DOI: 10.53469/jgebf.2025.07(10).10

The Impact of Digital Finance on Industrial Structure Upgrading—A Factor of Production Perspective

Wenwen Sun

School of Finance, Anhui University of Finance and Economics, Bengbu 233030, China

Abstract: ***High-quality development is central to building a modern socialist country, with industrial structure upgrading as a key pathway. In the era of globalization, strategic industrial planning and the transformation of traditional industries are vital for establishing the "dual circulation" development pattern, enhancing domestic market resilience and international competitiveness. This paper investigates the impact mechanisms of digital finance on industrial structure upgrading from a factor of production perspective. Using panel data from 290 Chinese prefecture-level cities (2011–2024), a Panel Vector Autoregression (PVAR) model is constructed to analyze the dynamic relationships among digital finance, industrial upgrading, and factor endowments. The findings reveal a time-lag effect: digital finance's impact is limited in the short term but becomes significantly positive over the long term, demonstrating its sustained potential to drive industrial transformation.***

Keywords: Digital Finance, Industrial Structure Upgrading, Factors of Production.

1. Introduction

The 20th National Congress of the Communist Party of China identified high-quality development as the primary task for building a modern socialist country. To ensure the smooth operation of the economy and achieve this high-quality development, upgrading the industrial structure is of critical importance (Guo Jitao et al., 2024). Firstly, amidst the wave of economic globalization, it is imperative to scientifically plan the industrial layout and accelerate structural upgrading to achieve the new "dual circulation" development pattern, where the domestic and international markets reinforce each other (Meng Yao, 2006). Secondly, China's economy remains, to some extent, reliant on traditional industries, which offer limited potential for further driving overall economic progress. Enhancing China's technological innovation capacity and core competitiveness has become essential to promoting economic development, making industrial structure upgrading an urgent priority (Yao Shujie et al., 2024).

In recent years, with the rapid development of information technology, digital finance, as a product of the integration of finance and technology, has increasingly become a key engine for economic transformation and industrial upgrading. According to data from the 2024–2028 China Digital Finance Market In-depth Research and Investment Prospect Analysis Report, the global digital finance market continued to expand in 2023, with China leading the world at a market scale of 41.7 trillion RMB, accounting for 15.6% of the global market. China places great emphasis on the development of digital finance, treating it as a crucial means of enhancing economic resilience and promoting high-quality development. Under the combined influence of policy guidance and technological evolution, digital finance has shown trends of rapid expansion, functional diversification, and broad population coverage (Li Tao et al., 2024).

Based on the above analysis, promoting industrial structure upgrading has gradually become a consensus in academia, and digital finance has emerged as a significant driving force in this process. This paper will conduct a systematic analysis of the impact of digital finance on industrial structure upgrading. It will explore the multidimensional pathways of this influence, examine the theoretical mechanisms through which digital finance affects industrial structure upgrading, and empirically investigate its specific effects. The aim is to provide theoretical support and empirical evidence for a deeper understanding of the new trends in industrial transformation in the context of the digital economy.

2. Literature Review

A comprehensive review of existing academic research reveals that scholars, both domestically and internationally, have conducted extensive and in-depth investigations into the topic of how digital finance influences industrial structure upgrading. This body of work is primarily reflected in the following two areas:

The development of digital finance has provided e-commerce enterprises with diversified financing channels, driving the upgrading and transformation of related industries and promoting regional trade development (Zheng, 2025). Based on panel data from 30 provinces, Jiang et al. (2024) found that digital finance has a positive effect on the green total factor productivity of agriculture, with the development of digital villages acting as a mediating factor. The research by Zhang et al. (2024) indicates that the popularization and deepening of digital finance promote changes in urban industrial structure, fostering innovation and entrepreneurial activities, and thereby playing a catalytic role in the formation and development of resilient cities. By analyzing prefecture-level city data from 2011-2020, Li et al. (2024) examined the relationship between digital finance, the business environment, and industrial structure upgrading. Their results show that digital finance has a positive indirect effect on the business environment, with industrial structure upgrading playing a mediating role. Using data from the China Household Finance Survey, Ma et al. (2024) explored the impact of digital finance usage on the upgrading of household consumption structure. The findings suggest that using digital financial services helps stimulate household consumption vitality and improves the consumption structure to some extent. A mechanism analysis further revealed that digital finance provides strong support for consumption upgrading by enhancing the efficiency of household financial asset allocation. Zhang Zhengping et al. (2024) concluded that digital finance leverages its technological advantages to channel more capital into the tertiary sector, thereby promoting the upgrading of county-level industrial structures. Taking the transformation of trade structure as a starting point, Zhang Yingying et al. (2023) combined matched data from Chinese cities and customs to analyze the impact of digital finance as an emerging financial form on the optimization of urban export structure and its underlying mechanisms. The study found that the development of digital finance contributes to the optimization and upgrading of urban export product structures, and this promotional effect shows a trend of gradual enhancement over time.

Factor mobility has been identified as a positive moderating factor in the effect of digital inclusive finance on promoting industrial structure upgrading (Jiao et al., 2024). In their research, Tang et al. (2022) set R&D innovation as a mediating variable to examine its transmission mechanism in the process of digital finance development promoting industrial structure upgrading within economic zones. The empirical analysis revealed that R&D innovation plays a mediating role in the path through which digital finance affects industrial structure upgrading. In the process of advancing the deepening of digital finance and the optimization and transformation of industrial structure, the effective allocation of government attention plays a crucial strategic role. When the government focuses its limited attentional resources on eliminating key aspects of the digital divide, it can stimulate the innovative vitality of market entities, thereby providing a solid institutional guarantee and policy momentum for the vigorous development of digital finance and its positive interaction with industrial structure upgrading (Xue et al., 2024). Cheng Qiongwen and Shen Ping (2023) found that digital finance can promote urban industrial structure upgrading by enhancing the level of regional innovation and entrepreneurship. The conclusion that the advancement of digital inclusive finance is a key driver of rural industrial integration is further supported by findings that the credit support provided by digital inclusive finance has the most significant effect on promoting this integration (Zhang Yue et al., 2021; He Hongqing, 2020).

3. Theoretical Analysis and Research Assumptions

3.1 The Direct Effect of Digital Finance on Industrial Structure Upgrading

The impact of digital finance on industrial structure upgrading can be explained through the following three aspects. First, digital finance transcends the physical branch networks and credit threshold limitations of traditional finance, achieving broader coverage for small and medium-sized enterprises (SMEs), rural areas, and low-income groups (Xie Xueyan et al., 2021; Wu Benjian et al., 2025; Zhou Li et al., 2020). It provides greater financing channels and capital support to groups that previously struggled to access financial services, thereby fostering the rapid development of emerging industries, the service sector, and technology-intensive industries. This, in turn, promotes coordinated development and structural optimization among the primary, secondary, and tertiary sectors, accelerating the process of industrial upgrading.

Second, by leveraging technology, digital finance enables the rapid integration of capital flows, information flows, and data streams, significantly improving the responsiveness and transactional efficiency of financial services (Sun Lingyan, 2023; Zhou Lei et al., 2023). Digital finance alleviates corporate financing difficulties, reducing financing costs while simultaneously enhancing the efficiency of capital acquisition. This markedly strengthens the economic system's capacity for optimal resource allocation, guiding financial resources more precisely toward strategic emerging industries and making a valuable contribution to the further optimization and upgrading of the industrial structure.

Third, by utilizing technological means such as artificial intelligence, blockchain, and cloud computing, digital finance can be embedded into various segments of the industrial chain, achieving deep integration and empowerment of industrial activities (Tian Xuebin et al., 2024; Xu Xiaodan et al., 2024). Relying on the deep fusion of digital technology and financial services, it infuses traditional industries with new technological capabilities, effectively enhancing the efficient coordination of all links within the industrial chain. Ultimately, this powerfully promotes the structural optimization of the entire industrial ecosystem, steering it towards greater rationalization and sophistication. It drives resource allocation to become more scientific and efficient, supporting the development of a high-efficiency and intelligent industrial structure.

