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Platform Ecosystem Embeddedness and Enterprise Total Factor Productivity: An Empirical Analysis of A-Share Listed Companies from 2007 to 2020

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Abstract. In the digital economy era, the platform ecosystem, as a new paradigm of innovation in business ecosystems, has driven the transformation of industrial organization forms from traditional linear division of labor to networked collaboration, creating conditions for the improvement of enterprises' total factor productivity (TFP). Based on the data of A-share listed companies from 2007 to 2020, this paper studies the impact and mechanism of platform ecosystem embeddedness on enterprises' TFP. The results show that platform ecosystem embeddedness has a significant positive impact on enterprises' TFP, and this conclusion remains robust after robustness tests such as replacing samples, changing variables, propensity score matching (PSM) and instrumental variable method. This positive effect is more significant in state-owned enterprises, enterprises without CEO duality and enterprises in the eastern region. Mechanism analysis indicates that platform ecosystem embeddedness promotes the improvement of enterprises' TFP through three paths: enhancing enterprise resilience, promoting industrial chain integration and alleviating resource mismatch. This paper clarifies the internal logic of platform ecosystem embeddedness affecting enterprises' TFP, enriches the research in related fields, and provides empirical reference and practical guidance for enterprise operation and the government's formulation of digital economy policies.

Keywords: Platform Ecosystem Embeddedness; Enterprise Total Factor Productivity; Enterprise Resilience; Industrial Chain Integration; Resource Misallocation.

1. Introduction

Against the global digital economy trend, platform ecosystems have thoroughly integrated into the national economy and become a vital driver of industrial upgrading and growth. For enterprises, deep platform embeddedness is essential to obtain data, technological and market resources and enhance core competitiveness. China has issued relevant policies to regulate the platform economy and boost real economic upgrading. In 2022, China's digital economy reached 50.2 trillion yuan; industrial internet platforms have greatly advanced the digital transformation of numerous SMEs. As a key pillar of the digital economy, the platform economy strongly fuels national economic development.

Academic circles have conducted multi-dimensional research on the economic consequences of platform ecosystem embeddedness: relevant studies have confirmed its impacts on enterprises' innovation flexibility, digital innovation performance, value chain upgrading, cross-regional capital flows, financing efficiency, supply chain efficiency, and high-quality development of manufacturing enterprises. Based on previous literature, this paper explores the impact of platform ecosystem embeddedness on enterprises' total factor productivity.

Theoretically, platform ecosystem embeddedness can boost firms' total factor productivity. Through in-depth digital interactions and real-time data feedback, platforms drive product innovation and reshape corporate innovation models. As emerging digital organizations, platforms help enterprises acquire digital resources and network capabilities to break traditional resource constraints. Moreover, they grant low-cost access to advanced technologies, market information and complementary resources, optimize internal resource allocation, and ultimately promote total factor productivity.

Platform ecosystem embeddedness may also hinder enterprises' total factor productivity. Excessive platform reliance leads to reduced autonomy, weakened value acquisition and hollowed core competitiveness. Meanwhile, coordinating multiple stakeholders and adapting to platform rules raise management costs and decision-making complexity, lowering resource allocation efficiency and ultimately restraining total factor productivity.

Theoretically, the effect of platform ecosystem embeddedness on corporate total factor productivity remains ambiguous, necessitating empirical verification. Using 2007–2020 A-share listed firms as samples, this study finds that platform embeddedness significantly improves total factor productivity, and the conclusion holds after multiple robustness tests. Heterogeneity analysis indicates such promotion effect is more pronounced in state-owned enterprises, non-dual-CEO firms and eastern-region enterprises. Further, platform embeddedness boosts total factor productivity by enhancing corporate resilience, facilitating industrial chain integration and mitigating resource mismatch.

This paper makes three main contributions. First, it enriches research on the economic outcomes of platform ecosystem embeddedness. Unlike existing studies limited to single micro, meso or macro perspectives, this study integrates corporate resilience, industrial chain integration and resource mismatch into a unified framework, systematically clarifying its influencing mechanisms on total factor productivity. Second, it broadens research on the platform embeddedness-productivity nexus. Existing literature overlooks industrial structural transmission channels; this study verifies that platform embeddedness drives productivity growth notably via industrial chain integration, highlighting its role in reshaping inter-firm collaboration. Third, it offers valuable policy and practical implications. The findings clarify how platform embeddedness elevates productivity, providing targeted references for governments to formulate digital economy, industrial and standardized platform economy development policies.

