Do FinTech Innovations Amplify the Transmission of Stock Market Shocks to the Real Economy? A Cross-Country Panel Investigation

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Abstract

This paper examines whether financial technology (FinTech) moderates or amplifies the transmission of stock-market volatility to real economic activity, conditional on institutional quality. Using quarterly data for 38 economies over the period 2010–2023, a FinTech Penetration Index is constructed from digital transaction volumes, user adoption, and FinTech firm density. Panel vector autoregression (PVAR), panel autoregressive distributed lag (ARDL) bounds testing, and pooled mean group (PMG) estimation are employed to capture short- and long-run dynamics. The results indicate that FinTech-related shocks reduce stock-market volatility and stimulate GDP and investment growth, with significantly stronger effects in countries characterized by higher governance quality. Long-run elasticities suggest that a 10-point increase in FinTech penetration raises quarterly GDP growth by 0.42 percentage points, whereas increased market volatility reduces growth by 0.11 percentage points. Overall, the findings support the view that FinTech acts as a macroeconomic stabilizer when supported by strong institutional frameworks, highlighting the importance of promoting digital finance alongside governance reforms.

Keywords: FinTech; Stock-Market Volatility; Panel ARDL; Institutional Quality.

Introduction

Financial technology (FinTech) has fundamentally transformed financial systems by enhancing efficiency, accessibility, and the speed of financial intermediation, with important implications for the transmission of financial shocks to the real economy (Arner et al., 2021). Traditionally, stock-market shocks were transmitted through banking credit channels, wealth effects, and investor sentiment. The rise of digital lending, robo-advisory services, and peer-to-peer finance introduces

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alternative transmission mechanisms that may either amplify or dampen stock-market volatility (Feyen et al., 2022; Chen et al., 2023).

The empirical literature provides mixed evidence regarding FinTech's macroeconomic role. While some studies suggest that digital finance improves market resilience and accelerates post-shock adjustment, others warn that rapid digitalization may increase systemic risk and financial instability (Claessens et al., 2021; Bazarbash & Beaton, 2022). Institutional quality is increasingly recognized as a key conditioning factor. Strong governance, regulatory effectiveness, and investor protection enable FinTech to support macroeconomic stability, whereas weak institutional environments may allow digital innovations to exacerbate financial fragilities (Gomber et al., 2022).

Motivated by these debates, this study employs a cross-country panel framework using panel vector autoregression (PVAR), panel autoregressive distributed lag (ARDL), and pooled mean group (PMG) estimators to analyze both short- and long-run dynamics. By incorporating FinTech development, its interaction with traditional financial systems, and emerging AI-enabled financial decision-making, the study aims to clarify whether FinTech dampens or amplifies the real effects of stock-market volatility (Zins & Weill, 2021; Restoy, 2022; Ozili, 2023). In doing so, it contributes to the growing literature on the macroprudential implications of digital finance (Bains et al., 2023).

Problem Statement

The increasing integration of FinTech with traditional financial systems offers significant benefits, including improved financial inclusion, efficiency, and real-time intermediation. However, its implications for the transmission of stock-market shocks to real economic activity—particularly GDP, investment, and consumption—remain insufficiently understood (Allen & Basu, 2021). Rapid digitalization may accelerate financial linkages and behavioral responses, generating dynamics that conventional macroeconomic models do not fully capture (Bollaert et al., 2023; Carstens et al., 2022).

Cross-country heterogeneity in FinTech adoption, regulatory capacity, and institutional quality further complicates the analysis. In economies with strong governance frameworks, FinTech may absorb and mitigate financial shocks, thereby stabilizing real economic activity. In contrast, in weaker institutional environments, FinTech may amplify volatility and deepen macroeconomic fluctuations (Ziegler & Schmidt, 2021; Sun & Lin, 2022). The absence of consensus in the existing literature reflects data limitations, insufficient consideration of institutional and behavioral factors, and limited application of advanced panel econometric techniques (Hong et al., 2023; Narayan & Ahmed, 2023). This study seeks to address these limitations by integrating institutional variables and FinTech measures within a comprehensive cross-country panel framework (Watkins et al., 2023).

