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FINANCIAL INTEGERATION ACROSS BORDERS: INVESTIGATING THE CONNECTEDNESS OF FINANCIAL INTEGERATION AND ECONOMIC GROWTH IN DEVELOPED VS. DEVELOPING ECONOMIES

INTEGRAÇÃO FINANCEIRA TRANSFRONTEIRIÇA: INVESTIGANDO A CONEXÃO ENTRE A INTEGRAÇÃO FINANCEIRA E O CRESCIMENTO ECONÔMICO EM ECONOMIAS DESENVOLVIDAS E EM DESENVOLVIMENTO

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Abstract
This study examines the dynamic connections and interdependencies of financial markets across developed and emerging economies from 2010 to 2023. This study seeks to address this gap by analyzing the interconnectedness of financial markets in both developed and developing nations, employing the Granger causality test, the DCC-GARCH model, and the Diebold-Yilmaz methodology. The analysis reveals a substantial bi-directional positive correlation between the financial markets of advanced and emerging economies. The study employs the DCC GARCH approach, revealing that the connections between financial integration in established and emerging nations demonstrate significant volatility spillovers. Moreover, the t-DCC model computes volatilities and correlations unconditionally, indicating that the unconditional volatility across all markets is approximately one, denoting a significant level of integration, which leads to heightened volatility in both established and emerging markets. The Diebold and Yilmaz Connectedness test has clarified the degree of interconnectedness among various financial markets. The results indicate that while a substantial degree of correlation exists, the intensity of these relationships varies across different market circumstances and timeframes. These findings assert that financial integration significantly impacts economic growth, as demonstrated in this study. The integration of financial components into various investment portfolios may enhance risk-adjusted returns,

Resumo
Este estudo examina as conexões dinâmicas e as interdependências dos mercados financeiros entre economias desenvolvidas e emergentes de 2010 a 2023. Este estudo procura abordar essa lacuna analisando a interconectividade dos mercados financeiros em países desenvolvidos e em desenvolvimento, empregando o teste de causalidade de Granger, o modelo DCC-GARCH e a metodologia Diebold-Yilmaz.
A análise revela uma correlação positiva bidirecional substancial entre os mercados financeiros das economias avançadas e emergentes. O estudo emprega a abordagem DCC GARCH, revelando que as conexões entre a integração financeira em nações estabelecidas e emergentes demonstram efeitos colaterais significativos de volatilidade. Além disso, o modelo t-DCC calcula volatilidades e correlações incondicionalmente, indicando que a volatilidade incondicional em todos os mercados é aproximadamente um, denotando um nível significativo de integração, o que leva a uma volatilidade elevada tanto nos mercados estabelecidos quanto nos emergentes. O teste de conectividade de Diebold e Yilmaz esclareceu o grau de interconectividade entre vários mercados financeiros. Os resultados indicam que, embora exista um grau substancial de correlação, a intensidade dessas relações varia de acordo com as diferentes circunstâncias do mercado e prazos. Essas descobertas afirmam que a integração financeira impacta significativamente o crescimento econômico, conforme demonstrado neste estudo. A

particularly under sustainable investing paradigms.

Keywords: Financial Integration. Economic Growth. DCC GARCH. Diebold and Yilmaz Connectedness Test.

integração de componentes financeiros em várias carteiras de investimento pode aumentar os retornos ajustados ao risco, particularmente sob paradigmas de investimento sustentável.

Palavras-chave: *Integração financeira. Crescimento econômico. DCC GARCH. Teste de conectividade de Diebold e Yilmaz.*

1 INTRODUCTION

Financial integration refers to the process of interconnecting financial markets and institutions across countries and regions, allowing for the free flow of capital, investments, and financial services across borders. It is a critical aspect of globalization, enabling economic growth, integration, stability, and creating new opportunities for investors, businesses, and individuals (Shaheen.,2025). The concept of financial integration has been a topic of discussion and research for decades, and its importance has grown significantly in recent years. In 2022, the COVID-19 pandemic further highlighted the increased financial integration to support global economic recovery and resilience (Elgin., 2025). According to (Nguyen and Dinh.,2024) financial integration can take many forms, such as trade in financial assets, cross-border investment, international banking, and capital market integration. It is driven by various factors, such as advances in technology, deregulation of financial markets, increasing competition, and the growth of emerging markets. Modern research (Nguyen & Dinh, 2024; Li & Zhou, 2022) demonstrates the utmost significant assistance of financial integration is that it facilitates the efficient allocation of capital and resources, allowing investors to diversify their portfolios and reduce risk. It also enables businesses to access funding from a broader range of sources, reducing their dependence on local markets and increasing their competitiveness (Marquetti et al.,2025). It has been a topic of great interest in the field of international finance and economics in recent decades. Conventional portfolio and asset pricing theories offer a robust framework for comprehending risk and return; nevertheless, they primarily focus on domestic or segmented markets and fail to address the intricacies of the global financial system.

Modern Portfolio Theory (MPT), proposed by Markowitz in 1952, advocates for the diversification of assets with low or negative correlations to mitigate risk. This methodology is effective in one market but presupposes stable, local asset correlations. Global financial strain amplifies correlations among international assets. Diversification diminishes in efficacy. Markowitz's model overlooks cross-border capital flows, contagion effects, and synchronized market volatility in contemporary international markets. William Sharpe's 1964 Capital Asset Pricing Model (CAPM) employs beta to assess an asset's return. The Capital Asset Pricing Model (CAPM) employs a singular market portfolio, often consisting of domestic stocks. This assumption overlooks the reality that investors are progressively managing global portfolios, wherein domestic market fluctuations, global market integration, exchange rate volatility, geopolitical disturbances, and foreign policy ramifications amplify risk. Consequently, CAPM is unable to elucidate fluctuations in returns generated by global risk.

