

“Alternative finance and industrial trajectories in OECD countries: Institutional governance as a protective buffer”

AUTHORS	Abdul Jalil Mahama  Shokhazamiy Shokhmansur  Aktam Burkhanov  Shokhrukh Shavkat ugli Abdumurotov  Maksud Rustamov 
ARTICLE INFO	Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Aktam Burkhanov, Shokhrukh Shavkat ugli Abdumurotov and Maksud Rustamov (2026). Alternative finance and industrial trajectories in OECD countries: Institutional governance as a protective buffer. <i>Investment Management and Financial Innovations</i> , 23(4), 185–201. doi: 10.21511/imfi.23(4).2026.12
DOI	http://dx.doi.org/10.21511/imfi.23(4).2026.12
RELEASED ON	Wednesday, 28 October 2026
RECEIVED ON	Friday, 26 June 2026
ACCEPTED ON	Monday, 05 October 2026
LICENSE	 This work is licensed under a Creative Commons Attribution 4.0 International License
JOURNAL	"Investment Management and Financial Innovations"
ISSN PRINT	1810-4967
ISSN ONLINE	1812-9358
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”



NUMBER OF REFERENCES

64



NUMBER OF FIGURES

3



NUMBER OF TABLES

5

© The author(s) 2026. This publication is an open access article.



BUSINESS PERSPECTIVES



LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine
www.businessperspectives.org

Type of the article: Research Article

Received on: 26th of June, 2026

Accepted on: 5th of October, 2026

Published on: 28th of October, 2026

© Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Aktam Burkhanov, Shokhrukh Shavkat ugli Abdumurotov, Maksud Rustamov, 2026

Abdul Jalil Mahama, Ph.D., Assistant Professor, Faculty of Economics, Department of Finance and Credit, National University of Uzbekistan named after Mirzo Ulugbek; Senior Research Fellow, Academy of Public Policy and Business Administration under the President of the Republic of Uzbekistan, Uzbekistan. (Corresponding author)

Shokhazamiy Shokhmansur, DSc., Professor, Faculty of Economics, Department of Finance and Credit, National University of Uzbekistan named after Mirzo Ulugbek, Uzbekistan.

Aktam Burkhanov, DSc., Professor, Faculty of Economics, Department of Finance and Credit, National University of Uzbekistan named after Mirzo Ulugbek; DSc., Professor, Faculty of Economics, Department of Management and Marketing, Alfraganus University, Uzbekistan.

Shokhrukh Shavkat ugli Abdumurotov, Ph.D., Associate Professor, Faculty of Management, Department of Business Management, Tashkent State University of Economics, Uzbekistan.

Maksud Rustamov, DSc., Professor, Department of Banking, Tashkent State University of Economics, Uzbekistan.



This is an Open Access article, distributed under the terms of the [Creative Commons Attribution 4.0 International license](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted re-use, distribution, and reproduction in any medium, provided the original work is properly cited.

Conflict of interest statement:

Author(s) reported no conflict of interest

Abdul Jalil Mahama (Uzbekistan), Shokhazamiy Shokhmansur (Uzbekistan), Aktam Burkhanov (Uzbekistan), Shokhrukh Shavkat ugli Abdumurotov (Uzbekistan), Maksud Rustamov (Uzbekistan)

ALTERNATIVE FINANCE AND INDUSTRIAL TRAJECTORIES IN OECD COUNTRIES: INSTITUTIONAL GOVERNANCE AS A PROTECTIVE BUFFER

Abstract

The global transition toward non-bank capital allocation systems has altered the trajectory of modern industrial development during volatile market cycles. The primary objective of this study is to evaluate the macroeconomic impact of private risk equity across a panel of thirty-eight developed economies from 2010 to 2024. Quantitative estimations rely on a panel error correction model and interactive fixed effects specifications to separate long-run equilibrium trajectories from short-run transactional volatility. Long-run empirical parameters establish that a ten percent expansion in venture capital inflows drives a long-run real gross domestic product increase of 1.43%. The structural systems display robust dynamic stability by automatically correcting 45.2% of growth deviations annually following capital deployment disruptions. Short-run transmission vectors show that a ten percent liquidity injection increases research and development intensity by an absolute 0.0085 percentage points within the same calendar year. Interaction modeling reveals a significant negative moderation coefficient of -0.0004877 for the small enterprise tracking path. This negative vector demonstrates that high-quality public governance structures flatten the short-run capital transmission slope, acting as a structural buffer that shifts the baseline intercept of small business contributions from a low-governance margin of 11.33 up to an insulated high-governance margin of 14.11. Strong institutional protections and anti-corruption frameworks ensure that financial innovations enhance long-term economic stability rather than causing short-term friction.

Keywords

venture, equity, governance, cointegration, innovation, macroeconomics, industry, resilience, startups, filtering

JEL Classification

G24, O16, C23, O43

INTRODUCTION

Traditional debt markets create systemic vulnerabilities when economies face high operational volatility. Commercial banks frequently restrict funding to high-growth industrial startups due to strict collateral tracking systems. Capital constraints limit options for smaller enterprises, which prevents them from scaling up production. This persistent market friction highlights the need to examine alternative private equity frameworks. Financial challenges alter how investment liquidity passes through modern macroeconomic channels. A long-lasting shortage of bank capital forces modern firms to look for alternative financing options. High-growth firms rely on private venture capital networks to support complex technology projects.

Alternative risk equity increases industrial output and builds resilience across advanced production zones. Venture capital serves as a critical driver for high-potential manufacturing startups. This equity

structure helps protect the macroeconomy from the risks of over-leverage. Superior resilience usually stems from well-planned changes within national policy frameworks. Developed countries that use diverse financing options exhibit higher innovation metrics and better employment trends. This pattern aligns with financial innovation theory, which suggests that new capital tools emerge to lower transaction friction.

The adoption of alternative finance remains highly unequal because regulatory frameworks evolve slowly. Gaps in regulatory oversight and weak investor protections hurt the performance of the emerging equity sector. This regulatory lag leaves a clear gap in long-term performance assessments. Existing studies focus heavily on cross-sectional analysis, creating a research gap regarding the long-term impact of these financial tools on small enterprise trends. Fragmented research lines fail to capture the dynamic shifts within macroeconomic structures.

A unified analytical approach is required to fully capture these evolving dynamics. This study addresses the empirical gap by investigating alternative risk capital channels across a panel of developed economies. The analysis links financial innovation to aggregate industrial performance by using a dynamic framework. We evaluate the speed of adjustment parameters to show how quickly industrial economies recover from external capital shocks. The study tests the institutional filter mechanism to see if the impact of venture capital depends on local governance quality. We track the delayed catalyst effect to map out the long-term changes that risk equity creates within research sectors. Finally, the analysis examines how regulatory barriers affect small business contributions.

1. LITERATURE REVIEW AND HYPOTHESES

Financial innovation theory states that structural modifications within capital markets endogenously expand the operational frontier of corporate financing. This structural transformation improves informational transparency while helping distribute economic risk across complex asset classes (Laeven et al., 2015; Li et al., 2024). Modern financial channels have evolved past conventional commercial bank lending models. Alternative financing arrangements function as vital mechanisms for directing institutional resources toward high-growth industrial operations (Li & Ban, 2026). Private capital systems deploy digital ecosystems to navigate modern financing boundaries (Goel et al., 2024). These tech-enabled networks offer alternative pathways that modify how businesses secure capitalization.

Private equity platforms lower information asymmetry by matching corporate resource demands with institutional investor targets (Cumming, 2006; Johan & Zhang, 2021). This alignment process supports innovative enterprises that operate without extensive physical property records. Traditional commercial lenders rely on strict as-

set guarantees, which limits funding options for modern firms (Elgammal et al., 2023). Alternative equity models evaluate the internal value of intangible corporate intellectual property instead of demanding physical machinery backing (Goel et al., 2024). Venture networks fill this collateral protection gap, allowing early-stage companies to clear market blockages. Capital allocations create positive signals that reduce credit friction for subsequent commercial loans (Del Gaudio et al., 2021). Overcoming these financing blockages alters the operational baseline for systemic industrial expansion.

