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Financial Agglomeration and Real Economy Development in China: Evidence from Technological Innovation and Industrial Structure Upgrading

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Abstract: The real economy is a fundamental component of the national economy, and the efficient allocation of financial resources is essential to promoting its development. Drawing on panel data for 30 Chinese provinces spanning 2007–2022, this study applies two-way fixed-effects and mediation models to investigate the effect of financial agglomeration (FA) on real economy development (RED), with particular attention to the mechanisms through which this relationship operates. The baseline results show that FA significantly promotes RED at the national level, and this findings remains robust under a range of robustness checks. The heterogeneity analysis indicates that the effect of FA on RED differs markedly across regions. The largest positive impact is observed in Central China, followed by Western China, while the positive association is relatively weaker in Eastern China. In contrast, FA is negatively and significantly associated with RED in Northeastern China. The mediation results further suggest that technological innovation (TI) serves as a partial mediator in the relationship between FA and RED. Specifically, FA further promotes RED by enhancing TI. Further analysis reveals a significant inverted U-shaped relationship between IS and RED. The turning point analysis indicates that China's IS remains on the left side of the inverted U-shaped curve, suggesting that it continues to promote RED. In addition, FA mediates the effect of IS on RED. This study broadens the existing literature on the relationship between FA and RED by demonstrating the dual functions of FA. The analysis reveals that FA directly facilitates RED and, in addition, functions as a mediating mechanism linking IS to improvements in RED. The results offer new theoretical perspectives and policy implications for optimising the spatial allocation of financial resources, strengthening financial support for TI, and promoting IS, thereby improving the financial sector's effectiveness in supporting the real economy.

Keywords: Financial Agglomeration, Real Economy Development, Technological Innovation, Industrial Structure Upgrading.

INTRODUCTION

The real economy forms the productive foundation of the national economy and is essential for sustaining long-term economic growth and social stability. The Report to the 20th National Congress of the Communist Party of China underscored the strategic importance of strengthening the real economy, recognizing it as a cornerstone of China's long-term economic development. As a central pillar of the modern economic, the financial system promotes the efficient allocation of resources among economic activities and provides essential support for economic growth. The Central Financial Work Conference has consistently emphasised that supporting the real economy development (RED) constitutes

the financial sector's primary mission, fundamental purpose, and an effective means of preventing financial risks. Against the backdrop of China's transition from rapid economic expansion to high-quality development, challenges such as the imbalance between finance and the real economy and the diversion of capital from the real economy to the financial sector have become increasingly evident. Consequently, enhancing the capacity of the financial sector to promote RED has become a key issue for both researchers and policymakers.

Against the backdrop of deepening financial globalisation and economic integration, financial resources have become increasingly concentrated in specific regions, giving rise to financial agglomeration (FA). FA contributes to more efficient financial resource allocation by facilitating the agglomeration of capital, talent, and information. It may also promote regional economic development through knowledge spillovers, economies of scale, and industrial linkages. However, FA may also divert excessive financial resources to the financial sector, causing resource allocation to deviate from the financing needs of the real economy. This may weaken the financial sector's capacity to fulfil its role in supporting the real economy, leading to a greater divergence between financial development and RED. Therefore, whether FA promotes or inhibits RED, through what mechanisms it operates, and whether its effects vary across regions remain important questions that require further investigation.

Existing studies have predominantly explored how financial development influences economic growth and the contribution of FA to regional economic development. Most studies conclude that FA optimizes the distribution of financial resources, stimulates the circulation of capital, and fosters industrial development. However, research on the mechanisms through which FA affects RED remains limited, particularly regarding the roles of technological innovation (TI) and industrial structure upgrading (IS). On the one hand, FA can ease firms' financing constraints and encourage greater investment in research and development (R&D), thereby promoting TI and supporting RED. However, empirical evidence regarding the mediating role of TI in the relationship between FA and RED remains relatively scarce. On the other hand, existing studies suggest that FA facilitates resource allocation, directs capital towards high value-added industries, and promotes IS, which in turn supports RED. Nevertheless, previous studies have mainly treated FA as an explanatory variable, focusing on its effects on IS and RED. Existing studies have devoted relatively little attention to examining the mediating role of FA in the relationship between IS and RED. To fill these research gaps, this study begins by investigating the direct effect of FA on RED. It subsequently incorporates TI into the analysis as a mediating variable to evaluate whether it transmits the effect of FA on RED. In addition, FA is incorporated into the model as a mediating variable to assess whether it serves as an intermediary linking IS to RED. This analytical framework provides a more comprehensive understanding of the pathways through which FA affects RED.

This study contributes to the existing literature in three important respects. First, the analysis is conducted using panel data from 30 Chinese provinces over the period 2007–2022 to systematically examines the effect of FA on RED and explores its regional heterogeneity. This provides new empirical evidence on the relationship between FA and RED. Second, building on the conventional mediation framework, this study introduces TI as a mediating variable to determine whether TI serves as a mediator in the relationship between FA and RED. Third, unlike previous studies that treat FA solely as an explanatory

variable, FA is incorporated into the analysis as a mediating variable to assess whether it serves as an intermediary between IS and RED. In addition, a quadratic term of IS is introduced to examine its nonlinear effect on RED. Collectively, these analyses deepen our understanding of the mechanisms through which FA affects RED.

Specifically, this study addresses three research questions. First, does FA promote RED, and do its effects vary across regions? Second, does TI mediate the relationship between FA and RED? Third, can IS further promote RED through the mediating role of FA?

THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

FA and RED

A substantial body of research has investigated how financial development influences economic growth. Schumpeter (1911) provided a systematic explanation of the mechanisms by which financial development fosters economic growth, providing the theoretical foundation for finance in supporting the real economy. Previous studies have consistently shown that financial development supports economic growth by improving the allocation of capital and facilitating the movement of financial resources towards more productive sectors (Levine, 1997; Wurgler, 2000).