Arbitrage Pricing Theory (APT) incorporates macroeconomic considerations that elucidate asset returns. APT is versatile, although it pertains solely to specific factors rather than the entire system. The idea fails to recognize global interconnection or account for shocks originating from one country affecting international markets. In APT, economic issues are typically regarded as autonomous, despite global financial crises demonstrating that risk may propagate over networks.

Investors are attracted to this innovative financial asset because of their increasing environmental consciousness and the diversification opportunities it presents through overseas assets, which exhibit minimal correlation with domestic financial assets (Reboredo, 2018). Pham (2021) evaluated the frequency connectivity and cross-quantile dependency of global stocks, revealing that these factors are minimal under normal market conditions but exhibit significant connectedness during periods of extreme market volatility.

The significance of finance in economic stability and growth is well-documented both conceptually and experimentally. Dada et al. (2025) contend that financial integration substantially influences economic growth. New endogenous growth theories have rekindled interest in the ability of financial institutions to facilitate financial integration and stimulate economic growth. Economic downturns may intensify financial strain (Monterroso & Vilán, 2025). Schumpeter (1934) and Goldsmith (1969) examined financial integration, efficiency, and economic growth across many economies. The empirical studies (Tajgardoon, Behname, & Noormohamadi, 2013; Zarrouk et al., 2017) delineate financial integration networks that propel economic progress. In recent years, much attention has been directed towards financial and economic integration. Financial integration enhances risk sharing, portfolio diversification, and capital accessibility for enterprises and individuals. Nonetheless, it may exacerbate financial volatility, contagion risks, and the transmission of shocks across borders. The interconnectedness of worldwide financial institutions, markets, and economies generates global systemic risk, which is not addressed by any of the classical theories. The 2008 global financial crisis, the European sovereign debt crisis, and the market disruptions caused by COVID-19 demonstrated that threats are universal. Co-movement, contagion, and spillover effects frequently occur in financial markets, particularly among international assets.

This limitation creates a significant theoretical and empirical disparity. Portfolio theories do not encompass global connection indicators such as cross-market spillovers, volatility transmission, and network-based risk structures. This study is devoid of a global connectedness framework to analyze international asset returns and risks, which are influenced by global interconnections, cross-border interactions, and systemic shocks. This study enhances asset pricing theories by incorporating global risk and interconnectedness into portfolio analysis. It elucidates global financial market diversification, risk transmission, and investment decision-making.

This study selects both developing and developed economies. This study centers on the informal coalition of advanced economies, which includes Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, the European Union, Austria, Belgium, the Netherlands, Poland, Spain, Sweden, Switzerland, New Zealand, Ireland, Denmark, Hong Kong, Norway, Finland, Portugal, Iceland, Singapore, Australia, and the Czech Republic. Brazil, Russia, India, China, South Africa, Pakistan, Qatar, Kuwait, Bahrain, Saudi Arabia, Oman, Poland, Romania, Bulgaria, Malaysia, Argentina, Maldives, Mexico, Turkey, Mauritius, Thailand, Colombia, Lebanon, Indonesia, Jordan, Ukraine, Vietnam, Philippines, Morocco, Sri Lanka, Bangladesh, Kenya, Nigeria, Zimbabwe, Nepal, and the UAE are classified as emerging economies. Previous research has predominantly concentrated on developed or emerging markets, sometimes neglecting the intricate linkages between the two. This study used the Dynamic

Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) model to analyze financial integration in developed and emerging nations and its impact on economic growth. The DCC-GARCH model is optimal for this analysis since it facilitates the investigation of time-varying correlations among asset classes, essential for comprehending dynamic interactions that may develop in reaction to market shocks such as the pandemic. This study use the Diebold-Yilmaz Test and regression models to validate the robustness of the results across various situations.

2 LITERATURE REVIEW

Numerous theoretical frameworks analyze financial integration, economic integration, and growth. The "financial openness hypothesis" advocates worldwide financial unification. This concept posits that financial integration might enhance economic growth. Global financial markets are interconnected due to co-volatility, return correlation, and international business pressures. International investors can benefit from enhanced liquidity in financial markets, improved resource efficiency, and the capacity to leverage global financial markets. Financial markets are interconnected through shocks and returns. Developed markets predominantly impact emerging markets. Investors in emerging nations must consistently observe developments in developed markets, as these can profoundly influence their financial systems (Rodríguez & Sosvilla, 2020). The extent of asset connection differs by zone, asset category, and risk of shock (Li et al., 2024). These uncertainties influence asset relationships in both developed and developing nations (Adisa, 2024; Liaw, 2020). Financial integration enhances economic growth, technological advancement, and sustainable development (Liu et al., 2023) (Tomczak, 2024). Countries and corporations are implementing greater financial integration. Increased yields, less price volatility, and enhanced liquidity (Bachelet et al., 2019; Alonso and Rojo, 2020).

The integration of financial systems can enhance financial stability by establishing a more diverse and robust financial infrastructure. Chen and Novy (2023) demonstrate that financial integration reduces trade costs and enhances trade volumes, particularly in nations with underdeveloped financial systems. The integration of financial markets and institutions enables the global financial system to absorb and mitigate shocks and crises, therefore reducing the vulnerability of specific countries or regions. Financial integration increases risks such as global financial volatility, contagion, and regulatory arbitrage. Consequently, governments must meticulously manage these risks and advocate for transparent, well-regulated financial integration. Financial integration enhances economic growth, cohesion, and stability, yielding advantages for investors, corporations, and individuals. Financial integration poses challenges and risks; yet, authorities must collaborate to guarantee its judicious and sustainable execution.

