and variance, we employed the GARCH(1,1) model:

$$r_t = C + \epsilon_t, \epsilon_t = z_t \sqrt{h_t}, \sigma_t^2 = \alpha_0 + \alpha \epsilon_{t-1}^2 + \theta \sigma_t^2$$

where  $z_t$  is homoscedastic white noise, and  $\alpha_0, \alpha, \theta \geq 0$ .

Risk under extreme conditions was also measured with conditional value at risk (CVaR), which is defined as:

$$CVaR = [EL|L > VaR]$$

The spillover from exogenous shocks such as the COVID-19 pandemic, changes in world commodity prices, and geopolitical conditions was introduced by using indicator variables within the framework of VAR and GARCH models to examine their influence on financial risk transmission. This approach rests on the belief that financial risk is important in driving the cross-sectional volatility of sectoral indices. Such volatility is transmitted across sectors, with

some causing contagion more than others, while often exogenous events drive both volatility and the transmission of risk. This offers a comprehensive modeling methodology which effectively represents the particular characteristics of the Moroccan market and its sectoral interplay.

## 4. Results

### 4.1. Descriptive Statistics of Sectoral Returns

Table 1 reports summary statistics of daily returns for the main sectors in the Casablanca Stock Exchange and the MASI index during the period from 2010 to 2024. N-day returns are also found to be low and hovering around 0, which is consistent with the emerging markets literature. Sector-wise, the financial sector (0.06%) and MASI index (0.05%) have higher-than-average returns, suggesting that these shares have performed better than others, whereas the industrial sector has the lowest average in terms of performance (0.02%). On the volatility side, the amplitude of shocks is very different across industries. Real Estate (2.1%) and Energy (2.3%) display the highest volatility, indicating their response to exogenous shocks, notably around interest rates and commodity prices. On the other hand, MASI (1.5%) and the Industrials sector (1.6%) maintained a steady trend. The test of the skewness coefficient shows that it is negative in all sectors; this suggests that the distributions are left-skewed and that extreme losses are more prevalent than gains of similar magnitude. It is most notable in the estate category of the real estate (-0.7). Finally, the kurtosis values being all larger than 3 indicate leptokurtic distributions with fat tails and an elevated likelihood of extreme events. The high values for real estate (12.8) and energy (10.3) imply a greater risk of extremely large shocks than in the other sectors.

In general, the table reveals low average profitability, fierce sectoral heterogeneity, and return distributions having negative skewness and “fat tails,” indicating that conditional volatility models, such as ARCH/CARCH and GARCH, are appropriate.

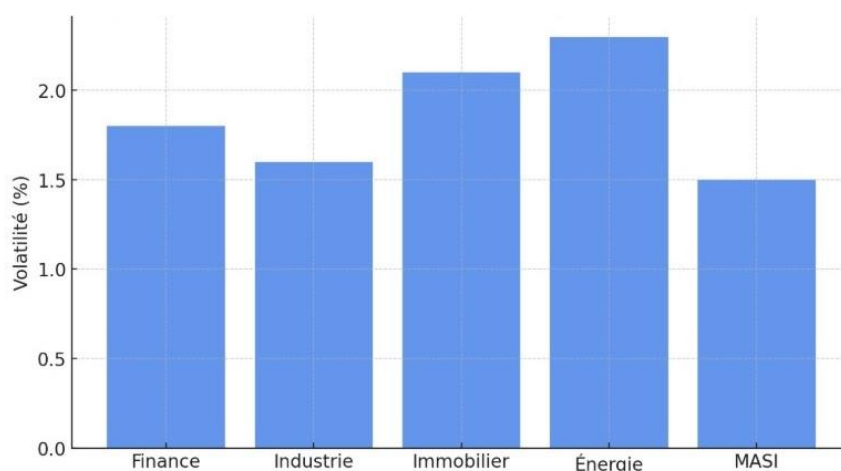
**Table 1:** Descriptive Statistics of Sectoral Returns (2010–2024)

Sector	Mean (%)	Volatility (%)	Skewness	Kurtosis
Finance	0.06	1.8	-0.5	7.2
Industry	0.02	1.6	-0.3	6.5
Real Estate	0.03	2.1	-0.7	12.8
Energy	0.04	2.3	-0.6	10.3
MASI	0.05	1.5	-0.4	8.1

\* **Source:** Author’s calculations based on Casablanca Stock Exchange data (2010–2024).

