“Fintech and banking sector dynamics: Exploring the long-term connectedness between Fintech and themed stock indices across five global markets”

AUTHORS	Rosa Galvão Rui Dias Paulo Alexandre

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Rosa Galvão (Portugal), **Rui Dias** (Portugal), **Paulo Alexandre** (Portugal)

FINTECH AND BANKING SECTOR DYNAMICS: EXPLORING THE LONG-TERM CONNECTEDNESS BETWEEN FINTECH AND THEMED STOCK INDICES ACROSS FIVE GLOBAL MARKETS

Abstract

This study is motivated by the rise of the Fintech sector and its relevant role in the growth and development of the banking sector. Its purpose is to examine the influence on price formation between indices related to Financial Technology companies (Fintech) and regional stock markets in Europe, emerging markets, Latin America, and the United States. The study uses the Gregory-Hansen test to assess the long-term co-movements between the main Fintech-related and regional stock indices. The results indicate that the characteristics of assets as hedging instruments can change over time and in different circumstances. During the pre-conflict period, 26 long-term comovements were identified between the Fintech indices and the regional stock markets, and 31 long-term comovements were identified during the conflict period. The Emerging Markets, Latin America, and S&P 500 stock indices were considered full hedging assets but partially lost these characteristics during the Conflict period. In the conflict sub-period, the European regional stock market displayed the characteristics of a hedging asset, as it did not influence the prices of any of the indices analyzed. The study's implications suggest that assets behave differently in different market conditions, so investors must adapt their asset allocation strategies to manage risk efficiently and build resilient investment portfolios. These findings are also relevant for financial institutions, particularly banks, as they continue to integrate Fintech-driven innovations into their business models and risk management frameworks.

Keywords digital, banking sector, stock markets, comovements, hedge, safe haven, diversification, risk, financial

JEL Classification G20, G21, G14, G15, F30

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Rosa Galvão, Finance Specialist, Master's Degree in Accounting and Finance, Professor, Department of Accounting and Finance, Escola Superior de Ciências Empresariais, Instituto Politécnico de Setúbal [School of Business and Administration, Polytechnic Institute of Setúbal], Portugal. (Corresponding author)

Rui Dias, Post-Ph.D. in Econophysics, Ph.D. in Finance, Professor, Department of Accounting and Finance, Escola Superior de Ciências Empresariais, Instituto Politécnico de Setúbal [School of Business and Administration, Polytechnic Institute of Setúbal], Portugal.

Paulo Alexandre, Finance Specialist, Master's Degree in Accounting and Finance, Professor, Department of Accounting and Finance, Escola Superior de Ciências Empresariais, Instituto Politécnico de Setúbal [School of Business and Administration, Polytechnic Institute of Setúbal], Portugal.

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INTRODUCTION

The escalation of the Fintech sector has been instrumental in transforming the banking industry. Over time, it has become increasingly apparent that Fintech and the banking sector coexist and are deeply interdependent. However, the influence of Fintech has evolved and goes far beyond the confines of the financial domain, extending its impact on fundamental aspects of society, particularly financial inclusion and the economic development of nations.

This evolution requires a comprehensive understanding of their connectedness to the stock markets. In addition, the potential of Fintech to extend financial services to underprivileged populations emphasizes their pivotal role in promoting financial inclusion, a cornerstone of economic development. However, this innovation wave introduces new risks, namely cybersecurity and information privacy. Therefore, a thorough understanding of connectedness is vital to assess and miti-

gate these emerging risks in the financial ecosystem. Therefore, examining the connectedness between Fintech indices and regional stock markets is imperative in adapting to the evolving financial scenario, ensuring regulatory harmony, identifying investment perspectives, and understanding these technological advances' broader economic and social consequences.

1. LITERATURE REVIEW

The term "Fintech" has permeated the lexicon, driven by the confluence of technological advances, innovative business models, the insatiable demand for financial services, and their unparalleled efficiency. These factors have converged to create a dynamic ecosystem that transcends traditional financial paradigms, redefining how individuals and companies interact with their finances.

Integrating advanced technologies into the banking sector has transformed the global financial landscape, positioning Fintech companies as major players. These firms now compete directly with both traditional financial institutions and non-financial organizations. The rapid expansion of Fintech, particularly during the COVID-19 pandemic, has accelerated this transition, with Fintech driving innovation and emphasizing sustainable development. Fintech's core functions include facilitating economic ventures, spurring business innovation, and promoting investments contributing to economic growth. Financial institutions have increasingly adopted innovative practices to maintain competitiveness, integrating environmental, social, and governance (ESG) principles into their operations and prioritizing research and development (Demir et al., 2020).

Fintech, which encompasses innovation in products, services, technologies, and the emergence of new business and organizational models, has been a prominent subject of discussion and study in recent years. Charter and Gray (2008) introduced the concept that Fintech goes beyond traditional financial services, challenging established norms and pushing the boundaries of what is possible in finance. The fintech industry has undergone remarkable expansion, primarily driven by the delivery of secure, efficient, and high-quality online banking services, as emphasized by Kang et al. (2018).

Fintech's integration with the financial industry has played a key role in improving financial inclusion by broadening access to services for populations not yet served. By optimizing the adoption of Fintech, financial access is expanded, mainly supporting at-risk groups, such as the unbanked, living in rural areas with restricted access to traditional financial services. As Setiawan et al. (2021) noted, Fintech serves as a transformative tool, bridging the gap between underserved communities and the digital financial landscape.

A significant aspect of Fintech is the development of innovative products, including, among others, digital payment platforms, cryptocurrency, robotic advisors, and point-to-point loans. These products provide individuals with greater convenience and flexibility in managing their finances, reducing the need for physical visits to the bank and speeding up the payment process. In addition, cryptocurrencies, such as Bitcoin, have challenged the traditional concept of currency and investment, opening up new pathways for consumers and businesses (Karthika et al., 2022; Siska, 2022).