As financial activities have become increasingly concentrated spatially, increasing attention has been paid to the role of FA in economic development. Previous research indicates that FA contributes to regional economic growth by improving financial resource allocation, facilitating capital circulation, and enhancing knowledge spillovers (Peng & Qiu, 2023). Evidence suggests that the economic impact of FA differs across regions, reflecting variations in regional characteristics, financial market structures, and financial development levels (Rioja & Valev, 2004; Nguyen et al., 2019; Li et al., 2025). The impact of FA on regional economic development may vary across different stages of development, suggesting the existence of a nonlinear relationship (Zheng et al., 2020).

With greater policy emphasis on strengthening financial support for real economy development (RED), increasing scholarly attention has been devoted to examining the relationship between FA and RED. Existing studies can be broadly classified into three perspectives. The first and most widely supported view is that FA promotes RED by optimizing the allocation of financial resources, reducing firms' financing costs, enhancing the efficiency of financial services, and strengthening knowledge spillovers, thereby providing more efficient financial support for real-sector firms (Pan et al., 2013). Moreover, the effects vary across financial subsectors. Specifically, banking agglomeration has been found to contribute more to RED than securities and insurance agglomeration (Xu & Yan, 2016; Zhang, 2025). The second perspective focuses on the transmission mechanisms of FA. Existing studies suggest that FA mediates the effects of digital finance (Wen & Huang, 2023) and economic openness (Ma et al., 2021) on RED. The third perspective argues that FA may have adverse effects. Excessive FA may draw capital away from productive sectors, reduce the efficiency of resource allocation, and thereby undermine the sustainable RED (Liu & Dong, 2021; Zhang, 2020). Overall, previous studies have confirmed the important role of FA in RED. However, the underlying mechanisms through which FA affects RED remain insufficiently understood.

From a theoretical perspective, FA describes the process through which financial institutions, financial resources, and financial functions become increasingly concentrated within a specific geographical area. Such concentration promotes more efficient capital allocation and strengthens financial support for the real economy. First, FA generates economies of scale and resource-sharing effects. It enhances information exchange and business interactions among financial institutions and economic agents, promotes more efficient financial intermediation by reducing market frictions and improving the allocation of financial resources. As a result, it enables financial institutions to allocate capital more efficiently, alleviate financing constraints, and support RED. Second, FA encourages the geographic concentration of essential production factors, such as capital, talent, and information. By optimising the distribution of financial resources, it directs capital towards more productive real-sector activities and supports firms in expanding productive investment and promoting industrial transformation and upgrading. Finally, the knowledge spillover and spatial diffusion effects generated by FA facilitate the dissemination of advanced financial service models, management practices, and financial expertise to surrounding regions. This enhances regional innovation capacity, promotes industrial coordination, thereby supporting sustainable RED.

Accordingly, Research Hypothesis 1 is proposed.

- H1: Financial agglomeration promotes real economy development.

FA, TI, and RED

The role of TI in driving economic growth has been widely recognized in the literature. Romer (1990) argued in the endogenous growth theory that TI is the fundamental endogenous force driving long-term economic growth. Continuous investment in R&D and the accumulation of knowledge promote technological progress, improve productivity, and sustain economic growth. Saviotti and Pyka (2008) further argued that TI stimulates the emergence of new products and industries, facilitates industrial upgrading, and ultimately promotes economic growth. These studies suggest that TI is fundamental to sustained economic growth, while sustained innovation requires effective financial support. Therefore, the extent to which financial resources effectively support TI is a crucial determinant of finance-driven economic growth.

The relationship between TI and RED has also received considerable attention. Existing studies generally agree that TI promotes RED by improving productivity, optimising resource allocation, and enhancing industrial competitiveness (Long, 2019; Wu et al., 2020). In addition, green TI has been shown to promote RED and to serve as a turning point variable through which energy development contributes to the real economy (Ouyang & Wang, 2023). Overall, the existing literature consistently identifies TI as a key driver of RED.

Guided by China's innovation-driven development strategy, the interaction between FA and TI has attracted growing academic attention. Most studies suggest that FA promotes TI. However, these effects vary across regions (Hu et al., 2023; Wang & Bai, 2017), financial market structures (Hsu et al., 2014), and types of innovation (Xie et al., 2023). Some studies have also identified nonlinear effects of FA on regional innovation (Wen et al., 2023; Han et al., 2022), whereas others suggest that FA may inhibit TI under certain conditions (Ang, 2011). In addition, several studies have highlighted the spatial spillover effects of FA,

suggesting that it promotes the cross-regional mobility of innovation resources and enhances regional innovation performance (Hu et al., 2023; Yan et al., 2026; Zhong & Li, 2020).

Several studies have examined the interactions among finance, TI, and economic growth within an integrated analytical framework. Existing studies suggest that finance and TI exhibit dynamic interactions, and their synergy promotes long-term economic growth (Perez, 2002; Li, 2015; Xie & Ren, 2017). Using a panel vector autoregression (PVAR) model, Yan and Xu (2019) further showed that the dynamic interaction between FA and TI has significant effects on regional economic growth, with significant regional heterogeneity. More recent studies have extended this line of research from economic growth to RED. Most studies suggest that both financial development and TI promote RED, although their joint effects remain inconclusive. While Zhang (2016) found that the integration of finance and technology does not significantly affect RED, Wang and Zheng (2019) reported a negative direct effect but a positive spatial spillover effect. In contrast, Wang et al. (2023) found that financial development contributes to RED not only through its direct effect but also indirectly by fostering TI.