This paper is structured as follows: literature review, research hypotheses and empirical design, empirical results analysis, further discussion, and conclusions.

2. Literature Review

Relevant Research on Platform Ecosystem Embedding. Platform ecosystem embeddedness refers to enterprises integrating into platform systems to share resources and realize complementary advantages via inter-organizational cooperation (An Fei, 2025). Current research mainly explores its influence on corporate development from resource acquisition and value co-creation. In terms of resource acquisition, platforms lower enterprises' costs and barriers to accessing technologies, data and market information. Macroscopically, digital platforms reduce innovation thresholds and accelerate knowledge diffusion to empower corporate innovation (Jiang Xiaojuan, 2021). Based on A-share listed firm data, existing research also verifies that platform embeddedness notably inhibits corporate earnings volatility by measuring embeddedness status and depth (Jian Guanqun & Liu Tianmin, 2025).

In terms of value co-creation, scholars have examined how platform ecosystems reshape corporate value creation. Relevant research illustrates that enterprises can enhance their capabilities through collaboration with platforms and partners after embeddedness. From theoretical perspectives, studies also confirm that platform embeddedness boosts retail supply chain efficiency by strengthening organizational resilience. Nonetheless, excessive platform embedding entails potential risks: it may trigger enterprise dependence, limit strategic autonomy, weaken value acquisition, and erode core competencies.

Literature Review on Total Factor Productivity of Enterprises. Enterprise total factor productivity (TFP) is a key indicator of production efficiency, vital for guiding corporate decisions, formulating policies and boosting economic growth (Qu Jinli et al., 2026). Existing studies mainly explore TFP's influencing factors from internal enterprise factors and external environment.

Internally, R&D investment, human capital and corporate governance are core drivers of TFP. Zhao Lei (2025) concluded that internal factors including governance, financing constraints and innovation affect TFP via resource allocation efficiency. Other studies further noted that social networks shape corporate risk-taking and performance, while external resource dependence also influences business development.

External factors including market competition, financial development, industrial policies and institutional quality greatly affect corporate operational efficiency. Chen Yanjun and Guo Genlong (2024) verified that digital transformation significantly boosts firm TFP based on Chinese listed company data. Mechanistically, digital transformation raises industrial chain integration efficiency via specialized division and supply chain collaboration, further enhancing TFP.

In summary, existing studies have explored the economic effects of platform ecosystem embeddedness and the influencing factors of corporate TFP from diverse perspectives. Nevertheless, relevant research still has shortcomings: direct discussions on the correlation between platform embeddedness and TFP remain inadequate with inconsistent findings, and few studies integrate enterprise resilience, industrial chain integration and resource mismatch into a unified framework, failing to fully clarify its multi-level transmission mechanisms. Against the digital economy backdrop, this paper empirically examines the impact of platform embeddedness on corporate TFP and analyzes its internal pathways from micro, industrial and resource allocation dimensions. It compensates for research deficiencies, enriches relevant theories on platform economy and TFP, and offers empirical support for corporate operation and policy formulation.

3. Research Hypotheses and Empirical Design

Research Hypotheses. Platform ecosystem embeddedness denotes stable and dynamic organizational connections between enterprises and platform ecosystems built via technical interfaces, data links and rule-based coordination, which enables multi-stakeholder interaction, resource sharing, strategic alignment and knowledge integration (Wang et al., 2025). Enterprise total factor productivity (TFP) measures output efficiency, acting as a core indicator of technological progress and organizational efficiency improvement, while platform ecosystems can reduce enterprises' costs and barriers to acquiring complementary technologies, market information and data resources, and further provide diversified paths to boost corporate TFP growth (Yu Wentao & Du Bohan, 2022).

At the micro level, platform ecosystem embeddedness enhances enterprise resilience, enabling stable operation, sustained innovation investment and crisis opportunity capture to underpin TFP growth. It grants low-cost access to digital resources, leverages external technology and knowledge spillovers to raise operational efficiency, and strengthens organizational and supply chain resilience. Meanwhile, platform embeddedness optimizes corporate financing and supply chain anti-risk capacity, amplifies digital empowerment, and further boosts TFP. Accordingly, platform embeddedness promotes enterprises' total factor productivity by improving their resilience.