Enhancing the banking sector facilitates savings for manufacturing, hence creating essential capital for economic expansion. Financial intermediation aggregates domestic and international savings to facilitate business investments. Financial intermediaries comprise banks, non-banking financial institutions (NBFIs), and capital markets. Akbari, Ng, and Solnik (2021) assert that integration occurs progressively and is impervious to cycles. Patra and Panda (2021) quantify the transmission of volatility among gold, oil, and the US stock market among the BRICS countries. The investigation indicates that internal volatility spillovers surpass external ones.

It is important to note that all these studies concentrate on developed and Western economies, excluding the financial and economic growth of emerging economies within and among developed nations. Kunt and Levine (2011) analyze the impact of financial structure—specifically bank-based and market-based financial systems—on economic growth across various countries. The research indicated that market-oriented financial systems enhance economic growth solely in countries with robust legal and regulatory frameworks. Emerging economy stock markets possess significant potential; yet, portfolio design decisions are contingent upon financial and economic convergence between emerging and developed nations. Financial integration increasingly influences stock market co-movement (Huang, Goodell, and Goyal.,2021).

In recent decades, economists and policymakers have concentrated on financial integration and stability. Lane (2023) examines contemporary trends in international financial integration, highlighting the increasing significance of emerging market economies alongside the challenges of financial instability and inequality. He contends that although financial integration offers numerous advantages, it necessitates global regulation and coordination. The finances of interconnected economies can lead to economic and monetary instability. Central banks, the IMF, the World Bank, and the

Bank for International Settlements have released multiple publications on financial system stability. Wu (2022) utilize cross-border mergers and acquisitions as an indicator of financial integration, demonstrating that it enhances economic growth, particularly in sectors characterized by low entry barriers and intense rivalry. This could enhance worldwide securities exchange connections and elevate the significance of economic volatility research.

This study analyzes the dissemination of financial and economic advancement between emerging and industrialized countries. This analysis investigates the interconnectedness of financial and economic factors in emerging nations, focusing on their interactions within these countries and their influence on associated variables in established economies. Emerging nations must be incorporated into this research, as numerous countries have underscored globalization inside their financial systems to attain economic growth and financial integration.

3 METHODOLOGY

The study analyzes the equity market dynamics and spillover effects between developed and developing economies. The population comprises significant established and emerging economies. Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, the European Union, Austria, Belgium, the Netherlands, Poland, Spain, Sweden, Switzerland, New Zealand, Ireland, Denmark, Hong Kong, Norway, Finland, Portugal, Iceland, Singapore, Australia, and the Czech Republic are encompassed. Argentina, Maldives, Mexico, Turkey, Mauritius, Thailand, South Africa, Colombia, Lebanon, Indonesia, Jordan, Ukraine, Vietnam, Philippines, Morocco, Sri Lanka, Bangladesh, Kenya, Nigeria, Zimbabwe, Nepal, and the UAE are classified as developing economies. The study utilized secondary data from 2010 to 2023. All financial integration data is sourced from DataStream.

The DCC GARCH model was employed to assess ecologically viable connections between industrialized and developing countries. A variety of connection indexes between developed and emerging economies will emerge. The DCC-GARCH model is frequently utilized to analyze and simulate correlations in financial time series data. This approach is frequently employed to measure the dynamic interplay among financial markets and assess financial integration. Ultimately, our technique precisely estimates the parameters of the DCC-GARCH model. Maximum Likelihood Estimation is prevalent. This phase calculates parameters utilizing maximum likelihood estimators to enhance the likelihood function for the data.

The DCC GARCH model for financial integration is well endorsed in the literature. Afzal et al. (2021) computed the Weighted Average Cost of Capital (WACC) for emerging market projects utilizing the DCC-GARCH model. DCC-GARCH can impose time-varying dynamics on the dynamic conditional correlations between variables. This facilitates the examination of time-specific dependencies more effectively than unconditional correlation (Yildirim et al., 2022).

The dynamic conditional correlation model for the conditional correlation between two series, denoted by ρ, is specified as follows:

$$Q_t = diag(\sigma 1_t, \sigma 2_t), R. diag(\sigma 1_t, \sigma 2_t) \quad (1)$$

where:

Q_t is the conditional covariance matrix.

σ_{1t} and σ_{2t} are the conditional standard deviations of the two series.

R is the correlation matrix, which follows a DCC process.

The DCC process is modeled as:

$$R_t = (1-\lambda).\bar{R} + \lambda. Q_{t-1}^{\frac{-1}{2}}. Q_t. Q_{t-1}^{\frac{-1}{2}} \quad (2)$$

where:

R_t is the conditional correlation matrix at time t.

R is the long-run average correlation matrix.

λ is a parameter that determines the speed of adjustment to the long-run average.

3.1 DCC-GARCH model

Combining the univariate GARCH models and the dynamic conditional correlation model, the DCC-GARCH model is formulated as follows:

$$\varepsilon 1_t = \sigma 1_t, Z1_t \qquad (3)$$

$$\varepsilon 2_t = \sigma 2_t, Z2_t \qquad (4)$$

$$\sigma 12_t = w1 + a1. \varepsilon 21_{t-1} + \beta 1. a12_{t-1} \qquad (5)$$

$$\sigma 22_t = w2 + a2. \varepsilon 22_{t-1} + \beta 1. a22_{t-1} \qquad (6)$$

Thus

$$Q_t = diag(\sigma 1_t, \sigma 2_t), R. diag(\sigma 1_t, \sigma 2_t) \qquad (7)$$

$$R_t = (1-\lambda). \bar{R} + \lambda. Q_{t-1}^{\frac{-1}{2}}. Q_t. Q_{t-1}^{\frac{-1}{2}} \qquad (8)$$

where:

ε_{1t} and ε_{2t} are the standardized residuals

$\sigma_{1t}t2$ and $\sigma_{2t}t2$ are the conditional variances $\omega 1, \alpha 1, \beta 1, \omega 2, \alpha 2, \beta 2$ are parameters to be estimated

$Z1t$ and $Z2t$ are standardized innovations (typically assumed to follow a normal distribution)

After estimating the DCC-GARCH model, this study has analyzed the dynamic conditional correlation matrix R_t to measure financial integeration integration. The elements of this matrix represent the time-varying correlations between the two series. A higher and more stable correlation indicates a higher level of financial integeration integration. The model simultaneously estimates the volatility of individual financial integeration and their dynamic conditional correlations. This provides a more comprehensive understanding of the joint behavior of financial integeration prices.