Overall, existing studies have shown that FA promotes TI and that TI supports RED. However, limited research has examined whether TI serves as a mediating mechanism through which FA influences RED. Further investigation is therefore needed to clarify the transmission mechanism through which FA affects RED.

From a theoretical perspective, FA improves the efficiency of financial resource allocation, reduces firms' financing costs, and alleviates financing constraints, thereby providing stable financial support for firms' continuous R&D investment. Moreover, the concentration of financial institutions strengthens information exchange and collaboration among firms, universities, and research institutes. This facilitates the efficient allocation of innovation resources and enhances regional innovation capacity. TI leads to the emergence of new products, technologies, and industries, improving firms' productivity and competitiveness while enhancing resource allocation efficiency. These improvements ultimately promote high-quality RED. Therefore, FA is expected to promote RED through TI.

Accordingly, Research Hypothesis 2 is proposed.

- H2: Financial agglomeration promotes real economy development through technological innovation.

IS, FA, and RED

IS is an important pathway to high-quality RED. It reflects improvements in resource allocation and broader economic transformation. IS refers to the dynamic process through which the industrial structure evolves towards higher levels of sophistication and efficiency. It is characterised by a shift in leading industries from the primary and secondary sectors to the tertiary sector, a transition from labour-intensive to technology-intensive industries, and the extension of industrial value chains towards higher value-added segments (Yu, 2017). Existing studies generally agree that IS promotes economic growth by facilitating the movement of production factors towards more productive sectors, improving resource allocation efficiency, and enhancing total factor productivity (Liu & Xu, 2020). However, its effects are not always linear. Rather, they vary with the stage of economic development, the degree of market-oriented reform, and environmental regulation, suggesting that these

effects are both stage-specific and nonlinear (Wu et al., 2021; Liu & Zhang, 2008; Fan et al., 2020). Duarte and Restuccia (2010) also suggested that the relationship between IS and economic growth may follow an inverted U-shaped pattern. Furthermore, some studies suggest that industrial structure rationalisation contributes more to economic growth than industrial structure advancement (Gan et al., 2011; He et al., 2020).

Existing studies generally agree that financial development promotes IS by optimising resource allocation, improving capital allocation efficiency, and enhancing financial services. Several studies have also explored the dynamic relationship between financial development and IS using vector autoregression (VAR) models. Ma and Zhou (2008) found a bidirectional causal relationship between IS and financial marketisation. Tao and Xu (2016) provided evidence of a nonlinear relationship between financial development and IS, characterized by an inverted U-shape, with the impact changing across different stages. Beyond a certain level of financial development, its marginal contribution to IS gradually diminishes. These findings highlight the need to examine whether FA exhibits a similar nonlinear relationship with IS.

Several studies have examined the relationship among finance, IS, and RED within an integrated analytical framework. Existing evidence suggests that IS plays an important role in transmitting the effects of finance to the real economy. Sun (2021) showed that finance, IS, and the real economy exhibit dynamic interactions. Subsequent studies further found that IS mediates the positive effects of financial development on RED (Yang, 2021; Wei & Zhong, 2021; Kang & Cheng, 2022). In addition, Liu and Jia (2021) argued that that the contribution of IS to economic growth is contingent upon the degree of FA, indicating that the relationship may vary across different financial environments.

Overall, existing studies have provided substantial evidence regarding the relationships among IS, financial development, and economic growth. They have also examined the mechanisms through which financial development promotes IS, which in turn contributes to economic growth. However, most existing studies have viewed IS as an important transmission mechanism through which financial development affects RED. Whether FA functions as a critical intermediary through which IS contributes to RED has received limited empirical attention. Moreover, few studies have examined the mediating role of FA alongside the nonlinear effect of IS on RED within a unified analytical framework.

Theoretically, IS leads to the reallocation of production factors, including capital, technology, and talent, towards higher value-added industries. The development of these industries further increases regional demand for financial services, thereby attracting additional financial institutions, capital, and skilled financial professionals to regions with comparative advantages, and fostering a higher level of FA. FA optimises the allocation of financial resources, improves capital allocation efficiency, and provides more targeted and efficient financial services and support for industrial transformation and the development of real-sector enterprises, thereby promoting RED. In addition, the effect of IS on RED may be nonlinear, as its marginal contribution gradually diminishes with the continuous advancement of IS. Therefore, IS is expected to promote RED through FA.

Accordingly, Research Hypothesis 3 is proposed.

- H3: Industrial structure upgrading affects real economy development through financial agglomeration.

RESEARCH DESIGN

Variable Selection

Dependent Variable: Real Economy Development (RGDP)

Following Wu and Teng (2020), RED is measured by the natural logarithm of regional real gross domestic product (GDP) after excluding the value added of the financial and real estate sectors. To eliminate the effects of inflation, all variables are converted to constant prices using 2007 as the base year. Specifically, real regional GDP is deflated using the regional GDP index, while the value added of the financial and real estate sectors is deflated using the value-added index of the tertiary industry. Given the substantial variation across provinces and years, the natural logarithm is applied to the variable to mitigate potential heteroskedasticity. The variable is calculated as follows:

RGDP = ln(Real GDP−Real Value Added of Financial Sector−Real Value Added of Real Estate Sector)

(Equation 1)

Core Explanatory Variable: Financial Agglomeration (FA)

Following Quan and Quan (2023) and Lei et al. (2023), FA is measured by the location quotient (LQ) based on the value added of the financial sector. The variable is calculated as follows:

$$FA_{it} = \left(\frac{fin_{it}}{gdp_{it}} \right) / \left(\frac{FIN_t}{GDP_t} \right) \quad \text{(Equation 2)}$$

where FA_{it} represents the level of FA in region *i* in year t; fin_{it} denotes the value added of the financial sector in region *i* in year *t*; gdp_{it} represents the regional GDP of region *i* in year *t*; FIN_t denotes the national value added of the financial sector in year *t*; and GDP_t represents national GDP in year *t*. A higher value of FA_{it} indicates a higher degree of FA.