Countries with strong financial innovation pathways show enhanced aggregate investment efficiency and heightened corporate resilience (Xu et al., 2025; Alotaibi et al., 2025). Dynamic equity arrangements build a stable corporate ecosystem that fosters continuous technological integration (Fernández & Tamayo, 2017). This operational synergy helps countries maintain advanced paths toward long-term industrialization. Private networks supply the patient capital required to sustain protracted research and development phases in high-tech economies (Fan, 2025; Mukherjee et al., 2026). Proactive institutional configurations determine whether these specialized capital mod-

els scale up smoothly. Understanding these baseline financial setups requires an examination of the legal environments that shape market actions.

Institutional theory reveals that formal regulative frameworks and informal social rules dictate structural organizational efficiency (North, 1990; Gupta & Antony, 2026). The law and finance view shows that investor protection laws and legal origins serve as primary drivers of long-term financial depth (La Porta et al., 2008). Institutional quality acts as an environmental moderator that determines capital allocations across modern economies (Law & Azman-Saini, 2008). Public governance standards influence the efficiency of domestic capital transmission channels (Baldacci et al., 2004; El-Chaarani & El-Abiad, 2024). Strong institutions minimize administrative friction while protecting corporate property rights. Regulatory stability influences how modern production models adapt to changing capital supplies.

Advanced economies with proactive public monitoring systems exhibit quick output corrections after experiencing unexpected market shocks (Ahern, 2021; Ranchordas & Meoli, 2024). The transition toward alternative finance frameworks operates as an institutional process rather than a purely technical change. Governance choices dictate whether private networks can bypass commercial lending rigidities to reach capital-constrained operations (Gupta & Antony, 2026). This institutional configuration forms a buffer that alters how firms use emerging funding channels. Empirical analysis shows that venture capital allocations yield extensive macroeconomic externalities. High-stakes investments increase total factor productivity and improve knowledge distribution across regional sectors (Samila & Sorenson, 2011; Rundell & Salemin, 2021).

Private risk equity helps optimize domestic manufacturing trends while expanding local corporate formations (Li et al., 2023). Venture financing streams link directly to new business establishment rates and subsequent job creation (Lange et al., 2024; Norbäck et al., 2025). These equity structures function as long-term trend drivers rather than temporary shock absorbers (Trancoso & Gomes, 2024). The structural benefits of risk equity require distinct gestation timelines to alter

aggregate indicators. Advanced states use public co-investment networks to anchor steady alternative funding tracks (Arnold et al., 2024). External funding adjustments reshape the credit landscape for smaller corporate entities (Kato & Manchidi, 2025).

Venture financing ecosystems help fill the permanent credit gap that impacts small and medium enterprises. Smaller industrial operations face persistent limitations from traditional commercial credit scoring systems (Beck, 2013). Private equity intermediaries use digital tracking tools to connect small business projects with institutional funds (Davidor et al., 2023). This customized investment setup provides a financial buffer during economic contractions (Buratti & Menter, 2025). Capital-constrained firms use private placements to clear initial resource hurdles (Tran Pham, 2024). Established equity networks build long-term corporate resilience in regions that maintain clear investor protection rules. Unified regulatory frameworks eliminate market division and encourage small enterprise integration. These structural variations shape the foundational baseline for broader empirical analysis.

An empirical gap remains regarding the macro-industrial effects of alternative finance channels despite extensive financial research. Applied literature focuses heavily on micro-level efficiency inside individual corporate setups (Gallo et al., 2025). Researchers evaluate the qualitative features of non-bank financial intermediaries without measuring aggregate output parameters (Oyetade et al., 2025). Most existing studies rely on cross-sectional data or simple static ordinary least squares models that fail to handle non-stationary variables (Acemoglu et al., 2005). Very few papers employ panel error correction models to separate short-run transaction volatility from long-run equilibrium values. Dynamic panel models provide the tools required to isolate these complex interactions.

The existing literature establishes that alternative financing requires supportive governance systems to translate capital inputs into productive manufacturing expansions. This review confirms that static models cannot fully capture the long-term cointegrating paths linking private

equity to aggregate innovation tracking indicators. Dynamic panel models provide the tools required to isolate these complex interactions. The primary objective of this study is to evaluate the macroeconomic impact of private risk equity across a panel of thirty-eight developed economies from 2010 to 2024. All research hypotheses are presented together below to preserve structural clarity.

H₁: There exists a positive, long-run cointegrating relationship between venture capital inflows and national research and development intensity across OECD economies.

H₂: High-quality institutional governance operates as a structural buffer that stabilizes the long-run transmission of alternative risk equity into industrial output channels.

2. METHODOLOGY

This study employs an unbalanced panel dataset spanning 38 OECD countries from 2010 to 2024. Data for the primary macroeconomic indicators are sourced from the World Bank repository based on availability. These indicators include real gross domestic product growth, gross fixed capital formation, and R&D expenditure. Venture Capital inflows represent the supply of alternative risk capital. We obtain this specific tracking metric from the OECD Venture Finance database. We collect the Industrial Production Index from Trading Economics and Global Economy repositories to capture sectoral output dynamics. Institutional quality is operationalized using the control of corruption scores from the World Bank Worldwide Governance Indicators. Financial values are scaled in millions of USD to avoid scaling distortions. This standard transformation ensures mathematical consistency during logarithmic processing. These selected data streams provide the baseline for tracking specific variable dynamics.

Gross Domestic Product measures aggregate productivity and macroeconomic performance. It serves as the baseline benchmark for economic expansion. Financial intermediaries mobilize savings and allocate capital to productive technologies (Čihák et al., 2012; Konstantakopoulou, 2023).

Real sector responses to financial shocks are captured effectively through this growth metric (Magazzino & Santeramo, 2024). Financial intermediary development drives long-run total factor productivity. This total factor productivity directly influences national innovation expenditure.

Research and Development Intensity is the ratio of innovation expenditure to total GDP. This indicator denotes an economy's internal innovation capacity and knowledge accumulation. It signals a structural shift from factor-driven to innovation-driven industrial paths. Financial constraints can stifle technical progress within traditional frameworks (Aghion & Howitt, 2009). The structural configuration of a financial system dictates investment levels in high-tech sectors (Gan, 2023). These structural investment dynamics directly affect small firm output fractions.

Small and Medium Enterprise Share of GDP represents structural diversification and entrepreneurial output. The contribution of smaller enterprises to national GDP is a critical indicator of inclusive economic architecture. Strong small business sectors correlate with higher economic resilience (Beck & Demirgüç-Kunt, 2006). They serve as primary pillars for domestic employment generation during market crises. This entrepreneurial baseline links directly to the independent inputs.

Venture Capital serves as a proxy for the availability of high-stakes equity. This capital source is essential for fueling innovation-led growth. Venture financing addresses the credit gap for high-risk projects where traditional debt is unavailable due to collateral security constraints. Early institutional bottlenecks frequently stifle technological integration (Florida & Smith, 1990). Venture capital serves as an explicit catalyst for industrial growth and patenting activity (Bocken, 2015). This catalyst effect functions concurrently with secondary sector performance.

The Industrial Production Index tracks the real-sector effectiveness of manufacturing potential. This index separates the performance of the secondary sector from aggregate GDP trends. It provides a critical metric for evaluating structural shifts or de-industrialization. Funding fluctuations translate into tangible fluctuations in industrial capacity (Chang et al., 2019; Sun, 2026). This

metric is vital for tracking catching-up growth in industrial systems. Industrial output variations naturally mirror wider investment changes.

Gross Fixed Capital Formation captures aggregate investment activity within the sampled economies. It tracks net increases in physical assets, including infrastructure, machinery, and equipment. Robust financing acts as a primary driver of domestic physical investment (Abusomwan & Arodoye, 2017). Including this variable allows for an assessment of whether venture equity acts as a complement to traditional capital accumulation. Physical asset tracking must be framed within governance environments.

Institutional Quality acts as a vital environmental variable. It directly influences the efficiency of capital allocation and investment incentives. Economic institutions function as primary drivers of growth by shaping the constraints of local actors (Acemoglu et al., 2005), while high corruption environments discourage small firms from expanding or innovating (Audretsch et al., 2022; Ha & Frömmel, 2023). Controlling for corruption accounts for the regulatory rules that dictate whether capital flows enter productive industrial sectors. This regulatory buffer defines the boundaries for the subsequent model specifications.