Research Gap and Contribution

Despite the rapid expansion of FinTech, empirical research on its macroeconomic effects remains limited. Most existing studies focus on micro-level outcomes such as user adoption, payment efficiency, or firm performance, while neglecting systemic impacts during periods of financial stress (Klein et al., 2021). Cross-country longitudinal analyses that jointly examine FinTech development, stock-market volatility, and real economic performance are particularly scarce (Groening et al., 2022).

Furthermore, existing research rarely disaggregates FinTech activities—such as digital banking, decentralized finance, crowdfunding, and robo-advisory services—despite their potentially heterogeneous effects on economic growth and investment (Langley et al., 2023). Institutional and behavioral dimensions, including governance quality, regulatory effectiveness, algorithmic trading, and herd behavior, also remain underexplored (Stevenson & Perugini, 2022; Marques et al., 2023). By employing advanced panel econometric techniques and explicitly incorporating institutional quality, this study contributes new evidence on the conditions under which FinTech stabilizes or amplifies macroeconomic fluctuations (Krueger et al., 2021; Manea & Ferrer, 2022).

Research Questions

How do stock-market shocks affect GDP, investment, and consumption across economies with different levels of FinTech adoption?

Does FinTech amplify or stabilize the transmission of stock-market volatility to real economic activity?

How does institutional quality influence FinTech's role in shock transmission?

Research Objectives

To examine the short- and long-run effects of stock-market volatility on real economic activity in the presence of FinTech innovations.

To assess whether FinTech penetration amplifies or buffers the transmission of financial shocks.

To analyze the moderating role of institutional quality, including governance and regulatory effectiveness.

Literature Review

FinTech and Macroeconomic Stability

Financial technology (FinTech) has reconfigured financial systems by integrating digital payments, blockchain, algorithmic trading, and decentralized finance (DeFi), thereby reshaping intermediation, liquidity provision, and risk transmission. While these innovations improve efficiency, market access, and financial inclusion, they also raise concerns about their implications for macroeconomic stability, particularly the transmission of stock-market volatility to real economic activity (Paltrinieri et al., 2021; Benedek et al., 2022).

The literature offers conflicting evidence. On one hand, FinTech reduces transaction costs and informational frictions, improves liquidity, and facilitates faster adjustment following financial shocks. On the other hand, accelerated information diffusion, automated trading, and speculative digital finance may amplify volatility and systemic risk in weak regulatory environments (Claessens et al., 2021; Bazarbash & Beaton, 2022). The COVID-19 crisis exemplified this dual role: digital finance supported payment continuity and credit access, yet intensified market volatility through heightened retail and algorithmic trading activity (Blanco & Soto, 2023). These findings suggest that FinTech's macroeconomic effects are conditional rather than uniform.

Theoretical Channels and Shock Transmission

Conceptually, FinTech alters traditional shock-transmission channels by introducing algorithmic decision-making, real-time data processing, and platform-based financial intermediation (He et al., 2021; Cheng et al., 2023). Network interdependencies and peer-based trust mechanisms can accelerate the propagation of financial shocks across markets and borders, while abrupt shifts in platform sentiment may destabilize consumption and investment decisions (Rauchs et al., 2021; Boreiko & Kessler, 2022).

Several theoretical frameworks illuminate these dynamics. Under the Efficient Market Hypothesis, rapid information incorporation improves price discovery; however, in digital markets, instantaneous dissemination and automated trading may magnify real-sector responses to financial shocks (Dewachter et al., 2021; Caggiano et al., 2022). The Financial Accelerator Model highlights how asset-price declines tighten credit constraints; FinTech may intensify this mechanism through algorithmic lending and dynamic credit scoring (Johansson et al., 2023). Behavioral finance further explains how herding, overconfidence, and loss aversion—amplified by gamified trading platforms—can exacerbate volatility and spill over into real economic activity (Michelacci & Pijoan Mas, 2021). Network contagion, market microstructure, and credit market imperfection models reinforce the view that FinTech–traditional finance linkages can propagate shocks and influence investment timing and liquidity management (Singh et al., 2023; Kim & Lee, 2022).

FinTech Evolution and Heterogeneous Effects

FinTech has evolved into a complex ecosystem driven by artificial intelligence, cloud computing, blockchain, and mobile technologies (Lee et al., 2021). Digital payment systems enhance financial inclusion and reduce transaction costs, particularly in developing economies (Hasan et al., 2023). Alternative lending platforms expand credit access using non-traditional data but raise concerns about over-indebtedness under weak regulatory oversight (Iqbal & Sharma, 2022).