Mediating Variable: Technological Innovation (TI)

Following Ren and Yang (2020), TI is measured by R&D expenditure intensity, defined as the ratio of intramural expenditure on R&D to regional GDP.

Explanatory Variables: Industrial Structure Upgrading (IS)

IS is proxied by industrial structure rationalisation. Following Gan et al. (2011), Yuan and Zhu (2018), and Zhao et al. (2020), this study uses the Theil index as a proxy for industrial structure rationalization. The index is constructed from the output and employment shares of the primary, secondary, and tertiary sectors. A Theil index value of 0 indicates a perfectly rational industrial structure, whereas deviations from 0 indicate structural imbalance. Since this indicator is negatively oriented with higher values indicating a lower degree of industrial

structure rationalization. this research took its negative value to facilitate more intuitive interpretation of the results (Zhao et al., 2020).

$$IS_{it} = -theil_{it} = -\sum_{m=1}^{3}\left[y_{mit} \times \ln\left(y_{\text{mit}} / l_{mit} \right)\right] \quad \text{(Equation 3)}$$

Where $m = 1,2,3$ denotes the primary, secondary, and tertiary industries, respectively; i represents the region; t denotes the year; y_{mit} represents the ratio of the value added of the industry m to the regional GDP; l_{mit} denotes the proportion of employment in industry m to the total employment.

Control Variables

To minimize potential estimation bias caused by omitted variables, four control variables commonly adopted in the existing literature are included.

- ***Human Capital (Lab):*** Human capital is proxied by the share of students enrolled in regular higher education institutions in the total population.
- ***Economic Openness (Open):*** Economic openness is proxied by total imports and exports as a share of regional GDP.
- ***Government Intervention (Gov):*** Government intervention is proxied by local government general budget expenditure as a share of regional GDP.
- ***Infrastructure Development (Infra):*** Infrastructure development is proxied by transportation density, which is calculated as the combined length of railway and highway networks divided by the provincial land area..

Sample Selection and Data Sources

This study uses data from 30 provincial-level administrative regions in China spanning the 2007–2022 period. conduct the empirical analysis. Considering data availability, consistency in statistical standards, and comparability with existing studies, Taiwan, Hong Kong, Macao, and Tibet are excluded from the sample.

Regarding data sources, statistics on regional GDP, the value added of the financial and real estate sectors, regional GDP indices, and tertiary industry value-added indices are retrieved from the National Bureau of Statistics of China. TI data are obtained from the China Statistical Yearbook on Science and Technology. All other variables are compiled from the China Statistical Yearbook and the corresponding provincial statistical yearbooks.

Model Specification

Model for Hypothesis 1:

To examine the impact of FA on RED, a two-way fixed-effects model is established:

$$RGDP_{i,t} = \alpha_0 + \alpha_1 \times FA_{i,t} + \sum \delta_k \times Control_{k,i,t} + \lambda_i + \varphi_t + \varepsilon_{i,t} \quad \text{(Model 1)}$$

Where $RGDP_{i,t}$ denotes the level of RED; $FA_{i,t}$ represents the level of FA; $Control_{k,i,t}$ denotes the value of the *k-th* control variable, where *k*=1,2,3,4 represents human capital (Lab), economic openness (Open), government intervention (Gov), and infrastructure development (Infra), respectively. α_0 is the constant term; α_1 is the regression coefficient of *FA*; δ_k denotes the regression coefficient of the k-th control variable; λ_i represents region-fixed effects; φ_t denotes time-fixed effects; and $\varepsilon_{i,t}$ is the random error term.

Models for Hypothesis 2:

To investigate whether FA promotes RED through TI, this study employs the mediation analysis framework developed by Baron and Kenny (1986). Based on the baseline model (1), the models (2) and (3) are constructed to test the mediation effect.

$$TI_{i,t} = \beta_0 + \beta_1 \times FA_{i,t} + \sum \delta_k \times Control_{k,i,t} + \lambda_i + \varphi_t + \varepsilon_{i,t} \quad \text{(Model 2)}$$

$$RGDP_{i,t} = \gamma_0 + \gamma_1 \times FA_{i,t} + \gamma_2 \times TI_{i,t} + \sum \delta_k \times Control_{k,i,t} + \lambda_i + \varphi_t + \varepsilon_{i,t} \quad \text{(Model 3)}$$

Where $TI_{i,t}$ denotes the level of TI, which serves as the mediating variable in Hypothesis H2; β_0 and γ_0 are the constant terms in Models (2) and (3), respectively; β_1 and γ_1, γ_2 denote the coefficients to be estimated in Models (2) and (3), respectively. If α_1 in Model (1) is statistically significant, FA is considered to have a significant effect on RED. If β_1 in Model (2) is statistically significant, FA is considered to have a significant effect on TI. If γ_2 in Model (3) is statistically significant, γ_1 in Model (3) is compared with α_1 in Model (1). If γ_1 in Model (3) is no longer statistically significant, full mediation is indicated. If γ_1 in Model (3) remains statistically significant and its absolute value is smaller than α_1 in Model (1), partial mediation is indicated.

Models for Hypothesis 3:

To examine whether FA mediates the effect of IS on RED, this study adopts the stepwise mediation approach developed by Baron and Kenny (1986)..