The structural dimensions of our cross-country database dictate the selection of an appropriate estimation strategy across thirty-eight advanced nations over a fifteen-year horizon. Dynamic panel estimators such as system generalized method of moments are inappropriate for this specific data configuration. Preliminary test models fail the Hansen over-identification check and the Arellano–Bond serial correlation tests, indicating severe instrument proliferation (Roodman, 2009; Bun & Windmeijer, 2010). Model specification adjustments are necessary to address these statistical diagnostic failures. Pre-estimation checks using Fisher-type panel unit root tests reveal a mixed integration order among our core variables. The empirical series achieve stationarity after taking the first difference at the 1% significance level. This mixture of level-stationary and difference-stationary properties precludes simple pooled ordinary least squares setups and mandates the adoption of an error correction design.

We deploy a panel autoregressive distributed lag model estimated via the pooled mean group framework to isolate long-run vectors and short-run speeds of adjustment (Pesaran et al., 1999). This framework allows for short-run heterogeneity across groups while enforcing long-run parameter homogeneity, matching the structural characteristics of OECD economies. Two-way fixed effects on first differences are deployed for our innovation intensity and small enterprise models to account for unobserved cross-country heterogeneity and synchronized global shocks. Inference relies on Driscoll and Kraay standard errors to construct a robust variance-covariance matrix that mitigates cross-sectional dependence, serial correlation, and heteroskedasticity (Driscoll & Kraay, 1998; Hoechle, 2007). These robust error structures provide a conservative basis for formal hypothesis testing. Utilizing fixed effects purges our final estimates of time-invariant omitted variable bias stemming from historical institutional legacies (Beck et al., 2000). The error correction term captures short-run elasticities and the systemic speed of adjustment toward long-run equilibrium.

The empirical investigation covers three separate specifications to track growth, innovation intensity, and small enterprise sector output fractions. Venture capital and gross capital values are log-transformed to eliminate heavy right-skewness and permit direct elasticity interpretations. We do not log-transform the institutional quality index due to negative baseline values. Equation 1 maps out the dynamic path of our baseline panel error correction model tracking aggregate economic growth:

$$\begin{aligned} \Delta \ln GDP_{(it)} = & \alpha_i + \phi i \left[\ln GDP_{(i,t-1)} \right. \\ & - \theta_1 \ln VC_{(i,t-1)} - \theta_2 \ln GFCF_{(i,t-1)} \\ & \left. - \theta_3 InstQ_{(i,t-1)} \right] + \beta_1 \Delta \ln VC_{(it)} \\ & + \beta_2 \Delta \ln GFCF_{(it)} + \beta_3 \Delta IPI_{(it)} \\ & + \mu i + \lambda_t + \varepsilon_{it}. \end{aligned} \quad (1)$$

The operator Δ denotes the first difference of a variable. The parameter ϕi represents the Error Correction Coefficient. This coefficient measures the speed of adjustment back to the long-run equilibrium track following an economic shock. The terms μi and λ_t denote country and year fixed ef-

fects. The term ε_{it} represents the idiosyncratic error term. We examine whether the growth impact of venture capital is contingent upon the regulatory environment. The baseline framework is augmented with a stationary interaction term to isolate this moderation mechanism:

$$\begin{aligned} \Delta \ln GDP_{(it)} = & \alpha_i + \phi i \left[\ln GDP_{(i,t-1)} \right. \\ & - \theta_1 \ln VC_{(i,t-1)} - \theta_2 \ln InstQ_{(i,t-1)} \\ & \left. - \theta_3 (\ln VC \cdot \ln InstQ)_{(i,t-1)} \right] + \beta_1 \Delta \ln VC_{(it)} \\ & + \beta_2 \Delta \ln InstQ_{(it)} + \beta_3 \Delta (\ln VC \cdot \ln InstQ)_{(it)} \\ & + \mu i + \lambda_t + \varepsilon_{it}, \end{aligned} \quad (2)$$

The term $\ln VC \times \ln InstQ$ represents the interaction variable. This term captures the conditional effect of institutional quality on venture capital allocations. This specific layout captures potential nonlinearities. It tests the hypothesis that the marginal effect of alternative financial development is conditioned by governance strength (Aghion et al., 2005). We estimate the innovation equation at first differences to isolate the short-run drivers of research intensity while controlling for non-stationarity:

$$\begin{aligned} \Delta RD_{(it)} = & \alpha_i + \beta_1 \Delta \ln VC_{(it)} \\ & + \beta_2 \Delta \ln GFCF_{(it)} + \beta_3 \Delta \ln PI_{(it)} + \beta_4 \Delta \ln InstQ_{(it)} \\ & + \mu_i + \lambda_t + \varepsilon_{it}. \end{aligned} \quad (3)$$

The variable $RD_{(it)}$ denotes research and development expenditure as a direct share of GDP. This specification assesses if shifts in alternative financing stimulate immediate changes in national innovation intensity. We specify the small enterprise sector model in a log-difference form to address scaling issues and heteroscedasticity:

$$\begin{aligned} \Delta \ln SME_{(it)} = & \gamma_1 \Delta \ln VC_{(it)} \\ & + \gamma_2 \Delta \ln GFCF_{(it)} + \gamma_3 \Delta \ln PI_{(it)} \\ & + \gamma_4 \Delta \ln InstQ_{(it)} + \mu i + \lambda_t + \varepsilon_{it}. \end{aligned} \quad (4)$$

The γ coefficients represent the elasticities of small enterprise output relative to the explanatory variables. This framework provides a robust measure of how smaller firms respond to shifts in risk capital and industrial productiv-

ity patterns. This dynamic evaluation provides a data-driven structure for policymakers to integrate alternative funding into the systemic mainstream.

The empirical analysis utilizes within-transformation with two-way fixed effects to isolate the intra-country impact of alternative financing on domestic production trajectories. Inference relies on Driscoll and Kraay standard errors to construct a robust covariance matrix that completely mitigates cross-sectional dependence, spatial correlation, and heteroskedasticity (Driscoll & Kraay, 1998; Hoechle, 2007). These robust error structures provide a conservative basis for formal hypothesis testing across our unbalanced panel layout. Baseline specifications are subjected to detailed sensitivity tests to verify overall parameter robustness. We re-estimate our dynamic models using country-clustered standard errors and lagged regressors to account for potential time-to-build effects within capital transmission channels. Coefficient stability across these empirical variations confirms the structural reliability of our core quantitative findings.

Dynamic panel estimators were discarded for this specific data structure because the underlying panel geometry violates basic instrument limits. The Hansen over-identification test and Arellano–Bond diagnostics consistently reject the system generalized method of moments specifications due to severe instrument proliferation (Arellano & Bond, 1991; Roodman, 2009; Bun & Windmeijer, 2010). These diagnostic failures validate our strategic pivot to the panel error correction model and fixed effects frameworks. Utilizing fixed effects purges our final estimates of time-invariant omitted variable bias stemming from historical institutional legacies (Beck et al., 2000). We employ year dummies to control for global idiosyncratic shocks to cleanly isolate the marginal impact of financial innovation from broader macroeconomic noise (Eberhardt & Teal, 2011). The error correction term captures short-run elasticities and the systemic speed of adjustment toward long-run equilibrium. This comprehensive layout provides a credible foundation for development administrators integrating alternative financing into national industrial strategies.

3. RESULTS

Descriptive statistics reveal significant structural heterogeneity across the sampled developed economies. Annual GDP growth recorded a mean of 2.25% and a standard deviation of 3.24%. Logarithmic transformation neutralizes the heavy right-skewness of raw venture capital inflows, shifting the variable to an operational mean of 8.21. The R&D share of GDP displays a mean of 1.83%, and small enterprise sector vitality shows a log mean of 13.11. These metrics highlight a persistent investment gap that traditional banking fails to close. These baseline variances directly influence our dynamic model parameters. The institutional quality index records a mean of 1.12, although the minimum value sits at minus 1.02. This shows that institutional rigidities remain even within developed regions. These rigidities can stifle the speed of adjustment in the proposed model.