3.2 Measuring connectedness

Diebold and Yilmaz (2012) present a methodology for assessing the degree of interconnectedness through the analysis of fluctuations in forecast errors. This is intricately linked to the well-established econometric principle of variance decomposition. The term "DijH" denotes the deviation in the precision of the H-step forecast at the ij-th location. dijH is the fraction of the variability in the prediction error of variable i during a designated time frame that can be directly ascribed to the influence of disturbances originating from variable j. It is essential to underscore that dij, for i, j = 1, ⋯N, where i ≠ j. The primary factor is the disparity between i and j, highlighting the "non-own" or "cross" dimension of our connectivity assessments.

While analyzing the data formation process that is both covariance-stationery and N-dimensional and includes orthogonal shocks. It is crucial to comprehend that Θ does not necessarily need to be in diagonal form. The current elements are combined in Θ, whereas the changing elements are represented by {Θ1, Θ2, ⋯}. To elucidate and consolidate the link, the set of variables {Θ1, Θ2, ⋯} must be transformed by variance decompositions. Diebold and Yilmaz introduce a connection table, which is essential for understanding the various interconnected metrics and their interactions. The variance decompositions are kept in the upper-left N × N block, which is commonly known as the "variance decomposition matrix" (DH = [dijH]). The connection table improves the DH by appending a row at the bottom that displays the total of each column, a column on the right that displays the total of each row, and an element at the bottom-right that displays the overall average.

Due to the inequality of Ci H←j and Cj H←i in general, there are N2 − N distinct pairwise directional connectedness measures. The net pairwise directional connectedness is defined as the difference between Ci H←j and Cj H←i, represented by the equation (9 and 10) as d_ij H.

We will now examine the aggregate values in the rows or columns that do not reside on the principal diagonal of DH. The off-diagonal row sums, denoted as "from others" in the connectivity table, represent the proportion of H-step forecast-error variance of variable xi attributable to shocks originating from all variables except one. The off-diagonal column sums, referred to as "to others," represent the percentage of the

H-step forecast-error variance of variable xi attributable to shocks from all other variables.

Table 1

Schematic of a connectedness table.

	x_1	x_2	…	x_n	$From\ Others$
x_1	d_{11}^H	d_{12}^H	…	d_{1N}^H	$\sum_{j=1}^{N} d_{1j}^{H}, j \neq 1$
x_2	d_{21}^H	d_{22}^H	…	d_{2N}^H	$\sum_{j=1}^{N} d_{2j}^{H}, j \neq 2$
.	.	.		.	.
.	.	.		.	.
.	.	.		.	.
x_N	d_{N1}^H	d_{N2}^H	…	d_{NN}^H	$\sum_{j=1}^{N} d_{Nj}^{H}, j \neq N$
$To\ others$	$\sum_{i=1}^{N} d_{i1}^{H}, i \neq N$	$\sum_{i=1}^{N} d_{i2}^{H}, i \neq 2$	…	$\sum_{i=N}^{N} d_{i1}^{H}, i \neq N$	

The connectedness measures are calculated based on the off-diagonal elements of the variance decomposition matrix DH, with a specific emphasis on the "non-own" or "cross" components. The off-diagonal elements represent the major components of the N forecast error variance decomposition, indicating the pairwise directional connection. The pairwise directional connection from j to i is defined as: The equation can be rewritten as

$$C_iH \leftarrow j = d_{ij}H \quad (9)$$

$$C_jH \leftarrow i = d_{ij}H \quad (10)$$

The concept of entire directional connectivity from others to i is defined as the complete and unidirectional flow of connections from others to i. The expression is as follow

$$C_i H \leftarrow \blacksquare d_{ij} H \quad (11)$$

The overall level of connectivity and interdependence with others from point j is referred to as total directional connectedness.

$$C\blacksquare \leftarrow H_j = \sum_{i=1}^{N} d_{ij} H \quad (12)$$

There are a total of 2N directional connectedness measurements. The net total directional connectedness of variable i is defined in the same way as the net pairwise directional connectedness.

$$C_i H = C\blacksquare \leftarrow H_i - C_i H \leftarrow \blacksquare \quad (13)$$

There are total of N measurements that quantify the level of directional connectivity in a network. Ultimately, the overall connectivity is determined by summing the values in the "from" columns or "to" rows, which corresponds to the sum of all the off-diagonal entries in DH. Total connectivity is defined as

$$CH = N1 \sum_i N_{j=1} d_{ij} H \quad (14)$$

The matrix utilized for the generalized variance decomposition (GVD) in the H-step methodology. $D^{gH} = \left[d_{ij}^{gH}\right]$ with entries, which is

$$gH = \frac{\sigma_{ij}^{-1} \sum_{h=0}^{H-1} (\acute{\varepsilon}_\iota \Phi_h \sum \varepsilon_j)^2}{\sum_{h=0}^{H-1} (\acute{\varepsilon}_\iota \Phi_h \sum \acute{\Phi}_h \varepsilon_i)} \quad (15)$$

The vector ej is characterized by a value of 1 in the j-th position and 0 in all other positions. The matrix Θ denotes the coefficients in the infinite moving average representation of the non-orthogonalized VAR. The covariance matrix Σ denotes the interrelationship among the various elements of the shock vector. The number σjj represents the j-th diagonal element of Σ. Employing the Koop-Pesaran-Potter-Shin generalized VAR framework, which integrates non-orthogonal shocks, the total contributions to forecast error variance may not consistently be equal. Consequently, we normalize each element of the generalized variance decomposition (GVD) matrix by dividing it by the sum of its respective row.