Fintech innovations are reshaping banking practices, offering new and simplified channels for financial transactions, and introducing accessibility and convenience previously unthinkable. The profound impact of the financial sector on people's lives transcends geographical borders. Financial services are vital in improving individuals' and nations' well-being and economic prospects in a globalized world. Financial inclusion, for which Fintech is fundamental, is not just an abstract concept but a tangible force for reducing economic disparities and empowering marginalized communities.

The Internet revolution, especially among cell phone and smartphone users, has been a catalyst for the rapid rise of Fintech. It has launched a new era in which personal and business finances are managed at the fingertips, transcending the

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traditional barriers of time and location. This unprecedented level of access made financial services democratic, making them available to a broader spectrum of the population (Anifa et al., 2022; Li et al., 2022; Zhou et al., 2022).

1.1. Fintech services in banks

The authors Gulamhuseinwala et al. (2015), Navaretti et al. (2017), and Buchak et al. (2018) examined the impact of Fintech on banks. In the survey conducted by Gulamhuseinwala et al. (2015) on consumer adoption of Fintech products regarding financial services offered by online non-banking and non-insurance companies, the authors found that 15.5% of digitally active consumers use Fintech products, reflecting a comparatively high adoption rate. Navaretti et al. (2017) argue that digital innovations and technology-driven business models present opportunities and threats to incumbent financial institutions, either transforming how they create value or disrupting the financial industry's existing structure through strategic disintermediation.

Similarly, Buchak et al. (2018) found that traditional banks operating in heavily regulated markets are increasingly challenged by Fintech creditors, who fill the gaps left by regulatory restrictions. Fintech lenders typically cater to more creditworthy borrowers and focus heavily on refinancing, often applying a premium of 14-16 basis points. Their approach places greater emphasis on borrower convenience than on cost savings.

1.2. Related research

Fintech startups are changing the financial services sector. Furthermore, the rise of Fintech poses regulatory dilemmas. Analyzing this connectivity helps regulators formulate appropriate rules to oversee these new market players, safeguarding consumers and market integrity. Investors, including institutional and retail players, must understand how Fintech influences stock markets. A connectedness analysis offers valuable insights into investment prospects, risks, and prevailing market trends.

Le et al. (2021) explored the interconnectedness between Fintech stocks and various financial assets, including gold, Bitcoin, a global stock index, crude oil, and the US dollar, during the COVID-19 crisis. Their findings reveal significant shocks between asset classes, with the intensity of spillovers decreasing as global COVID-19 cases declined. Their analysis supports the safe-haven role of the US dollar and gold during catastrophic events, whereas Fintech products, expressed by the financial technology index (KFTX) and Bitcoin, were notably vulnerable to external shocks. Similarly, Hachicha et al. (2022) studied the interconnectedness between the MSCI ACWI and Frontier Markets Index, focusing on volatility spillovers between commodities and financial markets. Their empirical findings underscore the critical role of volatility spillovers in financial markets, a phenomenon not observed in commodity markets, which experience lower external volatility. Financial markets act as net transmitters of volatility, whereas commodity markets are likelier to be net receivers.

Zhou and Li (2022), Alshater et al. (2022), and Aharon and Demir (2022) analyzed the relationships between Fintech and traditional markets. Zhou and Li (2022) assessed risk transmission between Fintech and traditional financial companies from 2012 to 2022, finding that the dynamic relationship between these sectors is predominantly positive. Notably, dynamic correlations between Fintech and real estate (development and operation) were significant. However, following the COVID-19 pandemic, the strength of the relationship between Fintech and traditional finance weakened. Alshater et al. (2022) examined the connection between various regional Fintech indices during Russia's invasion of Ukraine on dynamic spillovers. The authors show that Asia-Pacific and Japanese Fintech have significant levels of connectedness, and the short-term shocks between regional Fintech indices are stronger than the long-term relationship. Aharon and Demir (2022) explored the relationship between non-fungible tokens (NFTs) and other financial assets, including stocks, bonds, currencies, gold, oil, and Ethereum, from January 2018 to June 2021. Their findings suggest that NFTs are largely independent of shocks from conventional asset classes and Ethereum. Through their in-depth analysis, they found that while NFTs may transmit systemic risk under normal conditions, they help absorb risk spillover during periods of stress.

In more recent studies, Rashid and Amin (2023) explored the relationships between Sharia-compliant digital assets, Islamic Fintech, and the volatility index (VIX), comparing them to traditional cryptocurrencies. Their findings indicate that Islamic cryptocurrencies exhibit weaker linkages to stock market volatility than traditional cryptocurrencies (except Tether), highlighting their potential as hedging instruments. Wang et al. (2023) extended this analysis by investigating the connectedness between Fintech and themed indices, showing that the MSCI USA benchmark index had the highest interactions with emerging industries but maintained relatively low correlations with other benchmark indices.

Ha (2023) examined the connections between the ARK Fintech Innovation ETF (ARKF), the Global X Fintech ETF (FINX), and green assets. The results show that the pattern of ARKF and FINX is captured as a net transmitter of shocks. In addition, green bonds are net beneficiaries of long-term shocks during the global 2020 pandemic and the Russian invasion of Ukraine in 2022. Sharma et al. (2023) analyzed the links between Green Funds, Fintech, and index funds based on Artificial Intelligence. Their results revealed that Fintech-based assets demonstrated the highest resilience during pre- and post-COVID-19 periods, followed by AI-based and green funds. The authors emphasized that AI and green funds are ideal for long-term diversification, while Fintech assets are suited for short-and long-term investments.

Fintech startups are undeniably catalysts for change in the financial services sector. Their influence on traditional financial markets, driven by technological advances, is profound and transformative. Therefore, a comprehensive understanding of their connectedness to the stock markets is mandatory. In addition, the potential of Fintechs goes far beyond their role in bank development; they also contribute significantly to enhancing financial inclusion, a cornerstone of economic development. Examining the connectedness between Fintech indices and regional stock markets will help understand the evolving financial scenario, identify investment perspectives, helping investors with portfolio diversification and risk control.