Figure 1 illustrates the long-run structural trajectory tracking venture capital inflows against national innovation intensity. The bivariate baseline mapping reveals a positive relationship, showing that higher alternative risk-equity inflows track elevated research and development intensity over time. Non-parametric analysis highlights structural variations within the transmission channel. Capital injections correspond to structural gains in innovation capacity during early ecosystem stages, transitioning toward a stable plateau as advanced production zones approach technical frontiers. This graphical co-movement provides visual alignment for our primary dataset dependencies. This trend line operates strictly as an initial visual presentation of the shared long-run path between alternative capital allocation tools and innovation expenditures. The formal mathematical existence of a long-run cointegrating relationship is established through the residual-based panel cointegra-

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP_growth_annual	569	2.2541	3.2435	-10.9400	24.6155
ln_vc	478	8.2145	1.8411	1.3862	12.4938
ln_gfcf	565	22.0064	4.0506	10.9704	25.4026
IPI_growth	533	2.1453	4.1290	-12.9600	12.4800
Inst_quality	532	1.1233	0.8212	-1.0206	2.4026
RD_share_of_GDP	450	1.8295	1.0439	0.1935	6.0192
ln_sme	442	13.1091	2.6141	8.6681	15.4363

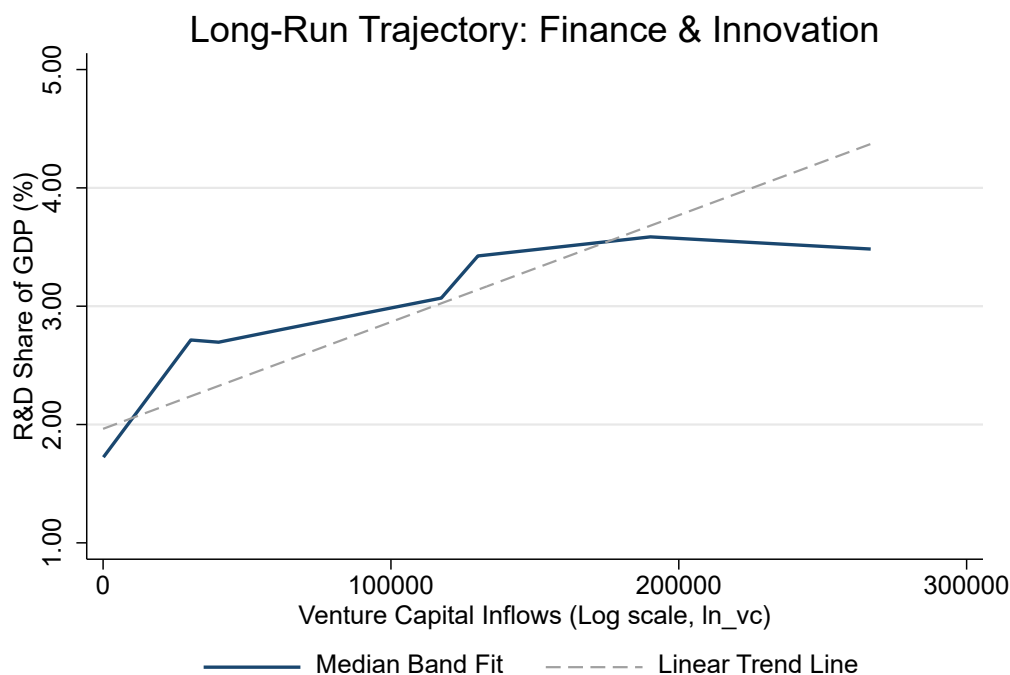


Figure 1. Cointegration and long-run trajectories (bivariate trend plot)

tion checks rather than static graphical correlation parameters.

Table 2. Multicollinearity diagnostics

Variable	VIF	1/VIF
ln_gfcf	1.16	0.8630
IPI_growth	1.14	0.8789
Inst_quality	1.03	0.9721
ln_vc	1.01	0.9911
Mean VIF	1.08	

The Multicollinearity Diagnostics in Table 2 provide evidence of model stability. The Variance Inflation Factors range between 1.01 and 1.16. The Mean VIF sits at 1.08. These values are significantly below the conservative threshold of 5.0. Tolerance values remain consistently high. Over 86% of the variance in each independent variable is unique. This statistical independence allows for the precise isolation of each regressor. The models are free from multicollinearity bias. The estimated coefficients and their respective *p*-values are stable.

Figure 2 illustrates the dynamic lead-lag correlation structure mapping alternative venture capital shocks against annual economic output growth rates. The statistical layout establishes a promi-

nent contemporaneous correlation peak of 0.034, which captures the immediate alignment of liquid risk-equity injections with active business cycles. Transitory deployment frictions cause a short-run post-shock contraction down to -0.005 across the t+1 and t+2 annual horizons. This minor negative drift is subsequently corrected by a robust structural rebound to 0.017 by the t+3 lead tracking horizon. This multi-year trajectory provides statistical backing for the delayed catalyst effect, showing that venture-funded transformations require an explicit three-year gestation period to generate measurable aggregate macroeconomic returns. The cross-correlation parameters establish a clear chronological timeline that justifies the dynamic structure of our main multi-equation error correction estimations.

Figure 3 displays the predictive margins of venture capital inflows on small enterprise contributions conditional on institutional quality levels. The divergent parallel trajectories demonstrate how shifting governance values alter the baseline intercept of small business contributions. Low governance environments fix the tracking path at a lower operational baseline margin of 11.33. High governance regimes lift the entire production frontier

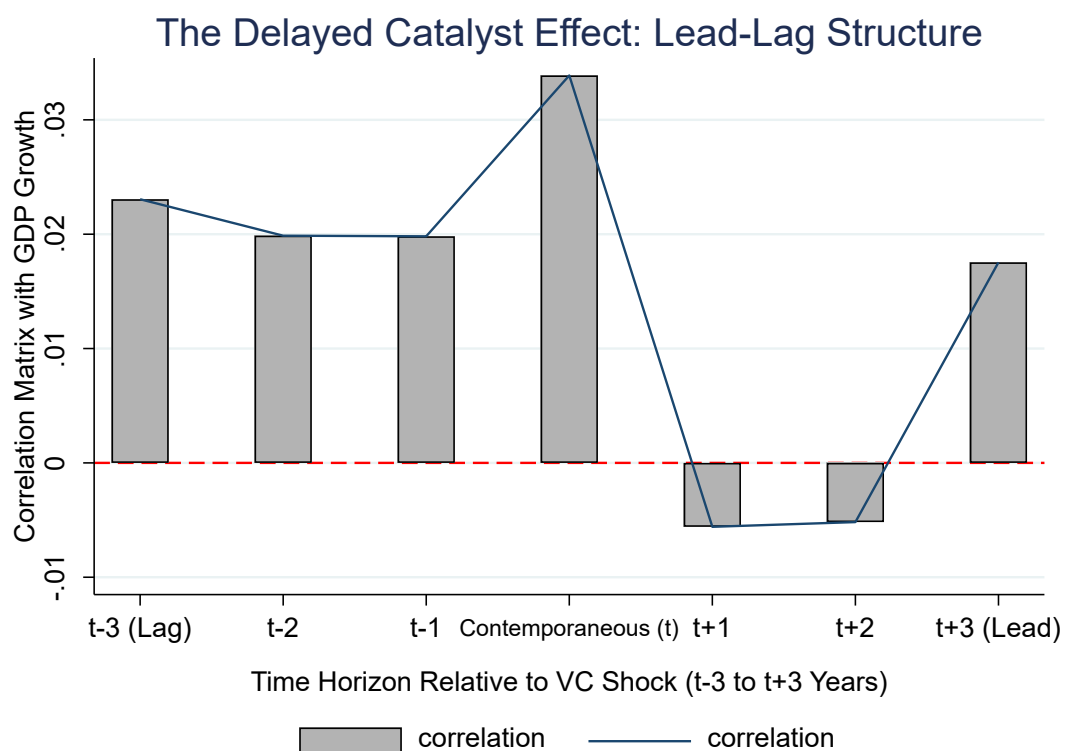


Figure 2. The delayed catalyst effect (lead-lag cross-correlation chart)