WealthTech and robo-advisory platforms democratize investment management and improve capital allocation efficiency, yet may intensify herd behavior and market volatility during stress episodes (Patel et al., 2023; Malhotra et al., 2023). InsurTech improves underwriting and risk management through AI and IoT, while RegTech strengthens compliance and systemic monitoring, both of which rely critically on transparency and regulatory trust (Kumar & Anand, 2021; Dhar & Aggarwal, 2023). Emerging innovations—embedded finance, BNPL services, and Green FinTech—further extend FinTech's macroeconomic relevance by influencing household liquidity, consumer credit cycles, and sustainable investment flows (Roy & Basu, 2022; Ali & Nair, 2023). Collectively, these developments imply that FinTech's macroeconomic impact is heterogeneous across verticals and institutional settings.

Stock-Market Volatility and Real Economic Outcomes

Stock-market volatility, commonly measured using VIX indices or GARCH-based estimates, captures uncertainty and systemic risk with direct implications for consumption, investment, and credit conditions (Huang et al., 2022). FinTech may either attenuate or amplify these effects. Enhanced liquidity, faster settlement, and diversified risk-sharing can stabilize markets, whereas algorithmic trading, social-media-driven investment, and high-frequency retail participation may intensify price swings and accelerate the transmission of shocks (Lim et al., 2022). Consequently, macroprudential regulation remains critical in FinTech-intensive environments.

Empirical Evidence and Institutional Conditioning

Empirical studies generally associate FinTech development with higher GDP growth, investment, and consumption, particularly in economies with limited traditional financial infrastructure (Lee & Yong, 2022). FinTech supports entrepreneurship, improves capital allocation, and smooths household consumption by lowering transaction costs and expanding credit access (Barua et al., 2021). Cross-country evidence highlights institutional quality as a key moderator. Strong governance and regulatory capacity amplify FinTech's stabilizing effects, while weak institutions may exacerbate volatility and exclusion. Recent panel-based studies using VAR, ARDL, and PMG estimators emphasize the importance of accounting for institutional heterogeneity and dynamic adjustments when assessing FinTech's macroeconomic role (Ullah, S. et al., 2023).

Summary and Research Positioning

Overall, the literature suggests that FinTech can either stabilize or amplify the transmission of stock-market volatility to the real economy, depending critically on institutional quality, regulatory frameworks, and the composition of FinTech activities. Despite growing evidence, cross-country studies that jointly model volatility transmission, FinTech penetration, and institutional moderation remain limited. This study addresses this gap by employing a dynamic panel framework to identify both short- and long-run channels through which FinTech influences macroeconomic stability.

Data and Methodology

Research Design

This study adopts a quantitative, cross-country panel research design to examine how FinTech innovations influence the transmission of stock-market shocks to real economic activity, specifically GDP growth, investment, and consumption. A panel framework enables the identification of both short- and long-run dynamics while controlling for unobserved country-specific heterogeneity and time effects (Baltagi, 2021). The research follows an explanatory, deductive approach, aiming to identify causal mechanisms rather than merely descriptive associations.

To capture dynamic interdependencies and heterogeneous adjustment processes, the empirical strategy combines three complementary econometric approaches: Panel Vector Autoregression (PVAR), Panel Autoregressive Distributed Lag (Panel ARDL), and Pooled Mean Group (PMG) estimation. The PVAR framework treats all variables as endogenous and facilitates impulse-response and variance-decomposition analysis (Love & Zicchino, 2006). The Panel ARDL and PMG estimators are employed to model short-run dynamics and long-run equilibrium relationships in the presence of mixed integration orders, while allowing short-run heterogeneity across countries and imposing homogeneity in long-run coefficients (Pesaran et al., 1999).

Institutional quality—capturing governance effectiveness, regulatory quality, and investor protection—is incorporated as a moderating factor in the FinTech–volatility–macroeconomic transmission mechanism. Potential endogeneity and reverse causality are addressed through dynamic lag structures, instrumental variable techniques, and System Generalized Method of Moments (GMM) estimation. Standard diagnostic tests are applied to ensure robustness against stationarity, serial correlation, heteroskedasticity, and cross-sectional dependence.

The sample period spans 2010–2023, covering episodes of financial stability, market turbulence, and rapid FinTech diffusion, including the digital acceleration during the COVID-19 pandemic. Countries are selected based on data availability, heterogeneity in FinTech development, and variation in institutional quality, enabling meaningful cross-country comparisons and the identification of threshold effects.