The purpose of this study is to understand the connectedness and estimate the influence on price formation between the main Fintech-related indices, such as the Global FintTechc, Artificial Intelligence and BigData (IAIQ), the Blockchain index (ILEGR), and the Disruptive Technology index (IDTEC), and regional stock markets in Europe (EURO STOXX 50), Asia-Pacific (MSCI ASIA PACIFIC), emerging markets (MSCI Emerging Markets), Latin America (MSCI Emerging Markets Latin America), and the United States (S&P 500).

2. METHODS

The indices used in the study were the price indices of the main Fintech-related indices, such as the Global Fintech Index, Artificial Intelligence & BigData Index (IAIQ), Blockchain Index (ILEGR), and Disruptive Technology Index (IDTEC). These indices represent cutting-edge areas of technological innovation that intersect with Fintech. It is important to stress that they were studied in connection with regional stock markets in Europe (EURO STOXX 50), Asia-Pacific (MSCI ASIA PACIFIC), emerging markets (MSCI Emerging Markets), Latin America (MSCI Emerging Markets Latin America), and the United States (S&P 500).

The data used in the study spanned from January 4, 2021 to October 13, 2023, and were obtained from the Thomson Reuters Eikon database. Two periods were considered: Pre-Conflict (before the conflict between Russia and Ukraine), which covered the period from January 4, 2021 to February 18, 2022, while the second sub-period, referred to as Conflict (the ongoing conflict between Russia and Ukraine), covered the period from February 22, 2022, to October 13, 2023. All prices in the study are listed in the original currency to avoid exchange rate fluctuations, allowing for a more accurate comparison between the different assets and indices.

Returns were obtained by calculating the Neperian logarithm in the first differences from the original prices to analyze the behavior of the main Fintech-related indices and the regional stock markets. This transformation allowed for more efficient analytical treatment, particularly if the time data have homoscedastic characteristics instead of heteroscedasticity. So, the following equation will be used:

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$$r_t = \ln P_t - \ln P_{t-1}, \quad (1)$$

where r_t is the rate of return on day t, and P_t and P_{t-1} are the closing prices of the series at period t and $t - 1$, respectively.

The main measures of descriptive statistics and the Jarque and Bera (1980) adherence test, which postulates the normality of the data, were used to characterize the sample.

To validate the assumption of stationarity of the time series, the tests of Breitung (2000), Levin et al. (2002), and Im et al. (2003) were used. For results validation, the tests of Dickey and Fuller (1981) and Perron and Phillips (1988) with Fisher Chi-square transformation and Choi (2001) were used. This test statistic follows a chi-squared distribution, and its significance level is used to determine the presence of a unit root.

Furthermore, the Choi Z-stat version of the ADF and PP tests was also used as an alternative approach that calculates the test statistic based on the maximum likelihood estimate of the autoregressive model. The methodology outlined by Gregory and Hansen (1996) was used to assess whether there were stable links. This method is widely used when conducting unit root tests and exploring long-term connections. The general procedure involves estimating a model with potential structural breaks and comparing it with a model without any structural breaks. The likelihood ratio test statistic is then calculated, and its distribution following the null hypothesis (no structural break) is used to determine whether the connections are stable. Researchers and analysts use this methodology to assess whether the relationships between variables change over time, which is crucial for understanding the dynamics of economic and financial time series data. If a structural break is detected, it suggests that the relationships between variables may have evolved, and this information can be valuable for making more accurate forecasts or designing appropriate economic or financial models.

3. RESULTS AND DISCUSSION

Figure 1 illustrates the evolution of the indices analyzed from January 4, 2021 to October 13, 2023. The data highlight several global challenges, notably the ongoing armed Conflict in 2022. Stock market performance, a critical indicator of economic health, reveals how this Conflict significantly affected investor sentiment and market stability, as evidenced by the sharp declines and potential structural breaks in the analyzed indices.

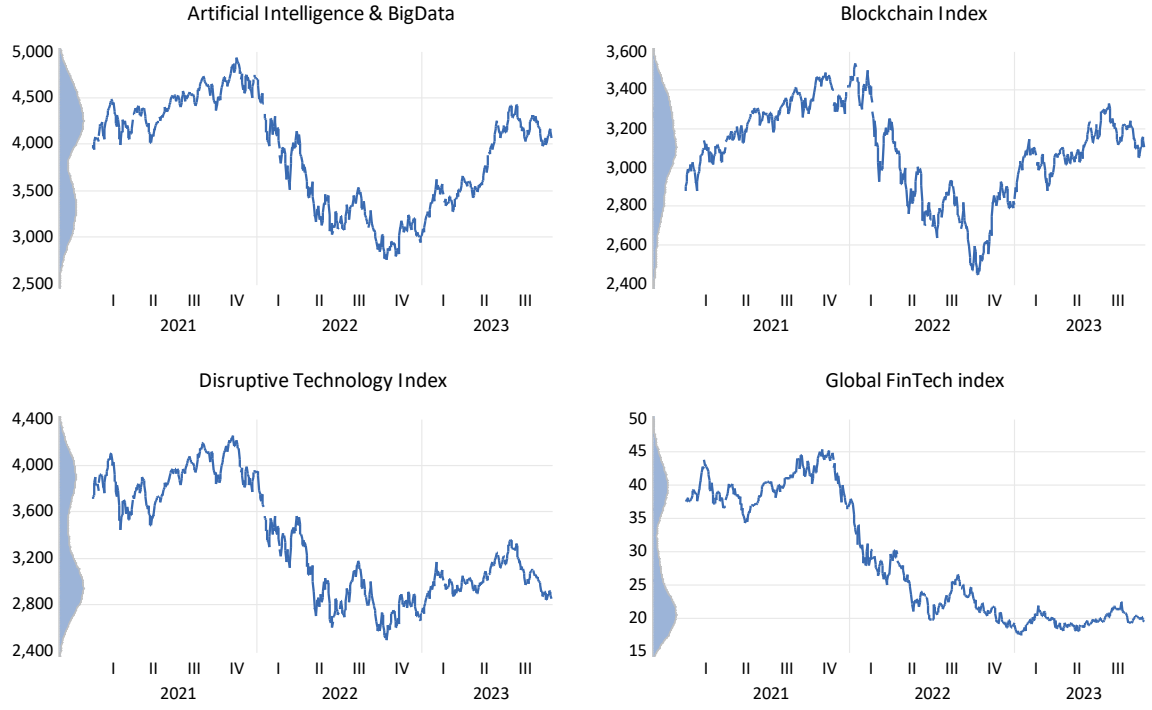

Figure 1. Evolution, in levels, of the Fintech indices from January 4, 2021 to October 13, 2023