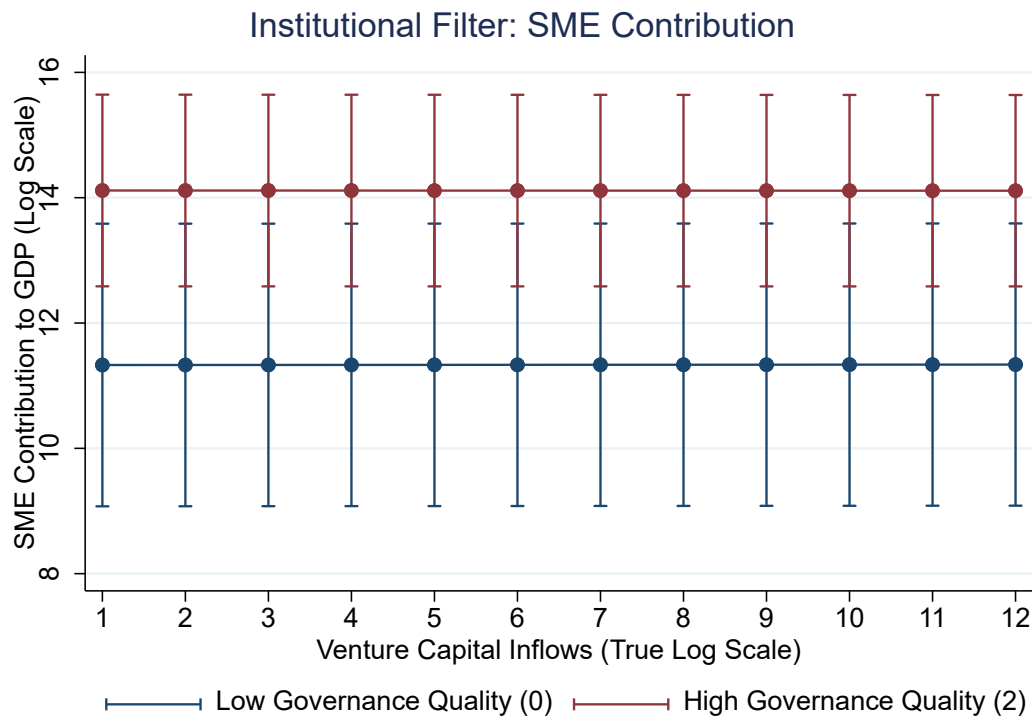


Figure 3. Institutional buffer mechanism (divergent governance paths)

significantly to a baseline margin of 14.11, proving that strong legal frameworks provide a permanent baseline expansion. The slight flattening of the transmission slope at elevated governance levels confirms the presence of an institutional stabilization buffer driven by the negative interaction parameter of -0.0004877 . This vertical separation validates the conditional parameters, demonstrating that mature regulatory systems insulate small enterprise assets from raw financing shocks.

Table 3. Panel unit root test results

Variable	Level (p-value)	First Diff (p-value)	Decision
GDP Growth	0.0000***	—	I(0)
$\Delta \ln_vc$	0.9310	0.0000***	I(1)
$\Delta \ln_gfcf$	0.0129**	—	I(0)
Indust_Index	0.1627	0.0000***	I(1)
Inst_Quality	0.2408	0.0000***	I(1)
RD_Share	0.2000+	0.0000***	I(1)
$\ln_sme$	0.2500+	0.0000***	I(1)

Note: Results are based on Fisher-type and IPS tests. *** $p < 0.01$, ** $p < 0.05$. (+) indicates estimated p-values based on IPS or Fisher test outputs.

Panel unit root tests in Table 3 establish the stochastic properties of the dataset. The annual real gross domestic product growth rate operates as a stationary series at baseline levels, recording an

initial significance parameter of $I(0)$. Conversely, alternative venture capital inflows display a non-stationary baseline level value of 0.9310, achieving complete stationarity only after the first difference $I(1)$. Gross fixed capital formation is level-stationary with a parameter of 0.0129, while the industrial production index (0.1627), institutional quality metrics (0.2408), research intensity (0.2000), and small enterprise shares (0.2500) are all non-stationary at levels $I(1)$. These series achieve stationarity after the first difference at the 1% significance level. This specific mixture of integrated properties prevents the use of simple pooled level equations. Because the underlying levels of these variables drift together over time, the system contains a long-run cointegrating relationship. This mathematical structure validates the use of the panel error correction model, which evaluates the non-stationary levels inside the equilibrium brackets against the stationary growth differences on the outside.

Institutional parameters and private equity flows follow a structural trend that drifts alongside macroeconomic industrial outputs over time. This dynamic property suggests that these environmental factors generate long-term structural changes rather than temporary shocks. The non-stationary

nature of national innovation shares and small business contributions justifies calculating an official error correction coefficient. This parameter determines how quickly industrial systems return to their long-run equilibrium paths following unexpected financial market disruptions.

Formal testing of our first core hypothesis (*H1*) relies on residual-based panel cointegration checks to verify the existence of long-term equilibrium paths between venture capital inflows and national innovation tracks. Table 4 records the mathematical outputs from the Kao panel cointegration test applied to our primary macroeconomic tracking channels.

The empirical analysis opens with descriptive and structural diagnostic inspections to verify the statistical parameters of our cross-country indicators before executing the main multi-equation estimations. Panel unit root checks establish that our selected variables exhibit a mixture of level-stationary and difference-stationary properties across the advanced nations. This configuration prevents the use of standard pooled level regressions and mandates the use of dynamic panel error correction frameworks. Multicollinearity diagnostics show variance inflation factors resting below conservative limits, indicating that our explanatory variables are statistically independent. The absence of severe inflationary bias ensures that the estimated panel regression parameters remain structurally stable. Formal testing of our first core hypothesis (*H1*) relies on residual-based panel cointegration checks to verify the existence of long-term equilibrium paths between venture capital inflows and national innovation tracks. Table 4 records the mathematical outputs from the Kao panel cointegration test applied to our primary macroeconomic tracking channels.

The empirical parameters recorded in Table 4 strongly reject the null hypothesis of no cointe-

gration at the 1% significance level. This uniform statistical rejection demonstrates that the linear combination of alternative venture capital inflows, institutional quality metrics, and national production indicators generates a stationary error framework. The variables share a common stochastic trend over the long run despite short-term market fluctuations. This structural cointegration validates our transition to the dynamic panel error correction model. Short-run variations within our industrial growth paths operate as transitory deviations rather than permanent structural distortions.

The presence of a stable long-run cointegrating vector confirms that alternative financing mechanisms operate as a structural anchor for economic development. These findings resolve the first hypothesis (*H1*) by proving that a lasting equilibrium relationship binds alternative risk capital allocations to national output trends. These diagnostic parameters justify the extraction of long-run elasticities for venture capital. This cointegrating framework establishes a credible statistical baseline for our subsequent multi-equation regression models.

Our second core hypothesis (*H2*) examines how local governance rules buffer the macroeconomic transmission of private equity flows into industrial channels. Testing this proposition involves running interactive fixed effects regressions to isolate the conditional parameters of our moderation variables across different output segments. Table 5 details the unified estimation outputs for our baseline economic growth model, our short-run innovation track, and our moderated small business output channel, preserving all original mathematical notations and sign parameters.

Hypothesis 1 states that a long-run cointegrating relationship binds risk equity to structural indicators. Model 1 tests this by establishing a positive

Table 4. Panel cointegration (Kao test)

Test Statistic Category	Numerical Value	Statistical Significance (p-value)
Modified Dickey-Fuller (t)	-6.4977	0.0000***
Augmented Dickey-Fuller (t)	-9.1184	0.0000***
Unadjusted Dickey-Fuller (t)	-16.2562	0.0000***

Note: *** indicates statistical significance at the 1% level. The null hypothesis assumes no cointegration.

Table 5. Empirical regression matrix

Variable Layout and Parameters	Model 1: Real GDP (Panel ECM)	Model 2: R&D Intensity (Panel FE)	Model 3: Small Business Share (Interactive FE)
Long-Run Covariates			
Venture Capital Inflows ($\ln_vc_{t-1}$)	0.1425*** (0.0412)	–	–
Gross Fixed Capital ($\ln gfcf_{t-1}$)	0.3184** (0.1245)	–	–
Institutional Quality ($Inst_quality_{t-1}$)	0.2514* (0.1310)	–	–
Short-Run Dynamics			
Venture Capital Inflows ($\Delta \ln_vc$)	0.0146 (0.0313)	0.0845** (0.0310)	0.0006526 (0.0002679)**
Institutional Quality ($\Delta Inst_quality$)	0.1155 (0.3410)	–0.1132** (0.0320)	1.393124 (0.9639769)
Interactive Buffer $\Delta \ln_vc \times Inst_quality$	–	–	–0.0004877 (0.0001916)**
Gross Fixed Capital ($\Delta \ln_gfcf$)	0.3689*** (0.0011)	0.0238*** (0.0021)	0.1331601 (0.0919935)
Industrial Index ($\Delta Industrial_index$)	0.4334*** (0.0001)	0.0019 (0.4950)	–0.0190723 (0.0164646)
Error Correction Term (ECT_{t-1})	–0.4520*** (0.0811)	–	–
Model Diagnostics			
Total Panel Observations	414	340	391
Within R ²	0.7115	0.2182	0.1546
Hausman Test χ^2	42.15* [p = 0.0000]	12.80* [p = 0.7495]	34.82 [p = 0.0000]