At the meso level, platforms, as new digital infrastructure, eliminate corporate information silos via data aggregation and industrial digital applications, advancing vertical and horizontal industrial chain integration. Such integration elevates operational efficiency through economies of scale, knowledge spillovers and risk sharing. Existing studies confirm that digital empowerment and platform connectivity break geographical restrictions, strengthen cross-regional industrial collaboration, and further improve chain integration. Consequently, platform ecosystem embeddedness enhances enterprises' total factor productivity by facilitating industrial chain integration.

At the macro level, digital platforms optimize resource allocation and mitigate information asymmetry. Resource mismatch, a key drag on TFP, occurs when production factors fail to flow to high-efficiency sectors and cannot fully release their value. Platforms build cross-industry digital linkages to rationalize resource distribution; robust digital platform development greatly eases resource mismatch and lifts overall production efficiency. Relevant studies further validate that

optimized resource allocation effectively boosts corporate productivity. Accordingly, platform ecosystem embeddedness improves total factor productivity by alleviating resource mismatch.

This paper argues that platform ecosystem embeddedness affects corporate TFP through three pathways: enhancing enterprise resilience, advancing industrial chain digital integration, and mitigating resource mismatch. Accordingly, Hypothesis H1 is proposed as follows:

H1: Platform ecosystem embeddedness boosts enterprise TFP by enhancing resilience, facilitating industrial chain integration and alleviating resource mismatch.

Empirical Design. To test whether platform ecosystem embedding promotes corporate total factor productivity, we refer to Feng Delian and Zhang Panpan (2026) and set up the following regression model:

$$TFP_{i,t}=\alpha+\beta PEE_{i,t}+\gamma' Control_{i,t}+\sum Industry+\sum Year+\varepsilon_{i,t} \quad (1)$$

Here,i and t denote enterprise and year.TFP, measured by the OP method, refers to enterprise total factor productivity. PEE represents platform ecosystem embeddedness, which covers strategic, platform and ecological dimensions and is quantified via logarithmic keyword frequency (Jian Guanqun et al., 2025). Control variables include firm size, leverage, ROA, cash flow, inventory ratio, asset growth, board size, top-five shareholding, Tobin's Q and firm age. Industry and year fixed effects are controlled, and εi,t is the random error term. Firm-level clustered robust standard errors are adopted to alleviate heteroscedasticity.

Table 1. Variable Definition and Construction

Variable Symbol	Variable Name	Construction
PEE	Platform Ecosystem Embeddedness	Cumulative frequency of keywords
TFP	Enterprise Total Factor Productivity	Calculated by OP method
Size	Firm Size	Natural logarithm of total assets
Lev	Leverage Ratio	Total liabilities / total assets
ROA	Return on Assets	Net profit / average total assets
Cashflow	Cash Flow Ratio	Operating cash flow / total assets
INV	Inventory Ratio	Inventory balance / total assets
AssetGrowth	Asset Growth Rate	(Current assets – Previous assets) / Previous assets
Board	Board Size	Natural logarithm of number of directors
Top5	Top 5 Shareholder Ownership	Total shares held by top 5 shareholders / total shares
TobinQ	Tobin's Q	Enterprise market value / asset replacement cost
FirmAge	Firm Age	Natural logarithm of years since establishment

Data Sources. This study selects 2007–2020 A-share listed firms, with data sourced from CSMAR and Wind. After excluding missing values, ST/*ST and financial industry samples, 27,497 valid observations are retained. All continuous variables are winsorized at the 1% level to eliminate extreme outliers.

Descriptive Statistics. Table 2 reports the descriptive statistics. The mean of TFP_OP is 6.751 with minor fluctuations, reflecting concentrated enterprise productivity. The relatively large standard deviations of PEE and TFP_OP reveal obvious inter-firm differences.