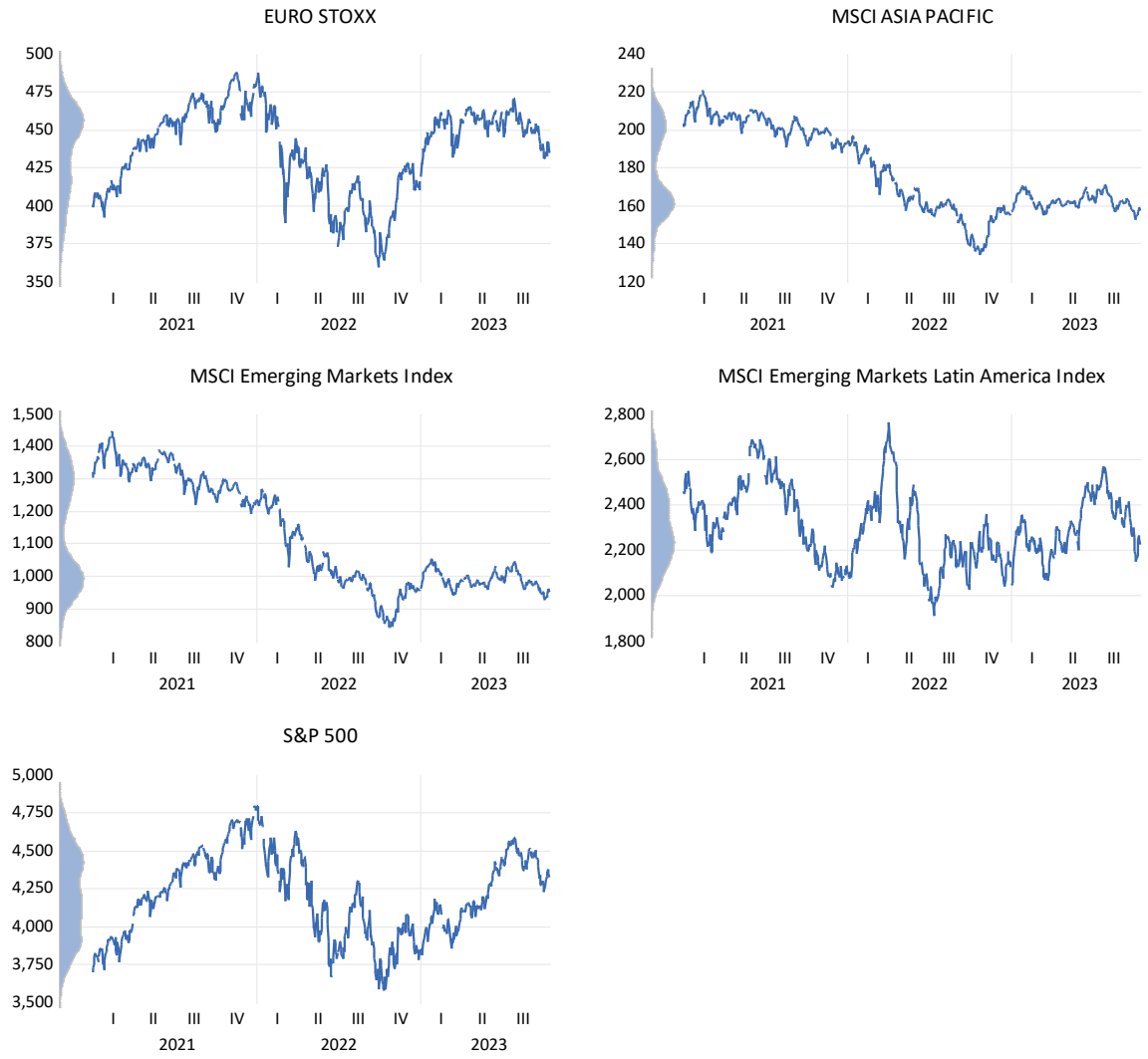

Figure 2. Evolution, in levels, of the regional stock indices from January 4, 2021 to October 13, 2023

Figure 2 illustrates the performance of regional stock markets from January 4, 2021 to October 13, 2023. The focus is on five main regions: Europe (EURO STOXX 50), Asia-Pacific (MSCI ASIA PACIFIC), emerging markets (MSCI Emerging Markets), Latin America (MSCI Emerging Markets Latin America), and the United States (S&P 500). This graphical analysis revealed the profound global challenges that emerged in 2022, with the ongoing armed conflict as one of the most significant. The sharp falls in these indices signify potential structural breaks in the data, highlighting periods of significant economic disruption associated with the Conflict. Structural breaks in the data signal abrupt changes or discontinuities linked to this geopolitical Conflict.

Table 1 provides a detailed outline of the main statistics for the Fintech indices, including the IAIQ, ILEGR, and IDTEC, for the same period. This statistical summary serves to highlight the volatility and dispersion present in the Fintech sector during this turbulent period.

The IAIQ and ILEGR indices showed positive mean returns of 2.73E-05 and 0.000109, respectively, while the IDTEC and FINTECH indices are characterized by negative mean returns (–0.000386, –0.000950, respectively). The FINTECH index had the highest deviation (0.020805), that is, a higher dispersion in relation to the mean. The skewness and kurtosis values indicated deviations from a normal distribution. The ILEGR (-0.053019), IDTEC (–0.010494), FINTECH (0.108261), and IAIQ (0.019787) indices showed negatively and positively distorted skewness, respectively. All the variables showed positive kurtosis, indicating sharp distributions with heavy tails. The Jarque-

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Bera test confirmed that these variables deviate significantly from a normal distribution, as the very low probability values indicate.