4 EMPIRICAL RESULTS

4.1 Descriptive stats

Table 1 presents the summary statistics on the returns of Financial integeration for the selected nations. The chosen series exhibit a range of returns and volatility. The financial integeration are having the positive returns which are 0.0385 but volatility in those returns is 0.2542. This indicates that financial integeration issued by the developed nations of the world are operating in profit. However, the mean returns on financial integeration issued by the developing countries are negative, indicating they are operating in loss. The findings have shown that volatility in returns is same in both developed and developing countries.

Table 1

Descriptive Stats

	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
EG	4.6979	9.9439	1.0050	2.2419	0.9159	2.8687
FI	1.4296	2.1363	0.6095	0.3305	-0.8287	4.7652
Developed_R	0.038514	0.763776	-0.99974	0.254254	-0.89196	5.524708
Developing_R	-0.01501	0.643981	-0.99953	0.259555	-0.80915	4.809966

Source(s):Developed from authors own source

The study has used the data from 2010-2023 of the main macroeconomic and trade variables for checking the heterogeneity among countries and across the time. The findings of descriptive statistics have shown in Table . It has shown that Financial Integration (FI) has the minimum value of 0.6095 and its maximum value reach at 2.1363 On the other hand, its mean value is 1.4296 and it shows the presences of right skewness of the data. It suggest that all the countries have modest level of financial integration and few of them have the highest level as well. Overall, the findings of descriptive statistics shows the diversity and complexity of the panel dataset due the presence of ranges, variances, and skewness. This heterogeneity justify the usage of modern econometric techniques because this have the ability to accommodate the complex structure of the data for getting meaningful insights.

4.2 Dynamics of financial integeration returns

Figure 1

Returns and volatility for Developed Financial integeration

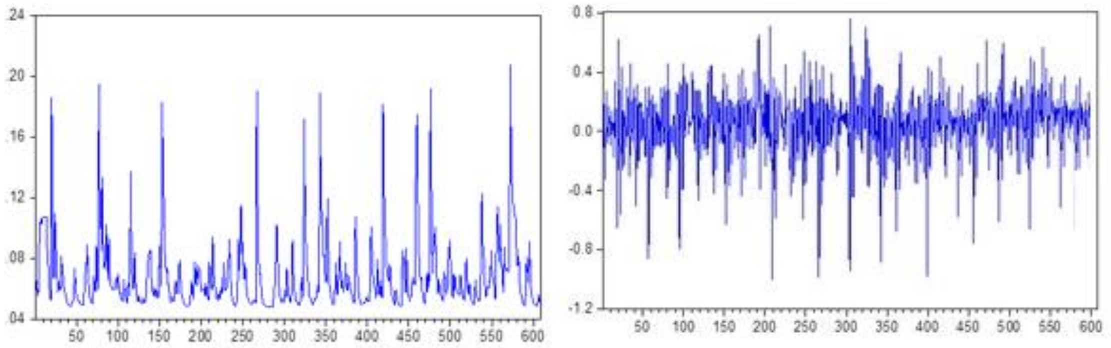
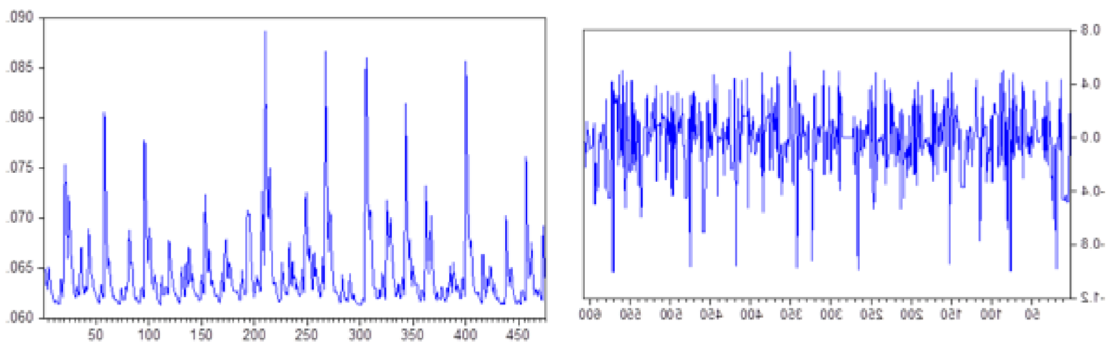


Figure 2

Returns and volatility for Developing Financial integeration



The graphs of financial integeration return display the fluctuating average and variability during the 2010–2023. The graphs indicate a decrease in volatility. The graph in Figure 1 illustrates the performance of developed nations, indicating a significant level of volatility in their returns. Additionally, there are noticeable large fluctuations in the returns, suggesting that the developing financial integeration markets are highly volatile and carry a higher level of risk, as depicted in Figure 2.

4.3 Correlation matrix

The correlation matrix elucidates significant linkages among economic growth (EG), financial integration (FI), trade, reserves, money supply (M2), and industrial production (IPI). Researchers get insight on the economic relationships between emerging nations and developed countries via their studies. The lack of causation between correlated variables does not hinder our comprehension of their directional and strength-based interactions. The results are reported in Table 2.