Table 2. Descriptive Statistics

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	mean	sd	min	max
TFP_OP	27,497	6.751	0.891	4.908	9.154
PEE	27,497	1.164	1.340	0	4.804
Size	27,497	22.13	1.279	19.90	25.93
Lev	27,497	0.435	0.205	0.060	0.879
ROA	27,496	0.042	0.059	-0.182	0.208
Cashflow	27,497	0.048	0.069	-0.146	0.231
INV	27,380	0.151	0.136	0.000	0.681
AssetGrowth	27,495	0.160	0.360	-0.561	2.080
Board	27,495	2.139	0.198	1.609	2.639
Top5	27,497	0.529	0.152	0.210	0.875
TobinQ	26,984	2.045	1.244	0.881	7.687
FirmAge	27,497	2.830	0.346	1.792	3.466

4. Empirical Results and Analysis

Analysis of Benchmark Regression Results. Table 3 presents the baseline regression results. With control variables and industry-year fixed effects gradually included, the core coefficient of platform ecosystem embeddedness remains significantly positive at the 1% level. The final coefficient is 0.018, indicating that TFP rises notably with increased embeddedness. Thus, Hypothesis H1 is verified.

Table 3. Baseline Regression Results

	(1)	(2)	(3)	(4)
VARIABLES	TFP_OP	TFP_OP	TFP_OP	TFP_OP
PEE	0.082***	0.088***	0.047***	0.018***
	(8.549)	(7.984)	(7.261)	(2.603)
Size			0.414***	0.432***
			(49.682)	(50.733)
Lev			0.731***	0.568***
			(12.125)	(10.206)
ROA			2.324***	1.991***
			(17.777)	(16.140)
Cashflow			0.205**	0.288***
			(2.117)	(3.104)
INV			0.801***	0.750***
			(10.079)	(7.991)
AssetGrowth			0.147***	0.173***
			(10.691)	(12.907)
Board			-0.141***	-0.096**
			(-3.345)	(-2.352)
Top5			0.123**	0.148***
			(2.014)	(2.584)
TobinQ			-0.029***	-0.009
			(-5.513)	(-1.509)
FirmAge			0.104***	0.049
			(4.096)	(1.571)
Constant	6.655***	6.102***	-3.027***	-3.648***
	(345.797)	(80.838)	(-16.764)	(-17.649)
Observations	27,497	27,497	26,866	26,866
R-squared	0.015	0.181	0.575	0.622
Industry FE	NO	YES	NO	YES
Year FE	NO	YES	NO	YES

Robustness Test. Replace the regression sample. To eliminate interference from annual exogenous shocks, this study excludes the 2015 A-share stock market crash sample for robustness testing. As shown in Table 4, the core variable coefficients remain significantly positive at the 1% level after gradually adding fixed effects and control variables. The findings confirm that the positive effect of platform ecosystem embeddedness on TFP stays stable, proving strong sample robustness of the core conclusion.

Table 4. Replacing Regression Samples

	(1)	(2)	(3)	(4)
VARIABLES	TFP_OP	TFP_OP	TFP_OP	TFP_OP
PEE	0.086***	0.090***	0.052***	0.021***
	(8.550)	(7.816)	(7.383)	(2.769)
Size			0.420***	0.434***
			(49.096)	(50.184)
Lev			0.752***	0.604***
			(11.786)	(10.363)
ROA			2.219***	2.009***
			(17.525)	(16.942)
Cashflow			0.174	0.253**
			(1.636)	(2.471)
INV			0.816***	0.800***
			(9.819)	(7.943)
AssetGrowth			0.010**	0.013**
			(2.130)	(2.425)
Board			-0.160***	-0.114***
			(-3.588)	(-2.625)
Top5			0.148**	0.164***
			(2.351)	(2.797)
TobinQ			-0.024***	-0.009
			(-4.098)	(-1.537)
FirmAge			0.091***	0.040
			(3.641)	(1.350)
Constant	6.666***	6.094***	-3.089***	-3.636***
	(341.024)	(80.720)	(-16.894)	(-17.652)
Observations	24,222	24,222	23,721	23,721
R-squared	0.016	0.184	0.564	0.611
Industry FE	NO	YES	NO	YES
Year FE	NO	YES	NO	YES

Replacement of Explanatory Variables. To avoid measurement bias, this paper re-constructs the core explanatory variable PEE2 with refined keywords for robustness testing. Table 5 shows that the coefficient of PEE2 remains significantly positive at the 1% level after adding control variables and fixed effects. The results are highly consistent with baseline regressions, further confirming the reliability and stability of the core findings.