Table 1. Summary of the statistics relating to the Fintech indices from January 4, 2021 to October 13, 2023

Statistics/ Index	IAIQ	ILEGR	IDTEC	FINTECH
Mean	2.73E-05	0.000109	–0.000386	–0.000950
Std. Dev.	0.015202	0.010027	0.014369	0.020805
Skewness	0.019787	–0.053019	–0.010494	0.108261
Kurtosis	3.952579	4.078403	3.881707	5.578676
Jarque-Bera	26.43595	34.14956	22.62241	194.7551
Probability	0.000002	0.000000	0.000012	0.000000
Observations	698	698	698	698

Table 2 outlines the main statistics related to the regional stock markets analyzed from January 4, 2021, to October 13, 2023.

Regarding mean returns, the MSCI ASIA (–0.000356), MSCI EMERGING MARKETS (–0.000456), and MSCI LATIN AMERICA (–0.000202) indices have negative values, while the EURO STOXX (0.000120), S&P 500 (0.000202) stock markets have positive mean returns. As for the standard deviation, it was found that the MSCI LATIN AMERICA stock market (0.014507) had the highest value, showing a higher dispersion relative to the mean, i.e., higher risk. Concerning asymmetries, the indices had values other than zero (reference value) and negative skewness, except for MSCI ASIA (0.084455) and MSCI Emerging Markets (0.135703). Kurtosis also showed values other than 3, with the European stock market (6.415867) showing the highest value. The Jarque-Bera test validated the evidence, suggesting that these were non-Gaussian distributions, rejecting the null hypothesis at a significance level of 1%.

Table 3 shows the summary table of the stationarity tests of Breitung (2000), Levin et al. (2002), and Im et al. (2003), and, for validation, the Dickey and Fuller (1981) and Perron and Phillips (1988) tests with Fisher Chi-square transformation and Choi (2001) were also be used. Based on the statistics values and the probabilities, the results reveal the time data as stationary only by transforming the original price indices into first-difference logarithms (returns), which validates the basic assumptions for obtaining robust results in the subsequent tests.

Table 3. Summary of the unit root tests for the Fintech indices and regional stock markets from January 4, 2021 to October 13, 2023

Group unit root test: Summary				
Method	**Statistic**	**Prob.****	**Cross-sections**	**Obs**
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	–126.373	0.0000	9	6257
Breitung t-stat	–48.7922	0.0000	9	6248
Null: Unit root (assumes individual unit root process)				
Im, Pesaran, and Shin W-stat	–79.9793	0.0000	9	6257
ADF – Fisher Chi-square	2201.82	0.0000	9	6257
PP – Fisher Chi-square	2370.52	0.0000	9	6261

Note: ** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Tables 4 and 5 show the results of the Gregory and Hansen (1996) test for long-term connections applied to indices analyzed during the two sub-periods.

Based on the results, it was possible to identify 26 long-term comovements between the Fintech indices and the regional stock markets:

Table 2. Summary table of regional stock market statistics from January 4, 2021 to October 13, 2023

Statistics/Index	EURO STOXX	MSCI ASIA	MSCI EMERGING MARKETS	MSCI LATIN AMERICA	S&P 500
Mean	0.000120	–0.000356	–0.000456	–0.000202	0.000202
Std. Dev.	0.010909	0.009824	0.010655	0.014507	0.011339
Skewness	–0.075881	0.084455	0.135703	–0.146978	–0.187683
Kurtosis	6.415867	4.475982	4.980118	3.909764	4.537186
Jarque-Bera	339.0442	64.00453	115.8414	26.50833	72.61141
Probability	0.000000	0.000000	0.000000	0.000002	0.000000
Observations	698	698	698	698	698

Table 4. Summary table of the long-term comovements between the main Fintech-related indices and the regional stock markets in the pre-Conflict period

Market	t-stat	Results
Global Fintech | IAIQ	**–5.89*** **	**Shock L/ Time**
Global Fintech | ILEGR	–3.26	Non-existent
Global Fintech | IDTEC	**–5.66*** **	**Shock L/ Time**
Global Fintech | EURO STOXX	–4.04	Non-existent
Global Fintech | ASIA PACIFIC	–4.38	Non-existent
Global Fintech | Emerging Markets	–3.47	Non-existent
Global Fintech | Latin America	–4.00	Non-existent
Global Fintech | S&P 500	–4.50	Non-existent
Market	**t-stat**	**Results**
IAIQ | Global Fintech	**–5.40****	**Shock L/ Time**
IAIQ | ILEGR	–2.24	Non-existent
IAIQ | IDTEC	–4.05	Non-existent
IAIQ | EURO STOXX	–3.66	Non-existent
IAIQ | ASIA PACIFIC	–4.20	Non-existent
IAIQ | Emerging Markets	–3.98	Non-existent
IAIQ | Latin America	–3.76	Non-existent
IAIQ | S&P 500	–3.65	Non-existent
Market	**t-stat**	**Results**
ILEGR | Global Fintech	**–5.51*** **	**Shock L/ Time**
ILEGR | IAIQ	**–4.93***	**Shock L/ Time**
ILEGR | IDTEC	**–5.15****	**Shock L/ Time**
ILEGR | EURO STOXX	**–5.20****	**Shock L/ Time**
ILEGR | ASIA PACIFIC	–4.49	Non-existent
ILEGR | Emerging Markets	–4.37	Non-existent
ILEGR | Latin America	–5.22**	**Shock L/ Time**
ILEGR | S&P 500	–4.75*	Shock L/ Time
Market	**t-stat**	**Results**
IDTEC | Global Fintech	**–5.68*** **	**Shock L/ Time**
IDTEC | IAIQ	–3.06	Non-existent
IDTEC | ILEGR	–3.18	Non-existent
IDTEC | EURO STOXX	–3.82	Non-existent
IDTEC | ASIA PACIFIC	–3.58	Non-existent
IDTEC | Emerging Markets	–3.17	Non-existent
IDTEC | Latin America	–3.97	Non-existent
IDTEC | S&P 500	–3.09	Non-existent
Market	**t-stat**	**Results**
EURO STOXX | Global Fintech	**–4.78***	**Shock L/ Time**
EURO STOXX | IAIQ	**–4.75***	**Shock L/ Time**
EURO STOXX | ILEGR	–3.88	Non-existent
EURO STOXX | IDTEC	**–5.20****	**Shock L/ Time**
EURO STOXX | ASIA PACIFIC	–3.42	Non-existent
EURO STOXX | Emerging Markets	–3.27	Non-existent
EURO STOXX | Latin America	–3.75	Non-existent
EURO STOXX | S&P 500	–5.38**	Shock L/ Time
Market	**t-stat**	**Results**
ASIA PACIFIC | Global Fintech	**–5.86*** **	**Shock L/ Time**
ASIA PACIFIC | IAIQ	**–4.97***	**Shock L/ Time**
ASIA PACIFIC | ILEGR	–4.35	Non-existent
ASIA PACIFIC | IDTEC	**–5.71*** **	**Shock L/ Time**
ASIA PACIFIC | EURO STOXX	**–5.03****	**Shock L/ Time**
ASIA PACIFIC | Emerging Markets	–3.97	Non–existent
ASIA PACIFIC | Latin America	**–5.26****	**Shock L/ Time**
ASIA PACIFIC | S&P 500	–4.81*	Shock L/ Time