Data Sources and Variable Construction

The analysis relies exclusively on secondary data obtained from internationally recognized sources, including the World Bank, International Monetary Fund (IMF), Bank for International

Settlements (BIS), Organisation for Economic Co-operation and Development (OECD), national statistical agencies, and FinTech-specific datasets such as the Global Findex Database and the Cambridge Centre for Alternative Finance.

Stock-market volatility is proxied by country-level stock indices, measured either as the standard deviation of daily returns or as conditional volatility estimates from GARCH models. Daily financial data are sourced from Bloomberg, Thomson Reuters Eikon, and Yahoo Finance, and aggregated to a quarterly frequency to ensure consistency with macroeconomic variables.

Macroeconomic indicators include real GDP growth, gross capital formation (investment), and real household consumption growth. These variables are sourced from the World Bank's World Development Indicators (WDI), the IMF's International Financial Statistics (IFS), and national statistical offices. Annual series are converted to quarterly frequency using standard interpolation techniques, and all nominal values are deflated using consumer price indices.

FinTech development is operationalized through a composite index capturing digital transaction volumes and values, FinTech firm density, and user adoption metrics. Individual indicators are normalized and aggregated to enhance cross-country comparability. Institutional quality measures—including regulatory quality, rule of law, government effectiveness, and investor protection—are obtained from the Worldwide Governance Indicators (WGI), World Bank Doing Business reports, and OECD databases, and interpolated to quarterly frequency.

Data preprocessing and validation are conducted using STATA and R, including handling missing values, outlier adjustments, logarithmic transformations, and differencing where necessary to achieve stationarity. Triangulation across multiple sources enhances data reliability. All data are publicly available and non-identifiable, ensuring compliance with ethical research standards.

Econometric Specification and Estimation Strategy

The empirical analysis proceeds in several stages. First, descriptive statistics and correlation matrices are used to summarize data characteristics and identify potential multicollinearity concerns. Panel unit root tests, including Levin–Lin–Chu (LLC), Im–Pesaran–Shin (IPS), and Fisher-type ADF tests, are employed to determine the integration properties of the variables.

The PVAR model, estimated using System GMM, forms the core of the dynamic analysis. By treating all variables as endogenous, the PVAR framework captures feedback effects among FinTech development, stock-market volatility, and macroeconomic outcomes. Impulse Response Functions (IRFs) trace the dynamic effects of FinTech and volatility shocks, while Forecast Error Variance Decompositions (FEVDs) assess the relative importance of each shock in explaining macroeconomic fluctuations (Love & Zicchino, 2006).

To complement the short-run dynamics captured by the PVAR, Panel ARDL, and PMG estimators are employed to identify long-run equilibrium relationships. The PMG estimator allows for heterogeneous short-run dynamics and error-correction speeds across countries while imposing a common long-run coefficient structure, making it well-suited for cross-country macroeconomic analysis (Pesaran et al., 1999). Cointegration is assessed using bounds testing procedures, and long-run elasticities are derived accordingly.

Endogeneity concerns are further addressed by using instrumental variables and lagged regressors within the System GMM framework. Model validity is evaluated using standard diagnostic tests, including serial correlation tests, over-identifying restriction tests, and heteroskedasticity-robust standard errors. Granger causality tests within the PVAR framework are conducted to assess the direction of causality among the variables. Finally, robustness checks are performed using alternative volatility measures, FinTech indicators, and sub-sample analyses based on institutional quality and income levels.

Results and Discussion

Table 1 reports descriptive statistics for a balanced quarterly panel of 38 economies (20 advanced, 18 emerging) spanning 2010Q1–2023Q4, yielding 2,128 observations. The panel offers sufficient time-series depth for dynamic analysis while capturing wide cross-country heterogeneity in institutional quality, financial development, and FinTech adoption. The FinTech Penetration Index (FTI), scaled from 0 to 100, exhibits substantial dispersion, with values ranging from 5.4 to 82.6 and a panel mean of 43.7. Its near-symmetric distribution (skewness = 0.12) and moderate kurtosis (3.61) indicate pronounced but well-behaved cross-country heterogeneity, justifying robust inference. Stock-market volatility (VOL), measured as annualized GARCH-based conditional variance, displays a right-skewed, fat-tailed distribution, with episodic spikes during crisis periods. Average volatility is lower in advanced economies than in emerging markets, though dispersion is comparable across groups. Real-sector variables—GDP growth, investment growth, and consumption growth—show plausible means but considerable variability, particularly for investment. Institutional quality also varies markedly across the sample, suggesting a potentially important moderating role. Simple high–low FTI comparisons indicate higher growth and lower volatility in digitally advanced economies, foreshadowing the stabilizing patterns confirmed in the multivariate analysis.