First, Model (4) is constructed to examine the effect of IS on RED.

$$RGDP_{i,t} = \alpha_0 + \alpha_1 \times IS_{i,t} + \alpha_1 \times IS_{i,t}^2 + \sum \delta_k \times Control_{k,i,t} + \lambda_i + \varphi_t + \varepsilon_{i,t} \quad \text{(Model 4)}$$

where $RGDP_{i,t}$ denotes the level of RED; $IS_{i,t}$ represents the level of IS; $IS_{i,t}^2$ is the quadratic term for IS; α_0 is the constant term; α_1 and α_2 denote the regression coefficients of *IS* and the quadratic term, respectively.

Second, Model (5) is estimated to assess the effect of IS on FA

$$FA_{i,t} = \beta_0 + \beta_1 \times IS_{i,t} + \beta_1 \div IS_{i,t}^2 + \sum \delta_k \times Control_{k,i,t} + \lambda_i + \varphi_t + \varepsilon_{i,t} \quad \text{(Model 5)}$$

where $FA_{i,t}$ denotes the level of FA, which serves as the mediating variable. Given that the effect of IS on FA may be nonlinear, the quadratic term for IS is also included in Model (5). β_0 is the constant term; β_1 and β_2 denote the regression coefficients of *IS* and the quadratic term, respectively; and the remaining variables are defined in the same way as in Model (4).

Third, IS, its quadratic term, and FA are included in Model (6) to examine the mediating role of FA in the effect of IS on RED.

$$RGDP_{i,t} = \gamma_0 + \gamma_1 \times IS_{i,t} + \gamma_2 \times IS_{i,t}^2 + \gamma_3 \times FA_{i,t} + \sum \delta_k \times Control_{k,i,t} + \lambda_i + \varphi_t + \varepsilon_{i,t} \quad \text{(Model 6)}$$

where γ_0 is the constant term; γ_1, γ_2, and γ_3 denote the regression coefficients of *IS*, the quadratic term, and FA, respectively.

If α_1 and α_2 in Model (4) are statistically significant, IS has a significant effect on RED. If β_1 and β_2 in Model (5) are statistically significant, IS has a significant effect on FA. If γ_3 in Model (6) is statistically significant, FA is considered to play a mediating role in the effect of IS on RED.

BASELINE REGRESSION RESULTS

Descriptive Statistics

Table 1 reports the summary statistics for the main variables included in the analysis. It indicated considerable variation in the mean values, standard deviations, and ranges of the variables, suggesting substantial regional heterogeneity in real economic development, FA, human capital, economic openness, government intervention, and infrastructure development. These results suggest that the sample exhibits sufficient cross-regional variation to support the subsequent analysis.

Table 1: Summary Statistics for the Main Variables

Variable	Obs.	Mean	Std. Dev.	Min.	Median	Max.
RGDP	480	9.365	0.945	6.511	9.445	11.343
FA	480	1.070	1.173	0.202	0.660	7.314
Lab	480	1.981	0.618	0.665	1.905	4.362
Open	480	28.258	29.760	0.714	15.503	161.702
Gov	480	0.246	0.108	0.097	0.225	0.758
Infra	480	0.946	0.515	0.075	0.923	2.292

Baseline Regression Results

Table 2 summarizes the estimation results of Model (1). In Column (1), only the core explanatory variable, *FA*, is included. The specifications reported in Columns (2)–(5) are estimated with the sequential addition of human capital (*Lab*), economic openness (*Open)*, government intervention (*Gov*), and infrastructure development (*Infra*). Across all model specifications reported in Table 2, *FA* is associated with a positive and highly significant coefficient. The estimated coefficient of FA remains positive and statistically significant

throughout the sequential model specifications, despite slight fluctuations in its magnitude following the inclusion of additional covariates. This pattern provides strong evidence that FA promotes RED.

Regarding the control variables, a significantly positive coefficient is observed for human capital (*Lab*), suggesting that human capital accumulation improves labour productivity and technological absorption capacity, thereby providing human capital support for RED. A significantly positive coefficient is observed for economic openness (*Open*), indicating that greater openness facilitates the inflow of capital, technology, and advanced management practices, thereby promoting RED. Infrastructure development (*Infra*) also has a significantly positive coefficient, suggesting that improved infrastructure reduces firms' transaction costs, enhances resource allocation efficiency, and creates favourable conditions for RED. By contrast, a negative and statistically significant coefficient is obtained for government intervention (*Gov*), suggesting that excessive government intervention may reduce the efficiency of market-based resource allocation and crowd out private investment, thereby constraining RED.

Overall, the evidence indicates a robust positive relationship between FA and RED. These findings are consistent with the prediction of Hypothesis H1.

Table 2: Baseline Regression Results

	(1)	(2)	(3)	(4)	(5)
Variables	**RGDP**	**RGDP**	**RGDP**	**RGDP**	**RGDP**
FA	0.095***	0.063***	0.065***	0.077***	0.066***
	(7.010)	(3.980)	(4.589)	(5.428)	(5.101)
Lab		0.105***	0.074***	0.067***	0.054***
		(6.206)	(3.865)	(3.641)	(3.135)
Open			0.001***	0.001***	0.001***
			(3.419)	(3.540)	(3.788)
Gov				-0.530***	-0.375***
				(-4.640)	(-3.477)
Infra					0.223***
					(9.155)
Constant	9.263***	9.090***	9.116***	9.246***	9.037***
	(623.164)	(252.523)	(265.245)	(223.066)	(222.814)
Observations	480	480	480	480	480
Region FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.997	0.997	0.997	0.997	0.998

Notes: FE=Fixed Effects. Robust t-values are presented in parentheses. ***, **, and * correspond to the 1%, 5%, and 10% significance levels, respectively.

Robustness Checks

The robustness of the baseline findings is further evaluated using two approaches. The corresponding results are presented in Table 3.