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Table 4 (cont.). Summary table of the long-term comovements between the main Fintech-related indices and the regional stock markets in the pre-Conflict period

Market	t-stat	Results
Emerging Markets | Global Fintech	**–5.76*** **	**Shock L/ Time**
Emerging Markets | IAIQ	**–5.15** **	**Shock L/ Time**
Emerging Markets | ILEGR	–4.60	Non-existent
Emerging Markets | IDTEC	**–5.79*** **	**Shock L/ Time**
Emerging Markets | EURO STOXX	**–5.36** **	**Shock L/ Time**
Emerging Markets | ASIA PACIFIC	–4.16	Non-existent
Emerging Markets | Latin America	**–5.58*** **	**Shock L/ Time**
Emerging Markets | S&P 500	–5.34**	Shock L/ Time
Market	**t-stat**	**Results**
Latin America | Global Fintech	–4.27	Non-existent
Latin America | IAIQ	–4.29	Non-existent
Latin America | ILEGR	–3.03	Non-existent
Latin America | IDTEC	–3.92	Non-existent
Latin America | EURO STOXX	–3.39	Non-existent
Latin America | ASIA PACIFIC	–4.34	Non-existent
Latin America | Emerging Markets	–3.74	Non-existent
Latin America | S&P 500	–3.89	Non-existent
Market	**t-stat**	**Results**
S&P 500 | Global Fintech	–4.54	Non-existent
S&P 500 | IAIQ	–3.02	Non-existent
S&P 500 | ILEGR	–2.78	Non-existent
S&P 500 | IDTEC	–3.44	Non-existent
S&P 500 | EURO STOXX	–4.62	Non-existent
S&P 500 | ASIA PACIFIC	–2.77	Non-existent
S&P 500 | Emerging Markets	–2.62	Non-existent
S&P 500 | Latin America	–3.87	Non-existent

Note: ***, **, and * significant at 1%, 5%, and 10%, respectively.

- The Blockchain Index (ILEGR) appears as an influencer in price formation six times (out of a possible 8), the exception being the Asia-Pacific and emerging stock indices, highlighting the hedging characteristics for these two regional stock markets;

- The MSCI ASIA PACIFIC stock market also appeared very influential with its Fintech peers and stock indices (6 out of a possible 8). Indeed, it influences most of the indices in the long term, the exceptions being the Blockchain Index (ILEGR) and the MSCI Emerging Markets, which validates the hedging assumption;

- The MSCI Emerging Markets stock index shows six long-term movements with the analyzed indices, verifying that this stock market has hedging characteristics for the Blockchain Index and MSCI ASIA;

- The European stock market (EURO STOXX 50) influences the price formation of the Global Fintech, Artificial Intelligence & Big Data (IAIQ), Disruptive Technology (IDTEC), and S&P 500 indices, which does not validate the hypothesis of hedging for these indices. However, it does show hedging properties for the Blockchain (ILEGR), MSCI Emerging Markets, MSCI ASIA, and MSCI Emerging Markets Latin America indices;

- The Global Fintech Index influences the price formation of the Artificial Intelligence & Big Data Index (IAIQ), Disruptive Technology Index (IDTEC), thus proving to be a hedging asset for the Blockchain Index (ILEGR), MSCI Emerging Markets, MSCI ASIA PACIFIC, EURO STOXX 50, MSCI Emerging Markets Latin America, and the S&P 500;

- The Artificial Intelligence & Big Data Index (IAIQ) has the characteristics of an influencer in the Global Fintech Index price formation, thus suggesting that it is a robust hedging asset for the other stock indices analyzed;

- The MSCI Emerging Markets Latin America and the S&P 500 are the stock indices with full hedging properties, as they do not influence either the Fintech indices or the regional stock markets.

These results offer valuable information to investors and portfolio managers looking to enhance their investments in the dynamic fields of Fintech and regional stock markets, suggesting auspicious hedging strategies options, and highlighting the various impacts of the different indices on price dynamics.