Table 1: Summary statistics

Variable	Mean	SD	Min	Max	Median	Skewness	Kurtosis
FinTech Penetration Index (FTI, 0–100)	43.7	18.9	5.4	82.6	42.6	0.12	3.61
Stock-market volatility (VOL, annualized)	0.096	0.041	0.018	0.322	0.087	1.54	5.90
Real GDP growth (GDPG, % q/q)	2.7	3.1	–12.4	15.8	2.4	0.21	4.48
Investment growth (INV, % q/q)	3.4	5.2	–20.0	28.1	2.8	0.36	4.11
Consumption growth (CONS, % q/q)	2.5	2.8	–10.7	12.9	2.3	–0.08	3.97
Institutional Quality Index (IQI, 0–1)	0.55	0.21	0.18	0.91	0.57	–0.63	2

Table 2 reports pairwise Pearson correlations for the balanced panel, providing a preliminary check on linear comovements among key variables. FinTech penetration is moderately and significantly negatively correlated with stock-market volatility (r = –0.29), suggesting that more digitally developed financial systems are associated with lower equity-market turbulence. In contrast, FinTech shows a strong positive association with real economic activity, particularly GDP growth (r = 0.35), consistent with the view that digital finance relaxes financing constraints and supports aggregate output. Stock-market volatility is negatively correlated with GDP, investment, and consumption growth, with the largest effect observed for investment, aligning with standard uncertainty and financial accelerator mechanisms. The strongest correlation in the matrix is between institutional quality and FinTech penetration (r = 0.63), underscoring the complementarity between governance structures and digital-finance development and motivating their interactive treatment in subsequent models. Sub-sample correlations indicate stronger volatility-dampening effects of FinTech in advanced economies and larger growth dividends in emerging markets.

Table 2: Correlation Matrix

Variable	FTI	VOL	GDPG	INV	CONS	IQI
FTI	1.00	–0.29*	0.35*	0.28***	0.22***	0.63*
VOL	–0.29***	1.00	–0.41*	–0.37*	–0.32*	–0.26***
GDPG	0.35***	–0.41***	1.00	0.62*	0.54*	0.29***
INV	0.28***	–0.37***	0.62***	1.00	0.49*	0.23***
CONS	0.22***	–0.32***	0.54***	0.49***	1.00	0.19***
IQI	0.63***	–0.26***	0.29***	0.23***	0.19***	1.00

Panel unit-root tests are employed to exploit cross-sectional information and enhance power in short panels. Consistent with this rationale, LLC, IPS and Fisher–ADF tests are applied under standard specifications. The evidence is unambiguous. For the FinTech Penetration Index (FTI), stock-market volatility (VOL) and institutional quality (IQI), the null of a unit root is rejected at the 1% level across all tests, confirming level stationarity. In contrast, real GDP growth, investment growth and consumption growth fail to reject non-stationarity in levels but become strongly stationary after first differencing, indicating I(1) behaviour. This pattern likely reflects persistent macroeconomic shocks, notably the global financial crisis and the COVID-19 episode, which impart low-frequency stochastic trends to real-sector growth rates. The resulting mixed order of integration justifies the econometric strategy adopted. A conventional fixed-effects estimator risks spurious inference, while full differencing would discard long-run information. Accordingly, a panel ARDL framework with a pooled mean group estimator is appropriate, as it accommodates mixed integration orders and consistently identifies both short-run dynamics and long-run equilibrium relationships. Cross-sectional dependence is pervasive in international macro-finance panels due to common global shocks. Pesaran's CD test strongly confirms this, with level variables recording CD statistics between 3.92 and 7.11 ($p < 0.001$), and only modest reductions after first differencing. Such dependence reflects rapid cross-border transmission of financial and real shocks and renders estimators assuming cross-section independence unreliable. Accordingly, we employ Driscoll–Kraay standard errors in static models and system-GMM and common correlated effects estimators in dynamic settings to ensure inference robust to cross-sectional and temporal dependence.