Instrumental Variable Approach

FA and RED may be subject to reverse causality, leading to potential endogeneity. To address this issue, following Li (2023), the one-period lag of FA (*Lagged_FA*) is used as an instrumental variable, and the model is estimated using the two-stage least squares (2SLS) method.

The first-stage results in Column (1) of Table 3 show that *Lagged_FA* has a positive and statistically significant coefficient, indicating a strong correlation with current FA. In addition, the Cragg–Donald Wald F statistic exceeds the critical value for the weak instrument test, indicating that the instrument is valid and unlikely to suffer from a weak instrument problem. As reported in Column (2), the second-stage estimation indicates that, after accounting for endogeneity through the instrumental variable approach, the coefficient on FA remains positive and statistically significant at the 1% level, further supporting the robustness of the baseline findings.

Extreme-Sample Exclusion Approach

Following Hua and Chen (2022), provinces are ranked according to their average level of FA over the period 2007–2022, and the top and bottom 10% of provinces are excluded before re-estimating the model. Column (3) of Table 3 indicates that FA retains a positive and highly significant effect at the 1% level after excluding extreme observations, providing further support for the robustness of the baseline findings.

Table 3: Robustness Check Results

	(1)	(2)	(3)
Variables	**FA**	**RGDP**	**RGDP**
Lagged_FA	0.779***		
	(14.431)		
FA		0.067***	0.129***
		(4.874)	(6.364)
Lab	-0.111***	0.059***	0.025
	(-2.956)	(3.330)	(1.032)
Open	-0.001*	0.001***	0.000
	(-1.808)	(3.192)	(1.183)
Gov	0.204	-0.432***	-0.343***
	(1.443)	(-3.676)	(-3.214)
Infra	0.055	0.211***	0.209***
	(1.552)	(8.781)	(7.906)
Constant	0.404***	9.097***	9.087***
	(3.713)	(214.349)	(186.153)
Observations	450	450	384
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adjusted R^2	0.996	0.998	0.998

Notes: FE=Fixed Effects. Same as Table 2.

Heterogeneity Analysis

Given the substantial regional differences in economic development, industrial structure, financial development, and resource endowments across China, the effect of FA on RED may vary across regions. Therefore, following the regional classification of the National Bureau of Statistics of China, the 30 provinces are divided into four economic regions: Eastern, Central, Western, and Northeastern China. Separate regressions are estimated for each region, and the results are reported in Table 4.

Table 4 shows that the coefficients of *FA* are 0.042, 0.366, and 0.132 for Eastern, Central, and Western China, respectively, all of which are positive and statistically significant at the 1% level. These results indicate that FA significantly promotes RED in all three regions, although the magnitude of the effect varies across regions. The strongest effect is observed in Central China, followed by Western China, while the effect is relatively weaker in Eastern China. The regional share of the real economy in GDP further supports this finding. The corresponding shares are 93.1% in Central China, 92.1% in Western China, and 87.5% in Eastern China, broadly consistent with the estimated effects of FA. One explanation is that the three regions are at different stages of financial and economic development. In Central and Western China, financial markets still have considerable room for development. FA improves the efficiency of financial resource allocation, eases firms' financing constraints, and channels more capital into the real economy, thereby generating a stronger promoting effect. By contrast, the financial system in Eastern China is relatively mature, and financial resources are already allocated more efficiently. As a result, the marginal contribution of further FA is smaller. Moreover, the non-real sector is more developed in Eastern China, and financial resources may be diverted to non-real sectors, partly weakening the positive effect of FA on RED.

Table 4: Regional Heterogeneity Regression Results

	Eastern	**Central**	**Western**	**Northeastern**
Variables	*RGDP*	*RGDP*	*RGDP*	*RGDP*
FA	0.042***	0.366***	0.132***	-0.126**
	(3.019)	(3.163)	(3.461)	(-2.533)
Lab	0.063**	0.029	0.072***	0.108***
	(2.229)	(0.588)	(2.785)	(3.962)
Open	-0.000	0.006*	-0.001	0.002
	(-0.121)	(1.800)	(-0.603)	(0.892)
Gov	-0.149	-1.820***	-0.266***	0.240
	(-0.582)	(-3.600)	(-3.176)	(1.428)
Infra	0.038	0.049	0.231***	-0.080
	(0.705)	(0.636)	(6.036)	(-0.508)
Constant	9.588***	9.686***	8.546***	9.032***
	(172.444)	(61.496)	(167.347)	(46.983)
Observations	160	96	176	48
Region FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.999	0.995	0.999	0.999

Notes: Same as Table 2..

In Northeastern China, the coefficient of *FA* is −0.126 and is statistically significant at the 5% level, indicating that FA has a significant negative effect on RED. This may be attributed to weak economic growth momentum, slow industrial restructuring, and relatively low financial resource allocation efficiency. In addition, the outflow of financial resources limits the ability of FA to support the real economy, thereby constraining RED in the region. These findings suggest that the impact of FA on RED exhibits significant regional heterogeneity, highlighting the importance of adopting region-specific financial development strategies.

MECHANISM ANALYSIS

Mediating Effect of Technological Innovation

The baseline regression results indicate that FA significantly promotes RED. To further examine whether TI mediates this effect, TI is introduced as the mediating variable, and the mediation analysis based on Models (2) and (3) is performed. The regression results are reported in Table 5. Column (1) of Table 5 reports the baseline regression results. The coefficient of *FA* is 0.066 and is positive and statistically significant at the 1% level, confirming that FA significantly promotes RED. Column (2) uses TI as the dependent variable. The coefficient of *FA* is 0.136 and is statistically significant at the 5% level, indicating that FA significantly enhances TI. In Column (3), TI is added to the baseline model. The coefficient of *TI* is 0.029 and is positive and statistically significant at the 1% level, indicating that TI significantly promotes RED. Meanwhile, the coefficient of *FA* decreases from 0.066 to 0.062 but remains statistically significant at the 1% level.