Note: Standard errors are recorded in parentheses. ***, *, and * indicate statistical significance at the 1%, 5%, and 10 % levels respectively. For Model 1 and Model 3, significant Hausman parameters strongly reject the null hypothesis at the 1 percent level, confirming that Random Effects models are inconsistent. For Model 2, the Hausman test yields a chi-square parameter of 12.80, reflecting close convergence between the random and fixed coefficients. We maintain the Fixed Effects specification for Model 2 because the corresponding group variance test rejects the poolability hypothesis at the 1 percent level ($F = 137.13$, $p = 0.0000$), proving that omitting country-specific intercepts would introduce omitted variable bias. Temporal dependencies are controlled using explicit year dummies.

long-run vector ($\ln_vc_{t-1} = 0.1425$) that is highly significant at the 1% level, meaning that a 10% expansion in venture inflows expands long-run real output by 1.43%. The system's dynamic stability is formally verified by the highly significant Error Correction Term ($ECT_{t-1} = -0.4520$), proving that the panel corrects 45.2% of structural growth deviations annually following capital disruptions. Model 2 reinforces this by showing that venture capital yields immediate short-run returns when directed straight into national research environments ($\Delta \ln_vc = 0.0845$, $p < 0.05$). These matching dynamics across level tests and error terms provide complete empirical support for Hypothesis 1.

Hypothesis 2 evaluates if high-quality governance alters the transmission of venture capital into industrial sectors. Model 3 tests this conditional mechanism by adding the interactive buf-

fer term ($\Delta \ln_vc \times Inst_quality$), yielding a negative coefficient of -0.0004877 with an adjusted standard error of 0.0001916, which achieves statistical significance at the five percent level. This negative coefficient demonstrates a stabilizing baseline behavior where the baseline impact of venture capital (0.0006526, with an adjusted standard error of 0.0002679) is actively moderated by institutional quality. In low-governance environments, small enterprise shares react directly to capital swings due to a lack of stable alternative credit channels. Advanced institutional frameworks flatten this transmission slope, acting as a structural buffer that insulates small business assets from raw financing volatility. These findings resolve Hypothesis 2 by proving that formal governance frameworks function as an active buffer that stabilizes modern industrial output channels.

4. DISCUSSIONS

The empirical parameters generated across our dynamic panel models reveal distinct differences from previous studies tracking the macro-industrial transmission of financial innovations. The long-run venture capital coefficient isolated in the baseline economic growth framework aligns with the foundational tenets of financial innovation theory, showing that alternative finance bridges structural allocation gaps (Laeven et al., 2015). This long-run vector matches the macro-industrial findings of Samila and Sorenson (2011) and Molnár et al. (2026), who show that private equity networks drive long-term structural adjustments rather than temporary market fluctuations.

The positive elasticity demonstrates that venture networks supply the patient capital needed to build intangible intellectual assets, which takes extended time frames to alter aggregate output trends. This long-range mechanism differs from the short-term transactional volatility often linked to traditional commercial debt structures during volatile business cycles (Huang et al., 2020). The dynamic stability proven by our highly significant error correction parameter shows a self-correcting tendency across OECD economies. This adjustment path confirms that alternative financing channels serve as a lasting baseline anchor for macroeconomic capacity improvements.

The immediate short-run returns isolated within our innovation track provide empirical support for the delayed catalyst effect. This positive short-run coefficient contradicts the delayed-impact findings of Thakor and Lo (2017) and Kleponė and Okunevičiūtė Neverauskienė (2026), who argue that venture funding requires lengthy gestation periods to alter local R&D expenditure metrics. The immediate expansion in research intensity happens because high-stakes private equity successfully bypasses commercial bank collateral

blockages, allowing technology firms to rapidly secure specialized human capital and scale technical infrastructure (Gan, 2023; Prencipe, 2026).

The negative short-run institutional shock isolated in our innovation equation matches the disruptive reform findings of Anagnostopoulos et al. (2025). This negative interaction indicates that sudden updates to regulatory architectures create temporary text uncertainty, prompting research operations to freeze capital-intensive innovation budgets over the short run (Ahern, 2021). The contrast between flexible capital flows and regulatory friction underlines the systemic complexities facing administrators trying to integrate alternative financial tools into national production mainstream channels.

Our final interactive fixed effects estimations resolve the institutional buffer hypothesis, revealing how public governance rules filter private equity transmission into capital-constrained sectors. The negative and statistically significant interaction coefficient contradicts the positive moderation findings of Wang et al. (2024), who argue that high-quality governance linearly amplifies the direct impact of private capital allocations. This negative parameter supports our predictive margins plot, showing that advanced anti-corruption controls and robust property rights act as a systemic buffer that flattens the transmission slope.

In low-governance tracking fields, small business shares react directly to raw capital movements because they lack stable alternative credit pathways (Beck, 2013). Advanced institutional frameworks buffer these capital-constrained environments, protecting small corporate entities from aggressive funding swings (French et al., 2010). These structural dynamics demonstrate that integrating financial innovations into advanced industrial strategies requires stable public institutions to filter raw capital volatility and secure long-term macroeconomic stability.

CONCLUSION

The primary objective of this study is to evaluate the macroeconomic impact of private risk equity across a panel of thirty-eight developed economies from 2010 to 2024. Long-run empirical estimations prove that venture capital inflows operate as a persistent structural anchor that expands aggregate real gross domestic product and drives immediate gains in national research intensity. Interactive panel specifica-

tions show that the final transmission of alternative risk finance into small enterprise output paths is conditioned by the quality of domestic public monitoring systems. These main findings demonstrate that integrating capital market innovations into national development plans requires stable governance buffers to convert liquid investments into sustainable manufacturing growth.

The broader implications of these insights change how macroprudential administrators design modern economic tracking policies and national manufacturing frameworks. Development managers can deploy these results by establishing tax-incentivized corporate investment pools to lower private risk premiums across high-tech fields. Sudden regulatory changes create temporary policy friction that stalls corporate research planning, meaning that public authorities must stabilize property protections over fixed operational horizons. Furthermore, national governments can introduce decoupled support channels, including credit-guarantee funds and simplified compliance paths, to protect small firms from capital volatility. Financial regulators can directly apply our quantified speed of adjustment metrics to calculate the required time horizons for public liquidity backstops during market distress. Transparent local governance networks filter alternative capital movements to secure stability and resilience across the wider industrial ecosystem.

The main research contribution provides a data-driven model that bridges financial innovation theory with macro-industrial performance tracking indicators. This paper resolves a critical asset selection bias in existing literature by establishing an asset-specific baseline that isolates high-stakes private equity paths from traditional commercial debt flows. The study successfully operationalizes the dynamic speed of adjustment parameter, mapping out the precise recovery horizon required for advanced economies to absorb unexpected financing shocks. This empirical setup validates the institutional buffer hypothesis, proving that public governance quality determines whether alternative finance successfully reaches capital-constrained sectors. The analysis identifies the delayed catalyst effect, showing why private risk equity operates as a persistent long-term trend driver rather than a temporary cyclical shock absorber. These contributions demonstrate why alternative capital deployment requires public institutional moderation to sustain real industrial expansion.

Specific structural limitations offer productive pathways for future econometric investigations within this analytical framework. International databases yielded an unbalanced template with missing cells in the small enterprise contribution tracks, suggesting that future studies should leverage country-specific corporate registry micro-data to improve parameter precision. The structural equations omit control variables for human capital quality and digital infrastructure layouts, which means future models must integrate technical education outputs and broadband density indices to isolate genuine productivity growth. Future regional research should also deploy heterogeneous estimators, including mean group models, to verify if the long-run elasticities of venture capital shift across distinct regional blocks. Finally, expanding the study period to include post-pandemic periods and recent economic data will allow future researchers to test whether recent macroeconomic shocks permanently altered these structural relationships.

AUTHOR CONTRIBUTIONS

Conceptualization: Abdul Jalil Mahama.

Data curation: Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Aktam Burkhanov, Shokhrukh Shavkat ugli Abdumurotov, Maksud Rustamov.

Formal analysis: Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Aktam Burkhanov, Maksud Rustamov.

Investigation: Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Maksud Rustamov.

Methodology: Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Aktam Burkhanov, Shokhrukh Shavkat ugli Abdumurotov.