Table 2

Correlation Matrix

Variables	Developed_R	Developing_R	EG	FI
Developed_R	1.000			
Developing_R	0.818***	1.000		
EG	-0.001	-0.002	1.000	
FI	0.000	-0.006	0.172***	1.000

Note: *** shows significance at p<.05

The results indicate that there is a strong positive correlation among the returns of developed and developing economies as the value of 0.818 shows a strong positive significant correlation among them. Similarly the correlation among the financial integeration index and economic growth is also significant with a value of 0.172 which depicts that there is also a relationship among them.

4.4 Granger causality test

This study has used the Granger Causality test to determine the integration between developed and developing financial markets. The findings of Granger causality between developed and emerging markets are displayed in Table 3. The results indicate a bidirectional link, as both null hypotheses were rejected. The interconnection of the financial integeration market between developed and developing nations is attributable to several economic, environmental, and financial concerns. Developed governments have instituted comprehensive financial frameworks that act as exemplars for developing countries. This success has motivated emerging nations to implement analogous frameworks, particularly in Southeast Asia, where market participants are progressively acknowledging the potential of financial integeration to fund sustainable development goals (SDGs) (Nguyen et al., 2022).

Similar results have been achieved by (Ding et al., 2023; Saravade & Weber, 2020) which employ a Granger causality test to examine the linkage between financial markets of different developed countries, revealing that these markets are interconnected across different quantiles and market conditions This suggests that the relationship between financial integeration is not only significant but also varies depending on the market environment. So, it shows that there is integration among developed and developing financial integeration market. Thus this study applies DCC GARCH for the integration among equity markets of developed and developing countries

Table 3

Pairwise Granger Causality Tests

Null Hypothesis	F-Statistic
DEVELOPED_GB does not Granger Cause DEVELOPING_GB	8.97926***
DEVELOPING_GB does not Granger Cause DEVELOPED_GB	3.36556***

Notes: *** indicate significance at the 1 % level.

4.5 DCC-GARCH model

The positive aspects of diversifying one's investment portfolio across multiple markets are influenced by the varying levels of volatility and correlations across them.

The study has utilized two DCC-GARCH models, one with a Gaussian distribution and the other with a t-distribution, in order to compare the maximum likelihood values. For instance, Afzal et al. (2021) employed the GARCH (DCC) tool to analyze the volatility dynamics in emerging markets, emphasizing its effectiveness in capturing the conditional correlations between financial integeration market.

The table 4 present the determined probability assessments for the parameters of volatility and decay (λ1 and λ2) in the DCC with t stats and DCC (Gaussian) models for the return series. The combined values of the volatility boundaries (λ1 and λ2) for each progression are below one, suggesting that the conditional volatilities display mean-reversion with a progressive decline in volatility with time. The risk metrics suggest utilizing a standardized set of decay parameters ranging from 0.95 to 0.97. Similar results have been achieved by (Hassan et al., 2018; Gupta & Guidi, 2012) where the volatility in the conventional market of developed countries can significantly impact the emerging markets, particularly during periods of economic uncertainty or financial crises

Investors looking to invest in a portfolio comprising industrialized nations and their trade counterparts can benefit from this situation, as disruptions would progressively decrease. According to (Zou & Zhang, 2022), the DCC-GARCH model has been effectively utilized to investigate the dynamic volatility spillover between developed and developing markets. For example, during the COVID-19 pandemic, many countries experienced heightened volatility in their financial markets, including financial integeration. The DCC-GARCH model can help identify periods of increased correlation between developed and developing markets, indicating a stronger interconnectedness during crises (Afuecheta et al., 2024; Afzal et al., 2022).

Table 4

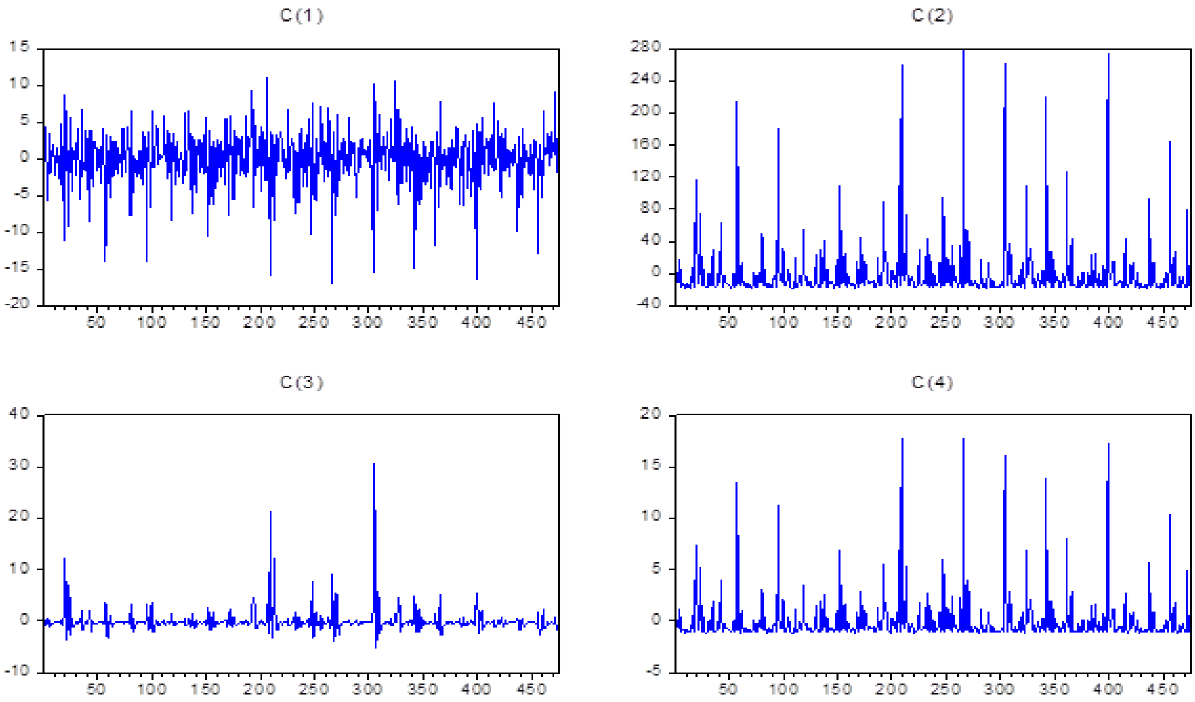
DCC model on financial integeration returns with Maximum Likelihood.