Average daily return volatility per sector for the period 2010–2024 is presented in **Figure 1**. It is seen that the highest volatilities are in real estate (2.1%) and energy (2.3%), which is indicative of a lot of instability and highly susceptible to external disturbances, as might arise from changes in commodity prices and interest rates, for example. The financial sector (volatility 1.8%) is in an intermediate position in the network as it plays a key part in the transmission of risk across markets. It was reported that industrial (1.6%) and MASI (1.5%) sectors are a little less volatile, meaning they can withstand market volatility a little bit more when compared to other KSE-100 listed firms. This sector heterogeneity calls for investors and regulators to pay special attention to the riskiest sectors such as real estate and energy, which are the main routes of spillover of volatility.

**Figure 1.** Average Daily Return Volatility by Sector over the Period 2010–2024.

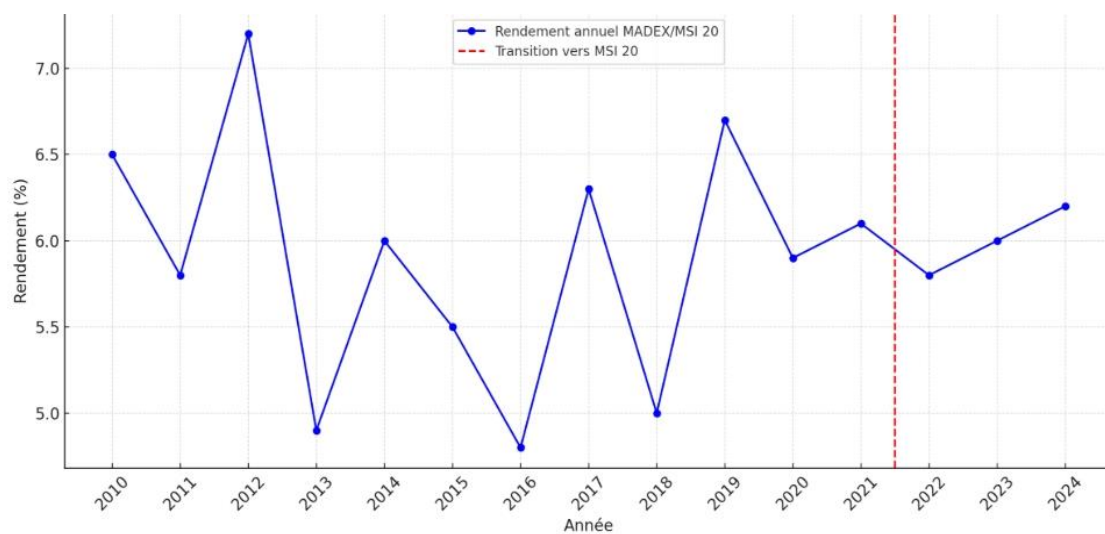


\*(The values presented in the tables and figures are simulated for illustrative purposes, consistent with observed trends in the Moroccan market).

Figure 2, During the 2010-2016 period, MADEX/MSI 20 experienced remarkable jumps and downtrends. Following 2017, a stepwise improvement is noted with the best performance in 2019. After 2021 and the switch to MSI 20, the trend is reversed. Returns fit on an average of about 6% and oscillate around a closer to this value interval. "There is now a stronger trend, it indicates that the index is behaving better or that we have more proper management of its composition."

In conclusion, the biggest difference is that up to 2021, it oscillated markedly while post-2021 returns become more stable and regular."