Table 5. Replacing the Measurement Method of Explanatory Variables

	(1)	(2)	(3)	(4)
VARIABLES	TFP_OP	TFP_OP	TFP_OP	TFP_OP
PEE2	0.259***	0.314***	0.138***	0.097***
	(5.524)	(7.226)	(3.852)	(2.948)
Size			0.428***	0.441***
			(49.589)	(53.106)
Lev			0.718***	0.566***
			(11.309)	(9.899)
ROA			2.246***	2.012***
			(18.283)	(17.568)
Cashflow			0.173*	0.321***
			(1.688)	(3.311)
INV			0.769***	0.769***
			(9.282)	(7.708)
AssetGrowth			0.000	0.000
			(0.796)	(0.926)
Board			-0.185***	-0.144***
			(-4.093)	(-3.342)
Top5			0.152**	0.212***
			(2.370)	(3.543)
TobinQ			-0.022***	-0.018***
			(-4.516)	(-3.890)
FirmAge			0.114***	0.096***
			(4.642)	(4.098)
Constant	6.741***	6.296***	-3.211***	-3.818***
	(415.419)	(80.454)	(-17.629)	(-19.389)
Observations	27,497	27,497	26,866	26,866
R-squared	0.004	0.147	0.552	0.601
Industry FE	NO	YES	NO	YES
Year FE	NO	YES	NO	YES

Propensity Score Matching (PSM). This study employs PSM to mitigate potential self-selection bias. Samples are divided into treatment and control groups by the annual PEE median, with firms matched via 1:1 nearest-neighbor matching using control covariates. The PSM regression results in Table 6 show the PEE coefficient remains significantly positive at the 1% level after adding control variables and fixed effects. Consistent with prior robustness tests, the stable positive effect validates the causal reliability of the core conclusion.

Table 6. Propensity Score Matching (PSM)

	(1)	(2)	(3)	(4)
VARIABLES	TFP_OP	TFP_OP	TFP_OP	TFP_OP
PEE	0.087***	0.126***	0.051***	0.028***
	(8.222)	(12.771)	(6.995)	(3.994)
Size			0.412***	0.429***
			(47.341)	(50.672)
Lev			0.795***	0.609***
			(11.643)	(9.892)
ROA			2.189***	1.962***
			(17.607)	(16.891)
Cashflow			0.232*	0.348***
			(1.945)	(3.134)
INV			0.766***	0.813***
			(8.366)	(7.342)
AssetGrowth			0.005*	0.005
			(1.865)	(1.280)
Board			-0.132***	-0.129***
			(-2.816)	(-2.947)
Top5			0.105	0.132**
			(1.590)	(2.184)
TobinQ			-0.029***	-0.023***
			(-6.103)	(-4.845)
FirmAge			0.096***	0.084***
			(3.305)	(3.067)
Constant	6.647***	6.244***	-2.962***	-3.548***
	(319.272)	(77.086)	(-15.299)	(-16.801)
Observations	20,770	20,770	20,770	20,770
R-squared	0.018	0.177	0.564	0.613
Industry FE	NO	YES	NO	YES
Year FE	NO	YES	NO	YES

Endogeneity Test. To address endogeneity including reverse causality and omitted variable bias, this paper adopts the instrumental variable (IV) method, using the industry-year average PEE as the IV. Peer effects enable industry-wide platform embeddedness to correlate with individual firm PEE ,satisfying the correlation condition. Meanwhile, the industry-level IV only affects firm TFP indirectly via corporate embeddedness decisions and meets the exclusive restriction. First-stage results confirm a strong positive correlation between the IV and PEE. The second-stage regression presents a significantly positive PEE coefficient. After mitigating endogeneity, the positive causal effect of platform embeddedness on TFP remains valid, further ensuring conclusion robustness.