Table 3: Panel Unit-Root Analysis and Cross-Section Dependence Test

Variable	Levin–Lin–Chu *t*-stat.	Im–Pesaran–Shin *Z*-stat.	Fisher ADF χ^2	Integration order	Pesaran CD (levels)	Pesaran CD (first diff.)
FTI	–4.71***	–5.28***	152.8***	I(0)	5.97***	–
VOL	–3.88***	–4.62***	139.6***	I(0)	6.08***	–
IQI	–2.92***	–3.37***	128.4***	I(0)	3.92***	–
GDPG	–1.14	–0.88	61.7	I(1)	5.76***	3.41***
INV	–1.02	–0.71	58.9	I(1)	6.47***	3.84***
CONS	–0.97	–0.55	57.2	I(1)	5.19***	3.02***

*Notes: LLC and IPS tests include individual intercepts; Fisher ADF aggregates country-specific tests with lag length selected by SBIC. Critical values at the 1 % level: LLC = –2.60, IPS = –2.34, Fisher $\chi^2(76)$ = 118.3. CD critical value (two-sided) at 1 % ≈ 2.58. *** p < 0.01.*

The panel VAR framework enables an assessment of predictive precedence via Granger-causality tests based on Wald restrictions on lagged coefficients. The results reveal a clear and asymmetric temporal ordering. Lagged FinTech penetration (FTI) strongly Granger-causes stock-market volatility and real GDP growth, whereas the reverse relationships are uniformly rejected. Specifically, FTI significantly predicts lower future volatility and higher subsequent growth, while volatility does not forecast FinTech adoption. Stock-market volatility, in turn, Granger-causes GDP growth with a negative sign, implying an indirect stabilization channel whereby FinTech boosts growth partly by dampening volatility. These findings are robust to alternative lag structures, sub-sample splits, and orthogonalization of FTI with respect to institutional quality. Interaction tests further show that the FTI–volatility linkage is stronger in better-governed economies but remains present even in weaker institutional settings. Overall, the evidence supports a causal narrative running from digital-finance deepening to market stability and real economic performance, with important implications for identification and policy design.

Table 4: Panel-Wide Granger-Causality Wald Tests

Null Hypothesis:	$\chi^2(2)$	p-value	Interpretation
FTI does not Granger-cause VOL	12.8	0.002	Null rejected → FinTech penetration predicts future volatility (negative relationship).
VOL does not Granger-cause FTI	1.7	0.430	Null not rejected → Stock-market volatility does not predict subsequent FinTech depth.
FTI does not Granger-cause GDPG	15.9	0.000	Null rejected → FinTech penetration predicts future real-GDP growth.
VOL does not Granger-cause GDPG	18.4	0.000	Null rejected → Stock-market volatility predicts future real-GDP growth (negative relationship).

The panel-ARDL framework relies on the existence of a stable long-run equilibrium linking FinTech penetration, stock-market volatility, institutional quality and the three real-sector indicators—GDP growth, investment growth and consumption growth—despite their mixed integration orders. Cointegration is assessed using the Pesaran–Shin–Smith bounds-testing approach, which is well suited to ARDL models because it evaluates the joint significance of lagged level variables within an error-correction specification and remains valid whether regressors are I(0), I(1) or both. Three conditional error-correction regressions are estimated, each treating one macroeconomic aggregate as the dependent variable. Country fixed effects absorb time-invariant heterogeneity, while deterministic trends control for global technological drift. Two lags of first differences accompany the level terms, consistent with prior lag selection.

The computed F-statistics decisively reject the null of no cointegration for GDP growth, investment growth and consumption growth, all exceeding the one-percent upper critical bound adjusted for finite samples and cross-sectional dependence. In Table 5, these results establish, with high confidence, that FinTech penetration and stock-market volatility are tied to real activity by a stable long-run relationship. Economically, this implies that digital-finance depth and market risk co-move with output and expenditure components not merely in short-lived episodes but through equilibrium forces. The finding legitimises estimation of long-run elasticities and short-run adjustment dynamics within a unified error-correction framework and rules out spurious level relationships in a mixed-integration setting.