Based on the results, 31 long-term shocks between the Fintech indices and the regional stock markets were identified. When compared to the previous sub-period, an increase from 26 to 31 comovements that influenced the formation of prices in the stock indices analyzed was found:

- The Global Fintech index influenced most of its peers (6 out of a possible 8), proving to be a hedging asset for the MSCI ASIA PACIFIC and MSCI Emerging Markets stock markets. Notice that in the pre-conflict sub-period, Global Fintech only influenced the price formation of IAIQ and IDTEC and was considered a hedging asset for the remaining indices, i.e., it went from 2 to 6 long-term comovements, thus losing some of its characteristics as a hedging asset for its peers;

Table 5. Summary table of long-term comovements between the main Fintech-related indices and regional stock markets throughout the Conflict period

Market	t-stat	Results
Global Fintech | IAIQ	**–5.31****	**Shock L/ Time**
Global Fintech | ILEGR	**–5.00****	**Shock L/ Time**
Global Fintech | IDTEC	**–5.62*****	**Shock L/ Time**
Global Fintech | EURO STOXX	**–5.09****	**Shock L/ Time**
Global Fintech | ASIA PACIFIC	–4.51	Non–existent
Global Fintech | Emerging Markets	–4.69	Non–existent
Global Fintech | Latin America	**–5.67*****	**Shock L/ Time**
Global Fintech | S&P 500	–5.55**	Shock L/ Time
Market	**t-stat**	**Results**
IAIQ | Global Fintech	–4.03	Non–existent
IAIQ | ILEGR	**–4.79***	**Shock L/ Time**
IAIQ | IDTEC	–4.22	Non–existent
IAIQ | EURO STOXX	–4.36	Non–existent
IAIQ | ASIA PACIFIC	–4.66	Non–existent
IAIQ | Emerging Markets	**–4.75***	**Shock L/ Time**
IAIQ | Latin America	**–5.27****	**Shock L/ Time**
IAIQ | S&P 500	–4.60	Non–existent
Market	**t-stat**	**Results**
ILEGR | Global Fintech	–4.41	Non–existent
ILEGR | IAIQ	**–5.34****	**Shock L/ Time**
ILEGR | IDTEC	**–5.11****	**Shock L/ Time**
ILEGR | EURO STOXX	–4.58	Non–existent
ILEGR | ASIA PACIFIC	**–5.46*****	**Shock L/ Time**
ILEGR | Emerging Markets	**–5.63*****	**Shock L/ Time**
ILEGR | Latin America	**–4.88***	**Shock L/ Time**
ILEGR | S&P 500	–5.73***	Shock L/ Time
Market	**t-stat**	**Results**
IDTEC | Global Fintech	**–4.86***	**Shock L/ Time**
IDTEC | IAIQ	–4.17	Non–existent
IDTEC | ILEGR	–4.53	Non–existent
IDTEC | EURO STOXX	–4.11	Non–existent
IDTEC | ASIA PACIFIC	–3.80	Non–existent

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Table 5 (cont.). Summary table of long-term comovements between the main Fintech-related indices and regional stock markets throughout the Conflict period

Market	t-stat	Results
IDTEC | Emerging Markets	–4.01	Non–existent
IDTEC | Latin America	**–4.74***	**Shock L/ Time**
IDTEC | S&P 500	–4.39	Non–existent
Market	**t–stat**	**Results**
EURO STOXX | Global Fintech	–4.47	Non–existent
EURO STOXX | IAIQ	–4.16	Non–existent
EURO STOXX | ILEGR	–4.52	Non–existent
EURO STOXX | IDTEC	–4.31	Non–existent
EURO STOXX | ASIA PACIFIC	–4.56	Non–existent
EURO STOXX | Emerging Markets	–4.40	Non–existent
EURO STOXX | Latin America	–4.53	Non–existent
EURO STOXX | S&P 500	–4.09	Non–existent
Market	**t–stat**	**Results**
ASIA PACIFIC | Global Fintech	–4.43	Non–existent
ASIA PACIFIC | IAIQ	**–5.29****	**Shock L/ Time**
ASIA PACIFIC | ILEGR	–4.02	Non–existent
ASIA PACIFIC | IDTEC	–3.75	Non–existent
ASIA PACIFIC | EURO STOXX	**–4.96***	**Shock L/ Time**
ASIA PACIFIC | Emerging Markets	**–5.52*****	**Shock L/ Time**
ASIA PACIFIC | Latin America	–3.18	Non–existent
ASIA PACIFIC | S&P 500	–4.81*	Shock L/ Time
Market	**t–stat**	**Results**
Emerging Markets | Global Fintech	–4.81*	**Shock L/ Time**
Emerging Markets | IAIQ	–4.37	Non–existent
Emerging Markets | ILEGR	–4.03	Non–existent
Emerging Markets | IDTEC	–4.01	Non–existent
Emerging Markets | EURO STOXX	**–5.02****	**Shock L/ Time**
Emerging Markets | ASIA PACIFIC	**–5.51*****	**Shock L/ Time**
Emerging Markets | Latin America	–4.00	Non–existent
Emerging Markets | S&P 500	–4.06	Non–existent
Market	**t–stat**	**Results**
Latin America | Global Fintech	**–4.79***	**Shock L/ Time**
Latin America | IAIQ	**–5.37****	**Shock L/ Time**
Latin America | ILEGR	–4.51	Non–existent
Latin America | IDTEC	**–4.93***	**Shock L/ Time**
Latin America | EURO STOXX	–4.49	Non–existent
Latin America | ASIA PACIFIC	–3.88	Non–existent
Latin America | Emerging Markets	–3.74	Non–existent
Latin America | S&P 500	–5.25**	Shock L/ Time
Market	**t–stat**	**Results**
S&P 500 | Global Fintech	–4.65	Non–existent
S&P 500 | IAIQ	–4.61	Non–existent
S&P 500 | ILEGR	**–5.30****	**Shock L/ Time**
S&P 500 | IDTEC	–4.48	Non–existent
S&P 500 | EURO STOXX	–4.43	Non–existent
S&P 500 | ASIA PACIFIC	**–5.31****	**Shock L/ Time**
S&P 500 | Emerging Markets	**–5.55*****	**Shock L/ Time**
S&P 500 | Latin America	–5.47***	Shock L/ Time

Note: ***, **, and * significant at 1%, 5%, and 10%, respectively.