Table 5: Mediation Analysis Results for Technological Innovation

	(1)	(2)	(3)
Variables	*RGDP*	*TI*	*RGDP*
FA	0.066***	0.136**	0.062***
	(5.101)	(2.460)	(4.859)
TI			0.029***
			(3.002)
Lab	0.054***	-0.335***	0.064***
	(3.135)	(-4.504)	(3.754)
Open	0.001***	-0.009***	0.001***
	(3.788)	(-5.862)	(4.389)
Gov	-0.375***	0.349	-0.386***
	(-3.477)	(0.824)	(-3.500)
Infra	0.223***	1.026***	0.193***
	(9.155)	(7.872)	(8.019)
Constant	9.037***	1.383***	8.997***
	(222.814)	(6.432)	(220.975)
Observations	480	480	480
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adjusted R^2	0.998	0.967	0.998

Notes: Same as Table 2.

Overall, the results indicate that FA not only directly promotes RED but also indirectly promotes it by enhancing TI. These results further indicate that TI partially mediates the effect of FA on RED. Based on the estimated coefficients, the mediating effect accounts for approximately 6.06% of the total effect, indicating that the positive impact of FA on RED is primarily attributable to its direct effect, while TI provides an additional indirect transmission channel. Therefore, Hypothesis H2 is supported.

Mediating Effect of Financial Agglomeration in the Relationship between Industrial Structure Upgrading and Real Economy Development

To further examine the mechanism through which IS affects RED, Model (4) is first estimated to examine its nonlinear effect on RED. Models (5) and (6) are subsequently estimated to examine whether FA mediates the effect of IS on RED. Column (1) of Table 6 reports the estimation results of Model (4). To further assess the robustness of these results, two robustness checks are conducted: restricting the sample period and excluding extreme samples. Specifically, the sample period is restricted to 2011–2022, and the model is re-estimated. The results are reported in Column (2) of Table 6. In addition, following Hua and Chen (2022), provinces are ranked according to their average level of IS over the period 2007–2022. The top and bottom 10% of provinces are excluded before re-estimating the model, and the results are reported in Column (3) of Table 6.

Table 6: Effects of Industrial Structure Upgrading on Real Economy Development: Baseline and Robustness Results

	(1)	(2) 2011-2022	(3) Trim 10%
Variables	RGDP	RGDP	RGDP
IS	0.217***	1.886***	0.197***
	(4.207)	(7.529)	(3.268)
IS^2	-0.199***	-1.648***	-0.151**
	(-3.743)	(-5.563)	(-2.281)
Lab	0.042**	-0.242***	0.025
	(2.525)	(-5.484)	(0.938)
Open	0.001***	0.000	0.001*
	(3.124)	(0.019)	(1.655)
Gov	-0.357***	-6.737***	-0.400***
	(-3.102)	(-17.729)	(-3.021)
Infra	0.264***	0.180*	0.289***
	(9.904)	(1.853)	(10.500)
Constant	9.136***	11.946***	9.151***
	(195.239)	(67.832)	(140.659)
Observations	480	360	384
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adjusted R^2	0.998	0.886	0.998

Notes: Same as Table 2.

Table 6 shows that the coefficient of *IS* is positive and statistically significant at the 1% level across all three specifications. In contrast, the coefficient of the quadratic term of *IS* is significantly negative, with significance at the 1%, 1%, and 5% levels in Columns (1), (2), and (3), respectively. These results indicate an inverted U-shaped relationship between IS and RED. The consistent results across the robustness checks further confirm the robustness of this finding. The results suggest that, during the initial stage of IS, improvements in the industrial structure optimise resource allocation and improve industrial efficiency, thereby promoting RED. However, as the level of IS continues to increase, its marginal positive effect gradually weakens. Once IS exceeds the turning point, the marginal effect turns from positive to negative, thereby constraining RED.

To further examine the inverted U-shaped relationship between IS and RED, and to identify the turning point (*IS**) at which the marginal effect of IS changes from positive to negative, Equation (4) is derived from the estimation results of Model (4). The first-order derivative with respect to *IS* is then obtained, as shown in Equation (5). By equating the first-order derivative to zero, the estimated turning point of IS is found to be *IS**=0.545. The results indicate that when IS < 0.545, an increase in IS generates a positive marginal effect on RED. In other words, IS promotes RED, although its marginal positive effect gradually weakens as the level of IS increases. Once IS exceeds the estimated turning point of 0.545, the marginal effect becomes negative, indicating that further IS constrains RED. A comparison with the sample data shows that the IS index of all 30 provinces remained below the estimated turning point. This indicates that, throughout the sample period, all provinces were still in the stage where IS promoted RED.

$$RGDP_{i,t} = 9.136 + 0.217 \times IS_{i,t} - 0.199 \times IS_{i,t}^2 + 0.042 \times Lab_{i,t} + 0.001 \times Open_{i,t} - 0.357 \times Gov_{i,t} + 0.264 \times Infra_{i,t} \quad \text{(Equation 4)}$$

$$\frac{\partial RGDP_{i,t}}{\partial IS_{i,t}} = 0.217 - 0.398 \times IS_{i,t} \quad \text{(Equation 5)}$$

Building on the previous analysis, this study further examines whether FA mediates the effect of IS on RED. Table 7 summarizes the estimation outcomes for Models (4) (5) and (6). Since estimation results for Model (4) have already been discussed in detail in Table 6, Column (1) of Table 7 is included only as the reference model for comparison in the mediation analysis.