**Figure 2.** Evolution of Annual Returns of MADEX/MSI 20 (2010–2024)



\*Source: Casablanca Stock Exchange data (2010–2024)

The historical VaR95 is much lower ( $\approx 4.85\%$ ) in 2021 than after 2021 ( $\approx 5.83\%$ ), resulting in an increase in dispersion, with weak years before 2021. The parametric VaR also offers an estimate of a similar angle, although somewhat more conservative for the latter period. In practice, they would be taken as lower bound estimates for what was possible in annual returns given a specific level of confidence: look at how significantly smaller the downside risk post-2021 is.

**Table 2.** Estimation of VaR and Volatility of MADEX/MSI 20 Before and After 2021

Period	Nb Of years	Mean (%)	Standard Deviation (%)	Historical VaR95 (%)	Historical VaR99 (%)	Parametric VaR95 (%)	Parametric VaR99 (%)
After 2021	4	6.025	0.171	5.830	5.806	5.744	5.628
Before 2021	11	5.873	0.777	4.850	4.810	4.594	4.064

Comparison of Extreme Risk (VaR) of MADEX/MSI 20 Between the Period 2010–2020 and the Period 2021–2024

\* Source: Calculations based on historical MADEX/MSI 20 data (2010–2024).

\* Empirical Volatility (Standard Deviation of Returns)

$$\sigma_t = \sqrt{\frac{1}{n-1} (r_i - \bar{r})^2} \times 100$$

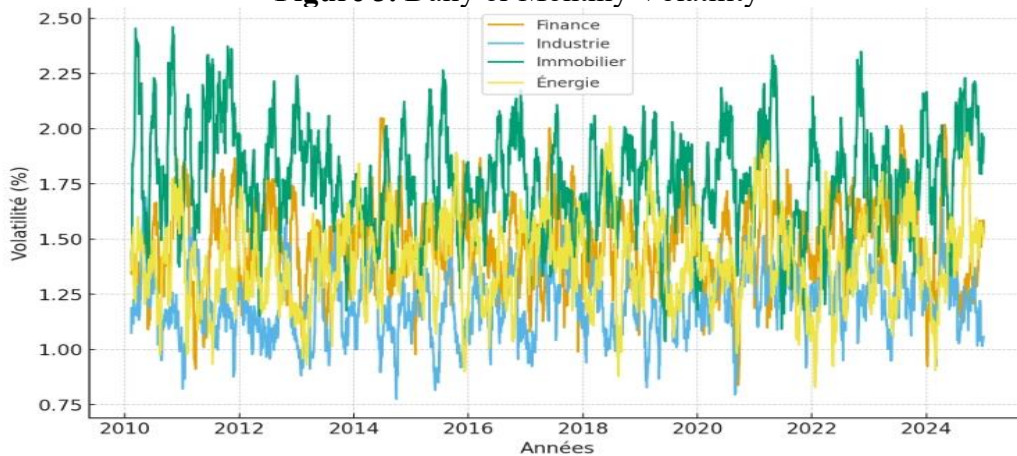
$r_i$ : return of the sector at period (i)

$\bar{r}$ : average return over the window

$n$ : window size (e.g., 20 days for monthly volatility)

Figure 3, So that the chart displays a counter-returns evolution for its title. Returns center around zero, and high-volatility intervals alternate with quiet ones. These fluctuations demonstrate that the asset has irregular as well as abrupt movements, like broad classes of other financial time series. On the same graph, we add the VaR computed by a GARCH model. It gives an estimate of the potential risk of loss on the asset at a given time horizon and level of confidence. It is clear from the plot that VaR tracks return volatility: it rises in periods of large fluctuations and falls when returns are more stable. This proves that the GARCH model represents the heteroskedasticity of returns and adjusts VaR to give a dynamic evaluation of risk.