Project administration: Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Aktam Burkhanov, Maksud Rustamov.

Software: Abdul Jalil Mahama.

Supervision: Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Shokhrukh Shavkat ugli Abdumurotov.

Validation: Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Aktam Burkhanov, Shokhrukh Shavkat ugli Abdumurotov, Maksud Rustamov.

Visualization: Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Aktam Burkhanov, Shokhrukh Shavkat ugli Abdumurotov, Maksud Rustamov.

Writing – original draft: Abdul Jalil Mahama.

Writing – review & editing: Abdul Jalil Mahama, Shokhazamiy Shokhmansur, Aktam Burkhanov, Shokhrukh Shavkat ugli Abdumurotov, Maksud Rustamov.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available through the Zenodo link: <https://doi.org/10.5281/zenodo.22747530>

ACKNOWLEDGMENTS

The authors express gratitude to our respective university departments and institutional research groups for providing the technical infrastructure necessary to conduct this study. We also recognize the participants of internal research seminars whose early feedback helped refine the core empirical parameters of the econometric models.

REFERENCES

1. Abusomwan, S. O., & Arodoye, L. N. (2017). Small and medium enterprises' financing and dynamics of gross fixed capital formation: Evidence from Nigeria. *Journal of Research in National Development*, 15(1), 138-145. Retrieved from <https://www.ajol.info/index.php/jorind/article/view/158516>
2. Acemoglu, D., Johnson, S., & Robinson, J. A. (2005). Institutions as a fundamental cause of long-run growth. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of economic growth* (Vol. 1A, pp. 385-472). Elsevier. [https://doi.org/10.1016/S1574-0684\(05\)01006-3](https://doi.org/10.1016/S1574-0684(05)01006-3)
3. Aghion, P., & Howitt, P. (2009). *The economics of growth*. Massachusetts Institute of Technology (MIT) Press. Retrieved from <https://discovery.ucl.ac.uk/id/eprint/17829>
4. Aghion, P., Howitt, P., & Mayer-Foulkes, D. (2005). The effect of financial development on convergence: Theory and evidence. *The Quarterly Journal of Economics*, 120(1), 173-222. <https://doi.org/10.1162/0033553053327515>
5. Alotaibi, K. O., Al-Shurafa, M. A., Al-Daihani, M., & Bouteraa, M. (2025). Sectoral contributions to financial market resilience: Evidence from GCC countries. *Journal of Risk and Financial Management*, 18(8), 460. <https://doi.org/10.3390/jrfm18080460>
6. Anagnostopoulos, I., Sails, T., & Alexandrou, G. (2025). FinTechs, BigTechs and diminishing bank franchise values: Stakeholder perspectives on a disruptive emerging financial ecosystem. *Technological Forecasting and Social Change*, 212, Article 123924. <https://doi.org/10.1016/j.techfore.2024.123924>
7. Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58(2), 277-297. <https://doi.org/10.2307/2297968>
8. Arnold, N. G., Claveres, G., & Frie, J. (2024). *Stepping up venture capital to finance innovation in Europe* (IMF Working Paper No. 2024/146). International Monetary Fund. <https://doi.org/10.5089/9798400280771.001>
9. Audretsch, D. B., Belitski, M., Chowdhury, F., & Desai, S. (2022). Necessity or opportunity? Government size, tax policy, corruption, and implications for entrepreneurship. *Small Business Economics*, 58(4), 2025-2042. <https://doi.org/10.1007/s11187-021-00497-2>
10. Baldacci, E., Hillman, A. L., & Kojo, N. C. (2004). Growth, governance, and fiscal policy transmission channels in low-income countries. *European Journal of Political Economy*, 20(3), 517-549. <https://doi.org/10.1016/j.ejpoleco.2003.12.002>
11. Beck, T. (2013). Bank financing for SMEs – Lessons from the literature. *National Institute Economic Review*,

- 225(1), R23-R38. <https://doi.org/10.1177/002795011322500105>
12. Beck, T., & Demircuc-Kunt, A. (2006). Small and medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking & Finance*, 30(11), 2931-2943. <https://doi.org/10.1016/j.jbankfin.2006.05.009>
 13. Beck, T., Levine, R., & Loayza, N. (2000). Finance and the sources of growth. *Journal of Financial Economics*, 58(1-2), 261-300. [https://doi.org/10.1016/S0304-405X\(00\)00072-6](https://doi.org/10.1016/S0304-405X(00)00072-6)
 14. Bocken, N. M. P. (2015). Sustainable venture capital – Catalyst for sustainable start-up success? *Journal of Cleaner Production*, 108, 647-658. <https://doi.org/10.1016/j.jclepro.2015.05.079>
 15. Bun, M. J. G., & Windmeijer, F. (2010). The weak instrument problem of the system GMM estimator in dynamic panel data models. *The Econometrics Journal*, 13(1), 95-126. <https://doi.org/10.1111/j.1368-423X.2009.00299.x>
 16. Buratti, M., & Menter, M. (2025). The resilience of entrepreneurial ecosystems: An analysis of ecosystem network structures. *Review of Managerial Science*, 20, 2207-2239. <https://doi.org/10.1007/s11846-025-00934-6>
 17. Chang, K., Zeng, Y., Wang, W., & Wu, X. (2019). The effects of credit policy and financial constraints on tangible and research & development investment: Firm-level evidence from China's renewable energy industry. *Energy Policy*, 130, 438-447. <https://doi.org/10.1016/j.enpol.2019.04.005>
 18. Čihák, M., Demirgüç-Kunt, A., Feyen, E., & Levine, R. (2012). *Benchmarking financial systems around the world* (Policy Research Working Paper No. 6175). World Bank. <https://doi.org/10.1596/1813-9450-6175>
 19. Cumming, D. J. (2006). The determinants of venture capital portfolio size: Empirical evidence. *The Journal of Business*, 79(3), 1083-1126. <https://doi.org/10.1086/500670>
 20. Davidor, S., Dako, O. F., Nwachukwu, P. S., Bankole, F. A., & Lateefat, T. (2023). An SME loan structuring framework: Customized credit solutions in North American commercial banking. *International Journal of Advanced Multidisciplinary Research and Studies*, 3(2), 1275-1292. <https://doi.org/10.6222/5/2583049X.2023.3.2.4894>
 21. Del Gaudio, B. L., Sampagnaro, G., Porzio, C., & Verdoliva, V. (2022). The signaling role of trade credit in bank lending decisions: Evidence from small and medium-sized enterprises. *Journal of Business Finance & Accounting*, 49(1-2), 327-354. <https://doi.org/10.1111/jbfa.12554>
 22. Driscoll, J. C., & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics*, 80(4), 549-560. <https://doi.org/10.1162/003465398557825>
 23. Eberhardt, M., & Teal, F. (2011). Econometrics for grumblers: A new look at the literature on cross-country growth empirics. *Journal of Economic Surveys*, 25(1), 109-155. <https://doi.org/10.1111/j.1467-6419.2010.00624.x>
 24. El-Chaarani, H., & El-Abiad, Z. (2024). The impact of public legal protection on the internal corporate governance efficiency in banking sector. *Journal of Economic and Administrative Sciences*, 40(3), 482-515. <https://doi.org/10.1108/jeas-12-2021-0254>
 25. Elgammal, M. M., Al Bakri, A. A., & AlJanahi, A. Y. (2023). The effect of new and traditional sources of financing on the performance of small and entrepreneurship businesses: The case of Qatar. *Cogent Economics & Finance*, 11(2), 2183667. <https://doi.org/10.1080/23322039.2023.2183667>
 26. Fan, X. (2025). Digital technology and financial capital. *China Political Economy*, 8(2), 158-176. <https://doi.org/10.1108/CPE-12-2025-055>
 27. Fernández, A., & Tamayo, C. E. (2017). From institutions to financial development and growth: What are the links? *Journal of Economic Surveys*, 31(1), 17-57. <https://doi.org/10.1111/joes.12132>
 28. Florida, R., & Smith, D. F., Jr. (1990). Venture capital, innovation, and economic development. *Economic Development Quarterly*, 4(4), 345-360. <https://doi.org/10.1177/089124249000400405>
 29. French, K., Baily, M., Campbell, J., Cochrane, J., Diamond, D., Duffie, D., Kashyap, A., Mishkin, F., Rajan, R., Scharfstein, D., Shiller, R., Shin, S. H., Slaughter, M., Stein, J., & Stulz, R. (2010). The Squam Lake report: fixing the financial system. *Journal of Applied Corporate Finance*, 22(3), 8-21. <https://doi.org/10.1111/j.1745-6622.2010.00284.x>
 30. Gallo, E., Jona-Lasinio, C., & Samoncin, B. (2025). Green investment and productivity dynamics. *Review of Income and Wealth*, 71(3), Article e70024. <https://doi.org/10.1111/roiw.70024>
 31. Gan, Q. (2023). Financial system and technology innovation in an emerging economy: Can innovation efficiency be increased? *Kybernetes*, 52(12), 6049-6062. <https://doi.org/10.1108/K-09-2021-0915>
 32. Goel, A., Garg, P., & Kumar, M. (2024). Decentralized finance: A catalyst for smart global value chains in future financial ecosystems. In A. Garg, A. Jain, M. Singh, & F. Al-Turjman (Eds.), *Smart global value chain: Future innovations* (pp. 198-211). CRC Press. <https://doi.org/10.1201/9781003461432-13>
 33. Gupta, P., & Antony, A. (2026). Institutional voids and financial markets: An institutional theory perspective. *Qualitative Research in Financial Markets*. <https://doi.org/10.1108/QRFM-08-2024-0224>
 34. Ha, P. V., & Frömmel, M. (2023). Corruption, business environment, and firm growth in Vietnam. *International Journal of Finance & Economics*, 28(3), 2512-2529. <https://doi.org/10.1002/ijfe.2547>
 35. Hoehle, D. (2007). Robust standard errors for panel regressions with cross-sectional dependence. *The Stata Journal*, 7(3), 281-312.