Parameter	λ_1	λ_2	$1-\lambda_1+\lambda_2$
Developed Financial integeration	0.423305***	0.412350***	0.164345
Developing Financial integeration	0.414988***	0.400098***	0.184914

Notes: *** indicate significance at the 1 % level.

Figure 4

Graphical representation of DCC Grach coefficients



4.6 The volatility and correlations with unconditional pairs

The t-DCC model computes volatilities and correlations unconditionally, providing insights into the potential advantages of diversifying a portfolio with financial integration in both developing and industrialized nations. The results in relation to Volatility and Correlations with Unconditional pairs are presented in Table 5.

Table 5

Rank of volatilities with unconditional pair.

Rank	Country	Volatility with Unconditional pair
1	Developing	1.6871**
2	Developed	0.9807***

Notes: *** indicate significance at the 1 % level. ** indicate significance at the 5 % level.

Table 6 shows the results of t-DCC GARCH which displays the correlation with unconditional marketplace sets, which signifies the degree of co-movement linking the markets. The relationship between developed and developing markets is strong. The correlation between developed and developing DCC is 0.93549, unconditionally. An effective correlation is advantageous for achieving portfolio diversification. Consequently, for investors, these markets offer a practical and achievable opportunity for portfolio investment. Similar results have been achieved by (Murty et al., 2022) all through COVID-19 endemic, the volatility in the bond market of developed countries can significantly impact emerging markets, highlighting the interconnectedness of these financial ecosystems.

Table 6

t-DCC Estimated volatilities and Correlation Unconditional pairs

	Developing	Developed
Developing	2.6749	0.93549***
Developed	0.93549***	0.954

Notes: *** indicate significance at the 1 % level.

4.7 Diebold and Yilmaz connectedness test

The results of of connectivity, employing the methods established by Diebold and Yilmaz (2012), are displayed in Table 7. This method quantifies the linkages or ripple effects among various elements within a network. The study utilizes a VAR (Vector Auto-regression) model to evaluate the degree to which disruptions from one entity can explain the variations in forecast errors of other entities. The values in the major section of the table represent the proportion of anticipated error variation in each row index attributable to disturbances in each column index.

As an illustration, the cell located at the intersection of the developing_R row and column contains a value of 35.0. This indicates that the discrepancies in the development of the "developing_ R" column contribute to 35% of the fluctuations in forecast errors in the "developed_ R" row. Similarly, the value 37.8 can be found at the intersection of the developing_ R row and column. This indicates that disturbances in the developed_ R account for 37.8% of the discrepancy between the forecast and the actual outcome. The diagonal of the matrix represents the proportion of the index's forecast error variance that may be attributed to its own shocks. As an illustration, the variable "developed_ R" has a diagonal value of 65, indicating that 65% of the variability in forecast errors for financial integeration from developed nations may be attributed to internal factors specific to those countries. Similarly, the diagonal of the matrix shows the extent to which the forecast error variance of the index is explained by its own shocks. As an illustration, the diagonal value of developing_ R is 62.2, indicating that 62.2% of the variation in forecast errors for financial integration issued by developing countries can be attributed to their own shocks.

These findings complement Reboredo (2018) who establish a strong connectivity between developed and developing market through Diebold and Yilmaz test both in terms of distribution and bilateral relationship.

Table 7

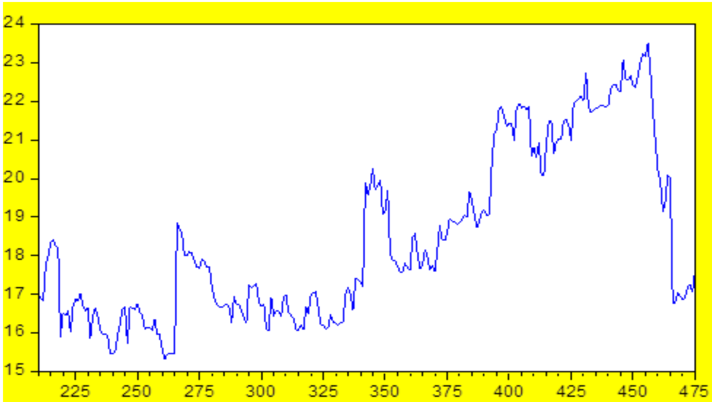
Spillover (Connectedness) Table

	developed_returns	developing_ returns	From Others
Developed_ returns	65.0	35.0***	35.0
developing_ returns	37.8***	62.2	37.8
Contribution to others	37.8	35.0	72.8
Contribution including own	102.8***	97.2***	36.4%

Notes: *** indicate significance at the 1 % level.

Figure 6

Directional Volatility Spillovers



The Figure 6 shows time-varying connectedness, where the values on the y-axis represent the connectedness index, and the x-axis likely represents time (with each point possibly representing daily or monthly data). The connectedness index measures the spillovers among financial markets. Higher values on the y-axis represent higher interconnectedness, suggesting stronger linkages between the developed and developing financial markets. Taghizadeh-Hesary and Yoshino (2021) reported the similar results using this type of figure by explaining higher values on the y-axis represent higher interconnectedness suggesting stronger linkages among different stock markets.