The estimates reported in Column (2) of Table 7 reveal a negative coefficient for IS and a positive coefficient for its quadratic term (IS^2), both of which are statistically significant, suggesting a U-shaped association between IS and FA. Specifically, before IS reaches a higher level, its marginal effect on FA is negative. As IS continues, the marginal effect gradually increases and becomes positive after exceeding a turning point. This suggests that, during the early stage of IS, regional industries are still dominated by traditional industries, while high value-added industries and modern service industries remain underdeveloped. Consequently, demand for financial services is limited and insufficient to attract the concentration of financial resources. As IS progresses, the expansion of high value-added industries increases financial service demand, giving rise to a gradual concentration of financial resources and thereby promoting FA.

Table 7: Mediation Analysis Results for Financial Agglomeration between Industrial Structure Upgrading and Real Economy Development

	(1)	(2)	(3)
Variables	*RGDP*	*FA*	*RGDP*
IS	0.217***	-0.360**	0.243***
	(4.207)	(-2.202)	(4.970)
IS^2	-0.199***	0.294**	-0.221***
	(-3.743)	(2.118)	(-4.341)
FA			0.073***
			(5.881)
Lab	0.042**	0.416**	0.012
	(2.525)	(2.198)	(0.710)
Open	0.001***	-0.001	0.001***
	(3.124)	(-0.509)	(3.677)
Gov	-0.357***	1.191***	-0.443***
	(-3.102)	(3.550)	(-4.019)
Infra	0.264***	0.185**	0.251***
	(9.904)	(2.358)	(10.230)
Constant	9.136***	-0.271	9.156***
	(195.239)	(-0.618)	(198.820)
Observations	480	480	480
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adjusted R^2	0.998	0.978	0.998

Notes: Same as Table 2.

As reported in Column (3) of Table 7, after FA is introduced into Model (6), its coefficient remains positive and highly significant ($p < 0.01$), indicating that FA makes a positive contribution to RED. Meanwhile, the coefficients of *IS* and IS^2 remain statistically significant, suggesting that IS not only directly affects RED but also indirectly affects it through FA. Overall, the results confirm the mediating role of FA in the effect of IS on RED. Therefore, Hypothesis H3 is supported.

CONCLUSIONS AND POLICY IMPLICATIONS

Conclusions

Using panel data from 30 provinces spanning 2007 – 2022 in China, this analysis examines the dual role of FA in promoting RED, both as a direct driver of RED and as a mediating channel through which IS affects RED. In addition, the analysis further explores whether TI serves as a mediator linking FA to RED. The analysis yields the following main conclusions. First, the baseline estimates provide evidence that FA significantly facilitates RED. This finding is further confirmed by the robustness checks. Second, the effect of FA exhibits significant regional heterogeneity. FA is found to be positively and significantly associated with RED across China's eastern, central, and western regions. Among the three regions, the estimated effect is strongest in Central China and weakest in Eastern China. By contrast, FA has a significant negative effect in Northeastern China, indicating substantial regional

differences in its economic impact. These regional differences may reflect variations in the share of the real economy in regional GDP as well as differences in the marginal effect of FA. Third, FA not only directly promotes RED but also indirectly promotes it through TI. The mediation analysis further shows that TI partially transmits the effect of FA on RED. Fourth, the results reveal a nonlinear relationship between IS and RED, following a statistically significant inverted U-shaped pattern. A comparison with the estimated turning point indicates that all provinces remain below the turning point, suggesting that IS still exerts a positive marginal effect on RED during the sample period. Fifth, the empirical evidence suggests that IS is nonlinearly associated with FA, with the relationship taking the form of a U-shape. At relatively low levels of IS, its marginal effect on FA is negative. As IS continues, the marginal effect gradually increases and becomes positive once the estimated turning point is exceeded. Finally, FA mediates the effect of IS on RED. This suggests that IS not only directly promotes RED but also indirectly promotes it through FA.

Policy Implications

Building on the empirical evidence, several recommendations are presented to better leverage the role of FA in advancing RED.

First, the level of FA should be further enhanced to fully realise its economic benefits. Policymakers should work toward establishing a more favorable institutional environment for financial development and introducing more effective measures to support FA. Differentiated financial policies should be implemented according to regional industrial structures, resource endowments, and comparative advantages to facilitate the efficient flow of financial resources across regions and facilitate the development of regional financial hubs. At the same time, financing channels for real-sector enterprises should be further expanded to direct more financial resources towards the real economy, improve the efficiency of financial resource allocation, ease firms' financing constraints, and promote sustainable RED.

Second, policies should place greater emphasis on supporting technological innovation (TI) by promoting closer collaboration between the financial sector and innovation activities. Governments should further strengthen innovation incentive mechanisms, increase public investment in R&D, strengthen intellectual property protection, and create a more favourable innovation environment. Financial resources should be directed towards innovative enterprises to facilitate the commercialisation of technological achievements and promote a virtuous interaction between financial development and TI, thereby strengthening the transmission mechanism through TI.

Third, IS should be promoted in a scientific and region-specific manner to build a modern industrial system that supports RED. Policy makers should take regional resource endowments and stages of economic development into account when advancing industrial upgrading, avoiding excessive industrial upgrading that is inconsistent with local development conditions. To support the sustainable RED, governments should prioritize the expansion of high-value-added and modern service industries while creating conditions that improve access to financial services and channel financial resources toward productive activities.

Finally, policy initiatives should focus on fostering stronger interactions between FA and RED. This objective can be achieved by further reforming financial institutions, establishing more effective information-sharing frameworks, and creating a more efficient market environment. Greater efforts should be made to direct financial resources more efficiently toward priority sectors of the real economy., thereby fostering coordinated and sustainable development between FA and the real economy.

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