- The Blockchain Index (ILEGR) also showed long-term comovements with most of its peers, except the Global Fintech indices and the EURO STOXX 50, thus proving to be a Safe Haven for these stock indices. In the previous sub-period, the ILEGR already showed

significant comovements with most of its peers, the exception being the regional markets MSCI ASIA PACIFIC and MSCI Emerging Markets, i.e., it maintained the six comovements during the two sub-periods, demonstrating that it is a weak long-term hedging asset;

- The MSCI Emerging Markets Latin America regional stock market had four long-term comovements (out of 8 possible), thus proving not to be a hedging asset for the Global Fintech, Artificial Intelligence & Big Data Index (IAIQ), Disruptive Technology Index (IDTEC), and the S&P 500 indices. However, it has the properties of a hedging asset for the Blockchain Index (ILEGR), EURO STOXX 50, MSCI ASIA PACIFIC, and MSCI Emerging Markets. Compared to the previous sub-period, this regional market has the characteristics of a full hedge asset because it did not create comovements with any of the stock indices analyzed, going from 0 to 4 long-term comovements;

- The MSCI Emerging Markets index showed long-term comovements with the Global Fintech, EURO STOXX 50, and MSCI ASIA PACIFIC indices, thus rejecting the hypothesis of being a hedging asset for these indices. However, for the Artificial Intelligence & Big Data Index (IAIQ), Blockchain Index (ILEGR), Disruptive Technology Index (IDTEC), MSCI Emerging Markets Latin America, and the United States (S&P 500), it had the properties of a hedging asset. In the pre-conflict period, this regional market showed significant long-term comovements with the majority of its peers, except for the ILEGR and MSCI ASIA; in sum, this market has increased its hedging properties with its peers, as it has fallen from 6 to 3 long-term comovements;

- The Artificial Intelligence & Big Data Index (IAIQ) confirmed the presence of 3 long-term comovements with the Blockchain Index (ILEGR), MSCI Emerging Markets Latin America, and MSCI Emerging Markets. However, it was found that this technology index can act as a hedging asset for the Global Fintech, Disruptive Technology Index (IDTEC), EURO STOXX 50, MSCI ASIA PACIFIC, and S&P 500 indices. In the pre-conflict, the IAIQ index showed long-term comovements only with the Global Fintech, which showed that this index has partially lost its hedging characteristics with its peers, having gone from 1 to 3 (out of a possible 8);

- The S&P 500 had 4 long-term comovements with the Blockchain Index (ILEGR), MSCI ASIA PACIFIC, MSCI Emerging Markets, and MSCI Emerging Markets Latin America; however, it had the characteristics of a hedging asset for the Global Fintech Artificial Intelligence & Big Data Index (IAIQ), Disruptive Technology Index (IDTEC), and EURO STOXX 50. In the pre-conflict sub-period, it had the characteristics of a full hedging asset, as it did not show long-term comovements with any index. In practice, it went from 0 to 3 comovements, which made it partially lose its qualities as a hedging asset;

- During this period of Conflict, the EURO STOXX 50 regional stock market had the characteristics of a complete Safe Haven, as it did not show any long-term comovements with its peers. When comparing the pre-conflict period, the European market had 4 comovements with the Global Fintech, Artificial Intelligence & Big Data Index (IAIQ), Disruptive Technology Index (IDTEC), and the S&P 500. In practice, the EURO STOXX 50 decreased its comovements from 4 to 0, which validated full hedging characteristics with the analyzed indices.

From a practical perspective, it was observed that the MSCI Emerging Markets Latin America and S&P 500 stock markets are considered full hedging assets during the pre-conflict period, but as explained, they have partially lost these characteristics. Regarding the conflict sub-period, it was found that the European regional stock market (EURO STOXX 50) has the qualities of a fully hedged asset, not influencing the prices of any of the indices analyzed. Summarizing, the results reveal that the hedging characteristics of various assets can change over time and under different circumstances. To effectively manage risk and build resilient investment portfolios, investors must adapt their asset allocation strategies, consider the unique characteristics of assets during different market conditions, and maintain a vigilant and diversified approach to investing.

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CONCLUSION

The purpose of this study was to examine the interconnection and impact on price formation among key Fintech-related indices, including the Global Fintech Artificial Intelligence & Big Data Index (IAIQ), Blockchain Index (ILEGR), Disruptive Technology Index (IDTEC), and regional stock markets in Europe (EURO STOXX 50), Asia-Pacific (MSCI ASIA PACIFIC), emerging markets (MSCI Emerging Markets), Latin America (MSCI Emerging Markets Latin America), and the United States (S&P 500).

The results highlight changes in the hedging characteristics of various assets during different market periods. The Global Fintech Index has increased its influence over several peers but has lost some hedging attributes during the Conflict period. The Blockchain index remains a safe haven, while the MSCI Asia Pacific has mixed hedging characteristics. The MSCI Emerging Markets Latin America and the S&P 500 have lost some of their full hedging attributes. The EURO STOXX 50 has gone from influencing some indices in the pre-conflict period to becoming a full hedging asset during the Conflict period.

Essentially, the research highlights that the ability of assets to serve as hedges can change over time and in different market situations. To effectively manage risk and build resilient investment portfolios, investors must be prepared to adjust their asset allocation strategies, consider the changing characteristics of assets in varying market conditions, and advocate a diversified and vigilant investment approach. These insights are particularly valuable for financial institutions, mainly banks, which must adapt their risk management and portfolio strategies in response to the evolving dynamics introduced by Fintech innovations and market uncertainty.

AUTHOR CONTRIBUTIONS

Conceptualization: Rosa Galvão, Rui Dias, Paulo Alexandre.
Data curation: Rosa Galvão, Rui Dias, Paulo Alexandre.
Formal analysis: Rosa Galvão, Rui Dias, Paulo Alexandre.
Funding acquisition: Rosa Galvão, Rui Dias, Paulo Alexandre.
Investigation: Rosa Galvão, Rui Dias, Paulo Alexandre.
Methodology: Rosa Galvão, Rui Dias, Paulo Alexandre.
Resources: Rosa Galvão, Rui Dias, Paulo Alexandre.
Validation: Rosa Galvão, Rui Dias, Paulo Alexandre.
Writing – original draft: Rosa Galvão, Rui Dias, Paulo Alexandre.
Writing – review & editing: Rosa Galvão, Rui Dias, Paulo Alexandre.

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