Table 8

DCC-GARCH Estimates of Financial Integration for Developing countries and Developed countries

Parameter	Developing countries	Developed Countries
ARCH Parameter (θ_1)	0.1152*** (1.9115 E 08)	-0.0545*** (0.0080)
GARCH Parameter (θ_2)	0.8564*** (7.5811E -07)	1.0340*** (0.0202)
Rho	0.7699 (7533.82)	0.5207 (55.1758)
Log-likelihood	104.6364	0.5808
Avg. Log-likelihood	-834.4248	-2.4396
Akaike Info Criterion	-1.2788	-1.4173
Schwarz Criterion	-834.26	-2.1704
Hannan-Quinn Criterion	-1.13	-1.1649
Stability Condition	$\theta1+\theta2<1$ Met	$\theta1+\theta2<1$ Met

*** Significant at 1%; ** significant at 5%, * significant at 10%;

The Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) model analyzes financial integration between Pakistan and various economies through time-varying correlation analysis from 2010 to 2023.

The Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) model generated results to analyze financial integration between Pakistan and various developed and developing economies from 2010 to 2023. The DCC-GARCH model determines variable correlations between financial markets through its Rho parameter which reveals market connection effects during periods of cross-border financial contamination (Engle, 2002). The DCC-GARCH analysis demonstrated different degrees of financial integration between developed and developing countries from 2010 to 2023. The financial integration between developed and developing countries reached its peak because the dynamic conditional correlation (ρ

= 0.7699, $p < 0.01$) was high and the ARCH ($\theta_1 = 0.1152$, $p < 0.01$) and GARCH ($\theta_2 = 0.8564$, $p < 0.01$) parameters were significant while the stability condition ($\theta_1 + \theta_2 = 0.9716 < 1$) was met which indicated robust estimates and potential contagion effects especially with developed markets The integration level of developing towards developed was moderate ($\rho = 0.5207$, $p < 0.01$) yet the significant ARCH ($\theta_1 = -0.0545$, $p < 0.05$) and GARCH ($\theta_2 = 1.0340$, $p < 0.05$) parameters raised concerns about model reliability despite a met stability condition (Forbes & Rigobon, 2002).

Table: 9

Regression: Estimates relationship between financial integration and economic growth

Path	Estimate	Std. Error	z-value	p-value	Std. Estimate
FI_c →EGindex (a1)	0.465***	0.073	6.351	<0.001	0.373
Dev/Devel_c →EGindex (a2)	0.249	0.068	3.645	<0.001	0.211
FI* Dev/Devel →EGindex (a3)	0.413	0.072	5.697	<0.001	0.334

The regression Equation model has been estimated with total three parameters, which converge after 1 iteration and it suggest the good numerical stability of the model. The Chi-square test statistics' coefficient value is 2.203 with insignificant p-value of 0.259, this shows that model fit the covariance structures properly. Similarly, the coefficient of Comparative Fit Index (CFI) is 0.996 and Tucker-Lewis Index (TLI) is 0.987. Both of these exceeded the cutoff value of 0.95 and shows the excellent relative fitness of the model. Then, the value of Root Mean Square Error of Approximation (RMSEA) is 0.042 with zero confidence interval and it shows the close fit to the covariance of population. Moreover, the value of Standardized Root Mean Square Residual (SRMR) is 0.022 and it also confirms the minimum value of residual variance and shows the good fitness of the model. All these results have shown in in the Table 8.

As far as the structural paths are concerned, the findings have reported in table 7. It shows that all the variables of Financial Integration (FI_c), devloped/developing (c) and their related interaction term of (FI*dev/devel) are positive and they are having statistical significant impact on the Index of Economic growth (EGindex). The value of their coefficient of Financial Integration (FI_C) is 0.373 and its related p-value is less than 0.001. Similarly, the coefficients value of developed/developing, and their related interaction term of (FI*dev/devel) is 0.211 and 0.334. Their p-values are also less than

0.001 and shows the significant impact at 1% level. Similarly, the direct effect of FI_C on the index of Economic Growth (EGindex) is positive as demonstrated by its coefficient value of 0.001, which shows it is statistically significant because it p-value is 0.001 and it shows that most of the impact of FI is on the Growth of the economies.

5 CONCLUSION

This study offers a thorough framework for comprehending the dynamic linkages and interdependencies between the financial markets of industrialized and developing economies from 2010 to 2023. The amalgamation of advanced and emerging financial integration, focusing on investment techniques and portfolio development. The research employed several econometric models, including the Granger causality test, the DCC-GARCH model, and the Diebold-Yilmaz connectedness test. The financial market demonstrates a bidirectional causality between established and developing nations, underscoring the responsiveness of overseas investments to changes in regulatory frameworks and market mood. This link highlights the significance of stable and supportive economic policies in promoting financial integration, especially in developing nations where such frameworks may be underdeveloped. A fundamental reason for the interconnection of financial markets is the common goal of funding sustainable projects that reduce investment opportunities. Developed nations have instituted strong financial structures that serve as exemplars for underdeveloped countries. The DCC GARCH model has elucidated volatility spillovers, revealing substantial financial market volatility transmission between developed and developing nations. Moreover, the Diebold and Yilmaz connectivity test has demonstrated the degree of interconnectedness among numerous financial markets in both established and emerging economies. Furthermore, financial integration significantly contributes to economic growth by enhancing the efficient distribution of capital among nations. Financial integration facilitates the allocation of savings to their most efficient use, broadens investment options, and enhances access to external financing, especially for developing economies. It promotes risk sharing, advances financial market development, and enables the transfer of technology and managerial knowledge. Consequently, financial integration is a crucial catalyst for sustained economic growth within an increasingly international financial system.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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