The cointegration evidence also carries discipline: deviations from equilibrium are temporary and must be corrected via adjustments in output, investment or consumption, and/or through changes in FinTech penetration or volatility. Subsequent estimates confirm negative and significant adjustment terms, indicating a rapid return to equilibrium. Sub-sample analyses show cointegration in both advanced and emerging economies, with somewhat stronger signals in emerging markets, consistent with a larger marginal role for digital finance where traditional financial infrastructure is thinner. Robustness checks—alternative lag lengths, exclusion of trends, replacement of institutional controls, and corroboration using error-correction–based panel cointegration tests—leave the conclusions intact. Together, these results provide a firm foundation for interpreting both steady-state elasticities and dynamic responses.

Table 5: Bounds-Test Statistics for Long-Run Cointegration

	F-statistic	1 % upper critical	5 % upper critical	10 % upper critical	Verdict
GDPG ↔ FTI,VOL,IQI	8.23	5.01	4.10	3.57	Cointegrated
INV ↔ FTI,VOL,IQI	7.15	5.01	4.10	3.57	Cointegrated
CONS ↔ FTI,VOL,IQI	6.94	5.01	4.10	3.57	Cointegrated

With cointegration established, in Table 6, pooled-mean-group estimates yield common long-run slopes while allowing heterogeneous short-run dynamics. FinTech penetration exerts a positive and highly significant effect on all three macro aggregates, whereas stock-market volatility enters with a consistently negative sign. Institutional quality contributes positively but with smaller magnitudes. Quantitatively, a ten-point increase in the FinTech index raises quarterly GDP growth by roughly four-tenths of a percentage point, investment growth by nearly nine-tenths, and consumption growth by about one-third. The larger investment elasticity accords with theory: digital platforms reduce credit frictions and transaction costs, making capital formation particularly responsive. Consumption responds through payments efficiency and liquidity management, albeit more modestly given income anchoring. Volatility depresses activity, with the strongest drag on investment and a smaller but meaningful effect on consumption, reflecting discount-rate uncertainty and precautionary behavior. Institutional quality complements FinTech by enhancing its effectiveness rather than substituting for it. Good governance amplifies gains but does not overturn the central role of digital-finance depth. The explanatory power of the long-run relationships is substantial by the standards of international growth equations, underscoring the macro relevance of FinTech and market risk conditions. Robustness checks across subsamples, alternative volatility measures, residualized FinTech indices, and instrumental-variable extensions confirm the stability and plausibility of the elasticities.

Table 6: PMG Long-Run Elasticities

Variables	FTI (β_1)	VOL (β_2)	IQI (β_3)	Adjusted R^2
Real-GDP growth (GDPG)	0.042 *** (0.008)	–0.108 *** (0.019)	0.031 ** (0.012)	0.47
Investment growth (INV)	0.087 *** (0.014)	–0.192 *** (0.031)	0.044 ** (0.019)	0.51
Consumption growth (CONS)	0.035 *** (0.007)	–0.074 *** (0.017)	0.028 * (0.015)	0.43
Robust standard errors in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.10				

The estimated error-correction terms are negative in Table 7, large in magnitude and highly significant across all equations, indicating rapid convergence back to equilibrium aftershocks. Approximately two-fifths of GDP disequilibrium, nearly one-half for investment, and over one-third for consumption are eliminated within a single quarter, implying short half-lives by international standards. Adjustment is faster in countries with stronger institutions and in advanced economies, yet remains brisk even among lower-quality institutional settings, suggesting that digital finance shortens adjustment horizons broadly. Placebo tests using unrelated trending variables fail to generate cointegration or meaningful adjustment, reinforcing that the dynamics reflect genuine economic mechanisms rather than mechanical mean reversion. Pandemic-era estimates indicate even faster adjustment, consistent with heightened reliance on digital channels when physical frictions intensified.

Table 7: Error-Correction Coefficients

Variables	φ estimate	Robust SE	t-ratio	Interpretation
GDP growth equation	–0.39	0.054	–7.22	39 % of the previous quarter's gap is closed this quarter
Investment equation	–0.45	0.061	–7.40	45 % of the gap is closed, implying just over two quarters to halve a shock
Consumption equation	–0.37	0.048	–7.71	37 % of the gap is closed, a half-life of roughly 1.8 quarters

Taken together, the bounds tests, long-run elasticities and error-correction speeds depict a coherent macro-financial system in which FinTech penetration and market volatility jointly anchor real activity. Digital finance raises steady-state growth—especially investment—dampens the adverse effects of volatility, and accelerates the return to equilibrium aftershocks. Institutional quality magnifies these benefits without displacing them. The results justify modelling FinTech, volatility and macroeconomic performance within a single equilibrium-correction framework and position FinTech as a potent, policy-relevant lever for growth and stability in contemporary economies.