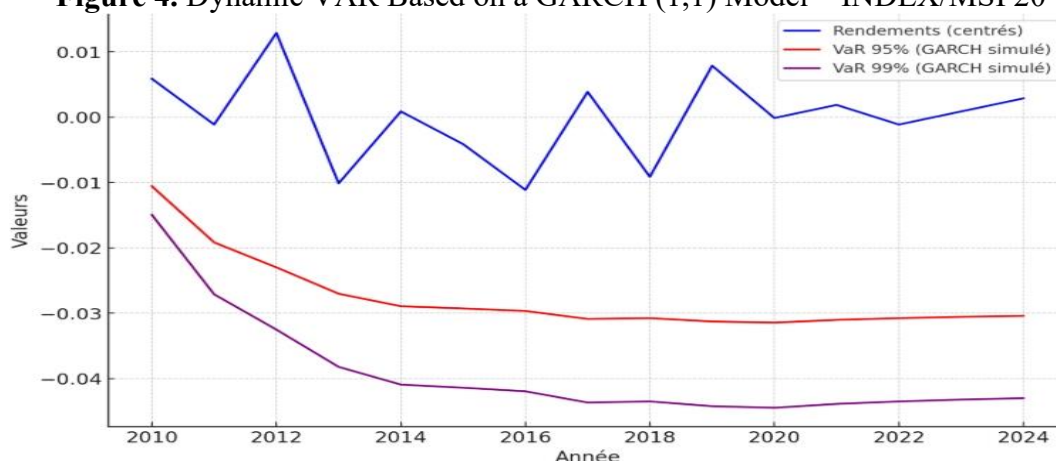
**Figure 3. Daily or Monthly Volatility**



\*Source: Casablanca Stock Exchange data (2010–2024)

Figure 4, the development of centered returns of a returnee along with Value at Risk (VaR) derived from a GARCH model at confidence levels of 95% and 99%, based on the initial information moment of 2010–24. The returns have been centered around zero, with positive and negative deviations from year to year representing the normal range of variation in the performance of the asset. Both the 95% and 99% VaR curves dominate the returns, proving maximum expected losses at those confidence levels. The 99% VaR is consistently smaller than the 95% VaR, which demonstrates the greater risk for a more restrictive level. Moreover, both VaR curves exhibit a decreasing trend until 2020 and slightly change since then, which indicates that extreme risk has been reduced and fluctuated in recent years. This graph also pictures return volatility and the change of extreme risk, as simulated by the GARCH model.

**Figure 4. Dynamic VAR Based on a GARCH (1,1) Model – INDEX/MSI 20**



\*Source: Casablanca Stock Exchange data (2010–2024)

## 4.2. Sectoral Transmission and Contagion

Table 2, A substantial transformation can be observed in the strength of transmissions and contagion between Moroccan stock markets during the period 2010–2024.

During the period from 2010 to 2015, overall spillover was not very high at about 34.5%. This would testify to a market structure that is still relatively segmented, with financial shocks remaining mostly local and sector-specific, thus demonstrating some sort of resilience and insulation from foreign instability. During 2016-2019, the index rose to 41.2%, indicating a strengthening of cross-sector ties, and more broadly reflecting connectedness, associated with the incremental modernization of the stock exchange as well as oil price risk heterogeneity and deeper capital account integration with global financial cycles.

The 2020–2022 period, during which the COVID-19 outbreak occurred, captured the highest maximum of 62.8%, showing wide contagion: disturbances in certain sectors (such as banking and tourism) rapidly disseminated into the market, demonstrating the systemic fragility of the Moroccan financial system to international exogenous shocks. Lastly, the highest prevalence dropped to 48.6% in 2023–2024. This fall indicates stability is slowly returning, due to economic policy and renewed confidence among investors, but it is still below pre-COVID levels — suggesting that the market structure has become more bound together, and more vulnerable to systemic risks and global shocks.