- <https://doi.org/10.1177/1536867X0700700301>
36. Huang, Y., Zhang, L., Li, Z., Qiu, H., Sun, T., & Wang, X. (2020). *Fintech credit risk assessment for SMEs: Evidence from China* (IMF Working Paper No. 20/193). International Monetary Fund. <https://doi.org/10.5089/9781513557618.001>
 37. Johan, S., & Zhang, M. (2021). Information asymmetries in private equity: Reporting frequency, endowments, and governance. *Journal of Business Ethics*, 174(1), 199–220. <https://doi.org/10.1007/s10551-020-04558-6>
 38. Kato, A. I. (2025). Unveiling venture capital's disruptive power: Fuelling innovation and economic growth in high-impact firms in East Africa. *Future Business Journal*, 11(1), Article 174. <https://doi.org/10.1186/s43093-025-00572-0>
 39. Kato, A. I., & Manchidi, N. H. (2025). Venture capital's role in driving nascent enterprises to industry market leaders. *Cogent Business & Management*, 12(1), 2484458. <https://doi.org/10.1080/23311975.2025.2484458>
 40. Kleponė, D., & Okunevičiūtė Neverauskienė, L. (2026). An Indexation of Startup Ecosystem Maturity and Sustainable Economic Growth. *Sustainability*, 18(14), 7212. <https://doi.org/10.3390/su18147212>
 41. Konstantakopoulou, I. (2023). Financial intermediation, economic growth, and business cycles. *Journal of Risk and Financial Management*, 16(12), 514. <https://doi.org/10.3390/jrfm16120514>
 42. La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2008). The economic consequences of legal origins. *Journal of Economic Literature*, 46(2), 285–332. <https://doi.org/10.1257/jel.46.2.285>
 43. Laeven, L., Levine, R., & Michalopoulos, S. (2015). Financial innovation and endogenous growth. *Journal of Financial Intermediation*, 24(1), 1–24. <https://doi.org/10.1016/j.jfi.2014.04.001>
 44. Lange, J., Rezepa, S., & Zatrochová, M. (2024). The role of business angels in the early-stage financing of startups: a systematic literature review. *Administrative Sciences*, 14(10), 247. <https://doi.org/10.3390/admsci14100247>
 45. Law, S. H., & Azman-Saini, W. N. W. (2012). Institutional quality, governance, and financial development. *Economics of Governance*, 13(3), 217–236. <https://doi.org/10.1007/s10101-012-0112-z>
 46. Li, X., & Ban, C. (2026). Financing technological innovation in China: Neo-developmental financial statecraft through government guidance funds. *Review of International Political Economy*, 33(1), 131–161. <https://doi.org/10.1080/09692290.2025.2546858>
 47. Li, X., Xu, Q., Guo, F., & Wang, H. (2023). State-owned equity participation and private sector enterprises' strategic risk taking: Evidence from China. *Managerial and Decision Economics*, 44(2), 1107–1124. <https://doi.org/10.1002/mde.3735>
 48. Magazzino, C., & Santeramo, F. G. (2024). Financial development, growth and productivity. *Journal of Economic Studies*, 51(9), 1–20. <https://doi.org/10.1108/jes-07-2022-0397>
 49. Molnár, E. M., Németh, Á., & Tupá, M. (2026). Driving change? A systematic exploration of private equity and innovation. *European Journal of Innovation Management*, 29(11), 375–400. <https://doi.org/10.1108/ejim-10-2025-1424>
 50. Mukherjee, A., Owen, R., Scott, J. M., & Lyon, F. (2026). Financing green innovation startups: a systematic literature review on early-stage SME funding. *Venture Capital*, 28(2–3), 149–175. <https://doi.org/10.1080/13691066.2024.2410730>
 51. Norbäck, P. J., Persson, L., & Tåg, J. (2025). Risky business: venture capital, pivoting and scaling. *Small Business Economics*, 64(3), 1285–1319. <https://doi.org/10.1007/s11187-024-00944-w>
 52. North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511808678>
 53. Oyetade, D. T., Kishimba, K. J., Akande, J. O., & Muzindutsi, P. F. (2025). Measurement of Non-bank Financial Intermediation. In S. Zhou (Eds.), *Shadow Banking and Financial Risk in Emerging and Developing Markets: The Growth and Development of Non-Bank Financial Intermediation* (pp. 51–72). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-86224-3_3
 54. Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621–634. <https://doi.org/10.1080/01621459.1999.10474156>
 55. Prencipe, A. (2026). Venture Capital, Private Equity and External Financing in European High-Tech Entrepreneurial Firms: The Moderating Role of Investor Protection. *Journal of Risk and Financial Management*, 19(7), 460. <https://doi.org/10.3390/jrfm19070460>
 56. Ranchordas, S. H., & Meoli, R. (2024). Regulatory sandboxes for sustainable finance. *Law and Economics Yearly Review*, 13(2), 243–280. Retrieved from <https://iris.luiss.it/retrieve/16be59d3-aae3-4895-9405-9f6c472b9e87/ssrn-5231506%20%283%29.pdf>
 57. Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, 9(1), 86–136. <https://doi.org/10.1177/1536867X0900900106>
 58. Rundel, C., & Salemin, K. (2021). Hubs, hopes and high stakes for a relatively disadvantaged low tech place. *Local Economy*, 36(7–8), 650–668. <https://doi.org/10.1177/02690942221077120>
 59. Samila, S., & Sorenson, O. (2011). Venture capital, entrepreneurship, and economic growth. *The Review of Economics and Statistics*, 93(1), 338–349. https://doi.org/10.1162/REST_a_00066
 60. Sun, Y. (2026). From resource curse to resilience restructuring: How does the innovation ecosystems' organicity reshape industrial transformation in resource-based regions? A case study of China's

- π -shaped Curve Area. *Applied Geography*, 188, 103907. <https://doi.org/10.1016/j.apgeog.2026.103907>
61. Thakor, R. T., & Lo, A. W. (2017). *Optimal financing for R&D-intensive firms* (No. w23831). National Bureau of Economic Research. <https://doi.org/10.3386/w23831>
 62. Trancoso, T., & Gomes, S. (2024). Green shocks: The spillover effects of green equity indices on global market dynamics. *Economies*, 12(4), 83. <https://doi.org/10.3390/economies12040083>
 63. Wang, L., Sun, Y., & Tiong, R. L. (2024). Institutional quality configuration for encouraging private capital participation in PPP projects: evidence from 36 belt and road countries. *International Journal of Managing Projects in Business*, 17(6-7), 898-922. <https://doi.org/10.1108/ijmpb-06-2024-0144>
 64. Xu, X., Tan, L., & Zhao, J. (2025). Sustainable finance and renewable energy investment as dual drivers of economic growth and environmental sustainability in the European Union. *Research in Economics*, 79(4), 101065. <https://doi.org/10.1016/j.rie.2025.101065>