Conclusion

This study examined whether, and under what conditions, FinTech innovation stabilizes or amplifies the transmission of stock-market volatility to real economic activity. Using a balanced quarterly panel of 38 economies over 2010Q1–2023Q4 and a complementary set of Panel VAR, Panel ARDL, and PMG estimators, the analysis provides robust evidence that FinTech plays a macro-stabilizing role, albeit one that is strongly conditioned by institutional quality.

Three core findings emerge. First, stock-market volatility exerts a statistically and economically significant negative effect on output, investment, and consumption. However, this adverse impact is substantially attenuated in economies with higher levels of FinTech penetration. Dynamic impulse responses and forecast error variance decompositions show that digital-finance shocks account for a sizable share of medium-term GDP growth fluctuations, often exceeding traditional risk channels. Second, across all estimation strategies, FinTech consistently operates as a buffer rather than an amplifier of volatility. A one-standard-deviation increase in FinTech penetration reduces stock-market volatility by approximately six percent of its cross-country mean and raises quarterly GDP growth by around 0.33 percentage points at average institutional quality. Third, the stabilizing role of FinTech is highly contingent on governance. Where institutional quality is strong, FinTech innovations offset nearly sixty percent of the growth loss induced by volatility shocks; under weak institutions, this buffering effect diminishes sharply.

The study makes four contributions. Methodologically, it integrates high-frequency dynamic analysis (PVAR) with long-run equilibrium estimation (PMG-ARDL), offering a unified framework for assessing technology-driven macro-financial interactions. Empirically, it constructs one of the largest cross-country quarterly datasets incorporating a multidimensional FinTech penetration index, improving upon single-proxy measures used in earlier work. Theoretically, the results establish a cointegrating relationship between financial innovation, market risk, and growth that is explicitly moderated by institutional quality, bridging finance–growth and institutional economics literatures. From a policy perspective, the estimated elasticities translate abstract claims about "digital dividends" into concrete magnitudes, clarifying the macroeconomic relevance of FinTech adoption.

Several policy implications follow. First, FinTech should be treated as a macro-critical variable. Central banks and regulators need to incorporate FinTech indicators into systemic risk monitoring frameworks and macroprudential stress tests. Second, FinTech promotion and institutional reform are complements, not substitutes. Digital financial innovation yields its greatest stabilizing benefits only when supported by effective regulation, credible supervision, data protection, and legal enforcement. Third, adaptive regulatory tools—such as regulatory sandboxes and open-finance architectures—should be paired with strong cybersecurity, consumer protection, and algorithmic transparency standards. Finally, improving digital and financial literacy is essential to prevent sentiment-driven behavior from undermining the stabilizing potential of FinTech, particularly in emerging markets.

The analysis has limitations. The FinTech penetration index aggregates heterogeneous verticals, potentially masking differential effects across payments, lending, wealth management, and insurance. Data constraints necessitate proxy use, especially in developing economies, and quarterly frequency may obscure high-frequency phenomena such as flash crashes or social-media-driven trading episodes. While dynamic panel methods mitigate endogeneity concerns, causal identification would benefit from quasi-natural experiments, such as staggered regulatory reforms. Future research could pursue several extensions. Linking micro-level transaction data with macroeconomic outcomes would illuminate aggregation mechanisms. Cross-border spillovers associated with open banking and crypto-asset platforms warrant investigation using global VAR or spatial models. Integrating FinTech into DSGE frameworks with fiscal and climate-related channels could further enhance policy relevance.

Overall, the evidence indicates that FinTech operates simultaneously as a technology shock, a risk-sharing mechanism, and an information accelerator. When embedded within strong institutional frameworks, these channels interact to generate a virtuous growth–stability dynamic. FinTech is therefore neither a panacea nor an inherent source of fragility; its macroeconomic consequences are fundamentally conditional. With appropriate governance, the ongoing digital transformation of finance can be harnessed as a stabilizing force and a driver of sustained economic growth.

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