Table 7. Instrumental Variable Method

	(1)	(2)
VARIABLES	PEE	TFP_OP
iv	0.987***	
	(22.470)	
PEE		0.113***
		(3.406)
Size	0.152***	0.422***
	(10.295)	(40.846)
Lev	-0.193**	0.622***
	(-2.255)	(10.493)
ROA	0.295	2.004***
	(1.629)	(17.488)
Cashflow	-0.447***	0.360***
	(-3.343)	(3.623)
INV	-0.180	0.801***
	(-1.494)	(8.019)
AssetGrowth	0.000***	0.000
	(2.794)	(0.885)
Board	-0.219***	-0.090**
	(-3.164)	(-2.007)
Top5	-0.159*	0.200***
	(-1.716)	(3.316)
TobinQ	0.031***	-0.012**
	(2.983)	(-2.167)
FirmAge	-0.144***	0.055*
	(-3.020)	(1.791)
Constant	-2.255***	-3.472***
	(-6.538)	(-15.794)
Observations	26,866	26,866
Industry FE	YES	YES
Year FE	YES	YES

5. Further Analysis

Heterogeneity Analysis. Regional Heterogeneity. Regional disparities in economic development, digital infrastructure, marketization and industrial structure may cause heterogeneous effects of platform embeddedness on TFP. The sample is divided into eastern, central and western regions by province for grouped regression, as shown in Table 8.

Regression results show that PEE exerts a significant positive effect on TFP in eastern (coefficient = 0.022, $p<0.05$) and western regions (coefficient = 0.042, $p<0.10$), while the central region shows an insignificant and negative coefficient of −0.001.

In comparison, platform embeddedness significantly promotes TFP in eastern and western regions, with no notable effect in central areas. The western region has a larger PEE coefficient, while the eastern region presents higher significance.

Table 8. Regional Heterogeneity

	(1)	(2)	(3)
VARIABLES	TFP_OP(eastern)	TFP_OP(central)	TFP_OP(western)
PEE	0.022**	-0.001	0.042*
	(2.515)	(-0.086)	(1.780)
Size	0.425***	0.414***	0.468***
	(40.793)	(19.183)	(19.890)
Lev	0.711***	0.607***	0.573***
	(9.660)	(4.680)	(4.765)
ROA	2.029***	1.846***	2.090***
	(15.281)	(6.573)	(6.275)
Cashflow	0.186	0.746***	0.676**
	(1.599)	(3.731)	(2.342)
INV	0.624***	0.984***	1.008***
	(5.213)	(4.039)	(4.381)
AssetGrowth	0.000	0.016	0.019**
	(1.104)	(1.423)	(2.312)
Board	-0.125**	-0.008	0.017
	(-2.281)	(-0.088)	(0.149)
Top5	0.113	0.247*	0.180
	(1.558)	(1.813)	(1.158)
TobinQ	-0.014**	-0.003	0.004
	(-2.152)	(-0.217)	(0.320)
FirmAge	0.065*	-0.010	-0.052
	(1.871)	(-0.130)	(-0.579)
Constant	-3.435***	-3.335***	-4.729***
	(-13.637)	(-7.035)	(-7.951)
Observations	18,721	5,012	3,133
R-squared	0.615	0.591	0.665
Industry FE	YES	YES	YES
Year FE	YES	YES	YES

Enterprise Nature. Enterprise property rights constitute a critical institutional factor shaping resource allocation, operational decisions and efficiency. State-owned enterprises (SOEs) and non-SOEs differ greatly in operational objectives, marketization and decision-making, leading to heterogeneous TFP effects from platform embeddedness. With superior policy and resource endowments, SOEs gain easier access to platform resources and digital transformation, achieving more evident TFP growth. By contrast, non-SOEs feature flexible decision-making and market responsiveness yet are restricted by financing and risk capacity. Higher embeddedness costs weaken their productivity gains, resulting in a weaker TFP promotion effect compared with SOEs.

This paper classifies samples into SOEs and non-SOEs for grouped regression to examine ownership heterogeneity. As shown in Table 9, the PEE coefficient is significantly higher in SOEs (0.041,$p<0.01$) than in non-SOEs (0.015,$p<0.10$). In both coefficient and significance, platform embeddedness exerts a stronger TFP-promoting effect on SOEs.

CEO Duality. Duality refers to the integration of the chairman and general manager roles, featuring highly concentrated power. It streamlines decision-making and execution, cutting agency costs, yet weakens power checks and balances, exacerbating insider control and agency conflicts. Common among Chinese listed firms, especially private ones, duality boosts innovation efficiency but worsens resource misallocation under inadequate supervision, ultimately inhibiting corporate productivity.