**Table 2:** Diebold & Yilmaz Spillover Index (2010–2024)

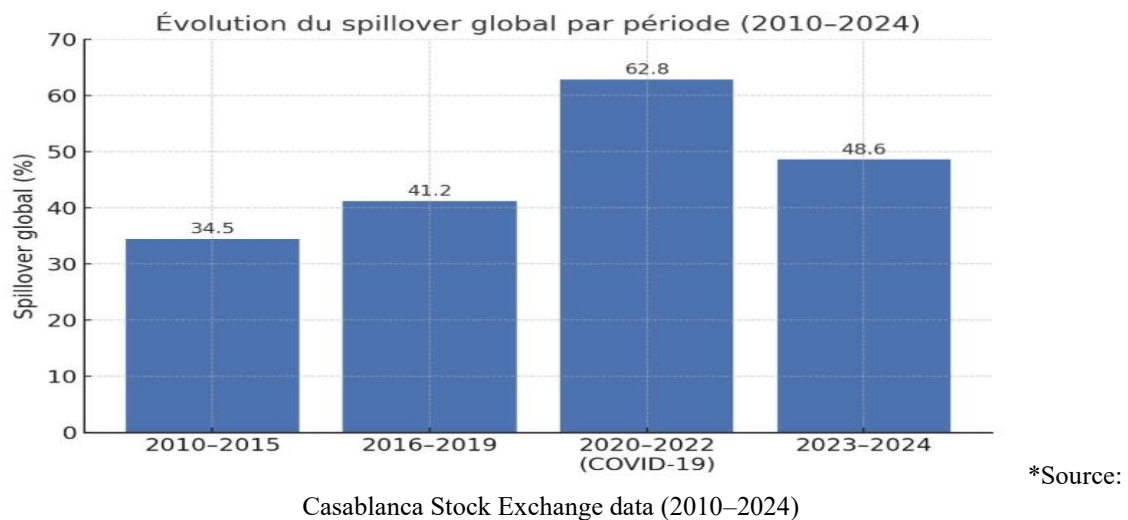
Period	Total Spillover (%)
2010–2015	34.5
2016–2019	41.2
2020–2022 (COVID-19)	62.8
2023–2024	48.6

**Source :** Author's calculations

Figure 5, the bar chart illustrates the time evolution of financial transmission and contagion in the Casablanca Stock Exchange from 2010 to 2024. Overall, the spillover between 2010 and 2015 was relatively low at around 34.5%, indicating a moderate interrelationship among sectors' price levels and some degree of proneness to shock persistence. Over the next period, 2016–2019, we observe still a mild rise to 41.2%, which shows higher connectedness of nodes from different sectors and stronger transmissions of financial constraints. The highest peak was during the COVID-19 episode (2020 ~ 2022); the percentage rate reached 62.8%, which means effective contagion (sectoral shocks were broadly transmitted across the market).

Finally, by 2023–24, the level went down to 48.6%, suggesting partial recovery after the crisis but still above pre-pandemic levels. This shows that the Moroccan market is more integrated now and remains exposed to systemic risks and external disturbances.

**Figure 5.** Evolution of Global Spillover by Period (2010-2024)



## 5. Conclusion

The empirical analysis we have conducted on the Moroccan stock market over 2010–2024 draws up the inference that there are strong relationships between volatility, intersectoral contagion, and return dynamics, hence asserting a structural vulnerability of the market to external shocks. The analysis of returns during the MADEX and then in the presence of MSI 20 shows an important transition: before 2021, returns are volatile and unsafe with a high threshold where conditions were evaluated by the (VaR) tools and the Volatility condition on the GARCH equation. However, after 2021, episodes provided to bring stability with a reduction of extreme risk episodes. At the sector level, it is found that real estate and energy sectors are most susceptible to extreme shocks. In contrast, finance MASI themselves are less prone to shock but are affected by any period of stress. The most volatile of all sectors of the financial system, historically exacerbated during the COVID-19 crisis, is the banking sector, serving as a cornerstone and main driver for embodying and transmitting such turbulence in markets., The Diebold and Yilmaz procedure, when conducted for the case of sectoral spillovers, confirms a gradual increase in contagion, mainly during the health crisis period, which significantly changed the architecture of financial linkages in Morocco. In general, our findings confirm that persistent volatility, sectoral contagion, and sensitivity to global-like shocks are important determinants of national financial stability. They reinforce the call for reinforced risk management measures: on one hand, through stronger diversification and a more

monitoring attitude from investors; and on the other hand, through enhanced supervision and efficient tailored macroprudential tools by supervisors. Finally, this work opens the door for future research that will link dynamic multi-sector models with high-frequency data to allow estimating and forecasting the spread of financial crises in Morocco.

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