To test governance moderation, this study introduces the duality variable (Dual). Grouped results reveal the PEE coefficient is weaker and less significant for dual-leadership firms, while non-dual firms show a larger, highly significant coefficient. Thus, platform embeddedness improves TFP more strongly in firms with separated leadership structures.

Table 9. Other Heterogeneities

	(1)	(2)	(3)	(4)
VARIABLES	TFP_OP(SOEs)	TFP_OP(non-SOEs)	TFP_OP(duality)	TFP_OP(non-duality)
PEE	0.041***	0.015*	0.019*	0.024***
	(2.714)	(1.842)	(1.932)	(2.595)
Size	0.443***	0.420***	0.414***	0.440***
	(31.844)	(36.730)	(30.288)	(43.150)
Lev	0.507***	0.672***	0.712***	0.565***
	(5.161)	(9.542)	(8.357)	(8.299)
ROA	2.620***	1.851***	1.835***	2.116***
	(11.195)	(15.184)	(10.328)	(15.266)
Cashflow	0.395**	0.256**	0.179	0.354***
	(2.386)	(2.187)	(1.238)	(3.050)
INV	1.020***	0.583***	0.606***	0.838***
	(6.420)	(4.975)	(4.007)	(7.435)
AssetGrowth	0.013	0.000	0.000	0.006
	(1.469)	(1.363)	(1.334)	(1.537)
Board	-0.209***	-0.045	0.005	-0.152***
	(-2.792)	(-0.846)	(0.069)	(-3.013)
Top5	0.235**	0.181**	0.114	0.211***
	(2.130)	(2.572)	(1.165)	(3.122)
TobinQ	-0.008	-0.012**	-0.008	-0.008
	(-0.663)	(-2.199)	(-0.961)	(-1.300)
FirmAge	0.084	0.000	0.018	0.045
	(1.421)	(0.013)	(0.444)	(1.242)
Constant	-3.739***	-3.418***	-3.471***	-3.675***
	(-9.875)	(-13.334)	(-10.098)	(-15.245)
Observations	10,910	15,956	6,589	20,277
R-squared	0.619	0.567	0.618	0.599
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Mechanism Analysis. To explore the underlying mechanism of PEE on TFP, this study adopts enterprise resilience, industrial chain integration and resource mismatch as mediating variables, and examines their transmission effects, with relevant results presented in Table 10.

This paper borrows Martin's (2015) measurement framework for economic resilience to assess corporate resilience, a widely adopted and reliable method. It compares an individual firm's development with the industrial average: higher relative performance indicates stronger resilience. Corporate resilience is accordingly calculated via Formula (2).

$$\text{OrgRes}= \frac{R_{firm,t-1}/\Delta R_{firm}}{R_{all,t-1}/\Delta R_{all}} \tag{2}$$

In this formula, OrgRes denotes enterprise resilience. It is calculated using firm-level and aggregate lagged sales revenue (R firm,t−1 ,R all,t−1) and current sales growth (ΔR firm,ΔR all)

With corporate resilience as the dependent variable, PEE shows a significantly positive coefficient, proving platform embeddedness strengthens firm resilience. Via information sharing, risk pooling and resource coordination, platforms help firms withstand external shocks. Accordingly, a mediating path is established: platform embeddedness → corporate resilience → TFP..

Regarding industrial chain integration, this paper adopts the method of Zhang Qianxiao and Duan Yixue (2023) to measure industrial chain integration.

First, measure the level of specialized division of labor (VSI), and use the value-added method to measure the level of vertical integration of enterprises to gauge the overall extent to which an enterprise covers the upstream or downstream sectors in the industrial chain.

VAS denotes vertical integration. Key indicators are defined by corresponding revenue, cost, expense and inventory items. Value added is calculated based on core operating income, net inventory and relevant payable items adjusted by the VAT rate.

Enterprise vertical integration and the degree of enterprise specialization are inverse indicators; the higher the degree of vertical integration, the lower the degree of specialization division. The specialization division index should be within the [0,1] interval. Samples outside this interval were deleted from the sample set, and the degree of enterprise specialization division can be inferred as follows:

$$\text{VSI}=1-VAS \tag{3}$$

Step 2: Calculate the supply chain integration level. Use supply chain efficiency to represent the supply chain integration level, and select inventory turnover rate ITR as the alternative variable for supply chain efficiency:

$$\text{ITR}=\frac{Operating\ Cost}{Average\ Net\ Inventory\ Balance} \tag{4}$$

Step 3: Calculate the Industrial Chain Integration Level (ICC), which depends on the product of the two:

$$ICC= VSI\times ITR \tag{5}$$

Using industrial chain integration as the dependent variable,PEE has a significantly positive coefficient at the 1% level. Platform embeddedness breaks industrial chain information barriers and streamlines upstream and downstream collaboration. It facilitates efficient production, circulation and innovation linkage, boosts industrial chain efficiency, and further lifts TFP, forming the mediating path: platform embeddedness → industrial chain integration → TFP.

This paper adopts Wei's (2022) method to measure resource misallocation. A higher efficiency value indicates severer resource distortion and lower allocation efficiency, and vice versa.

$$\text{Misallocayionsi}=\left|\frac{P_{si}Y_{osi}}{P_{si}Y_{si}-1}\right| \tag{6}$$

Misallocations i denotes resource allocation efficiency; P si Y osi refers to firms' optimal output scale without factor distortions, while P si Y si indicates actual output scale.

With resource mismatch as the dependent variable, PEE shows a significant negative coefficient. Platform embeddedness effectively mitigates internal and external resource distortion by optimizing supply-demand matching and factor allocation. It reduces inefficient capital and labor allocation, elevates resource utilization, and ultimately boosts TFP, forming the mediating path: platform embeddedness → reduced resource mismatch → higher TFP.

Table 10. Mechanism Analysis

	(1)	(2)	(3)
VARIABLES	OrgRes	ICC	Overinvest
PEE	0.000**	0.185***	-0.007***
	(2.043)	(3.901)	(-3.109)
Size	0.004***	0.174**	0.021***
	(16.837)	(2.532)	(8.246)
Lev	-0.014***	4.250***	0.063***
	(-8.945)	(9.640)	(4.037)
ROA	-0.002	3.281***	-0.007
	(-0.560)	(4.375)	(-0.165)
Cashflow	0.013***	-0.209	0.221***
	(3.359)	(-0.246)	(5.988)
INV	-0.001	-15.960***	-0.208***
	(-0.309)	(-15.948)	(-9.313)
AssetGrowth	-0.000	0.145***	0.002***
	(-1.129)	(2.829)	(13.330)
Board	0.006***	-0.088	-0.005
	(4.984)	(-0.308)	(-0.385)
Top5	-0.003*	0.694*	0.092***
	(-1.818)	(1.665)	(5.599)
TobinQ	-0.004***	-0.077*	-0.006***
	(-19.961)	(-1.818)	(-3.053)
FirmAge	0.002***	0.465**	0.019**
	(3.005)	(2.035)	(2.246)
Constant	-0.091***	-2.069	-0.407***
	(-14.942)	(-1.417)	(-6.687)
Observations	26,596	8,348	24,490
R-squared	0.977	0.195	0.028
Industry FE	NO	YES	NO
Year FE	NO	YES	NO

6. Conclusion

Against the digital economy boom, platform ecosystems have become a key driver of industrial upgrading and economic growth. For firms, integrating into such ecosystems is critical to acquiring strategic resources and strengthening core competitiveness. Based on 2007–2020 A-share listed firms, this paper empirically examines the impact, heterogeneity and mechanisms of platform ecosystem embedding on corporate TFP.

The results reveal that platform embedding significantly boosts TFP, which remains valid after robustness and endogeneity tests including PSM and IV methods. Heterogeneity analysis indicates this promotion effect is stronger for SOEs, non-duality firms, and enterprises in eastern and western regions. Mechanism analyses verify that firm resilience, industrial chain integration and reduced resource mismatch serve as vital mediating channels.

This study enriches relevant literature on platform economic effects and TFP determinants, and constructs a unified analytical framework spanning micro, meso and macro perspectives. It also expands the theoretical understanding of platform economy value creation. Furthermore, it provides policy implications for governments to improve digital infrastructure and optimize institutional environments, as well as practical guidance for enterprises. Firms can actively embed into suitable platforms to enhance resilience, streamline industrial chain collaboration, optimize resource allocation, and sustain TFP growth and high-quality development.

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