Based on the analysis above, this paper proposes the following basic hypothesis:

Hypothesis 1: Digital finance has a direct promotional effect on industrial structure upgrading.

3.2 Long-Term Mechanism Analysis

Compared with traditional finance, digital finance, leveraging new-generation information technologies such as big data, artificial intelligence, and blockchain, demonstrates significant advantages in promoting the optimal allocation of factor resources and enhancing the accessibility of financial services. However, this process is not immediately effective; instead, it exhibits characteristics of gradual penetration and progressive release of effects. From the perspective of its own developmental features, the popularization and deepening of digital finance often undergo stages from "superficial contact" to "deep integration" (Qian Haizhang et al., 2020). In the initial stage, the promotion of fintech is primarily manifested in the innovation of payment tools and the popularization of online credit, with its capacity for structural reshaping of the real economy being relatively limited. As technology further matures and the institutional environment continuously improves, digital finance gradually embeds itself into the production end, supply chains, and investment end, thereby exerting a deeper guiding influence on the industrial structure.

From the perspective of the path mechanism of industrial upgrading, structural change is essentially a long-term cumulative process requiring the co-evolution of capital, technology, and institutions (Rodrik, 2012). By expanding financing channels, reducing transaction costs, and improving resource allocation efficiency, digital finance provides necessary support for enterprise technological innovation and production model transformation. However, these positive impacts often exhibit a time-lag effect, especially under conditions such as the weak adaptive capacity of SMEs and uneven regional development levels, where their effects tend to become apparent only in the medium to long term. Furthermore, during its initial development, digital finance may face challenges such as imperfect regulation, insufficient risk identification capabilities, and lagging institutional adaptation, which could even cause disturbances to industrial resource allocation in the short term (Li Ying, 2022; Farea et al., 2025). Therefore, it is necessary to examine its role from a longer time dimension to distinguish its dual characteristics of “short-term fluctuations” and “long-term promotion.”

Based on the analysis above, this paper proposes the following basic hypothesis:

Hypothesis 2: The impact of digital finance on industrial structure upgrading exhibits a time-lag effect; its effects are limited in the short term but demonstrate a significant positive effect in the long term.

4. Research Design

4.1 Sample Selection and Data Sources

This paper utilizes panel data from 290 prefecture-level cities across China for the period 2011–2024 as its research sample to systematically investigate the impact mechanisms of digital finance on industrial structure upgrading. Macroeconomic and financial statistical data are sourced from the Wind Database; indicators related to technological innovation are obtained from the China Statistical Yearbook on Science and Technology; the Peking University Digital Financial Inclusion Index is employed to reflect the development level of digital finance; and additional socioeconomic development data are supplemented by the National Bureau of Statistics and various municipal statistical yearbooks. To address missing data for certain years, the linear interpolation method is applied to ensure the continuity and integrity of the panel dataset. Data processing is conducted using Stata MP 18 software. To eliminate dimensional effects and reduce potential errors, key variables calculated manually are subjected to centralization processing.

4.2 Variable Definition

Explanatory Variable: The Peking University Digital Financial Inclusion Index is selected as the representative indicator to comprehensively measure the overall development status of digital finance across various regions.

Explained Variable: Drawing on the Theil Index (TL) methodology proposed by Gan Chunhui et al. (2011), an indicator for industrial structure rationalization is constructed. The Theil Index, denoted as Risit, reflects the equilibrium of resource allocation among industries by calculating the deviation degree of each industry’s output value or employment proportion. Industrial structure advancement, denoted as Indh, signifies the increasing share of industries with high productivity and high technological content (Yuan Hang et al., 2018). To capture the transformation of cities towards service-orientation and high-end development driven by informatization and digitalization, this paper introduces the structural hierarchy coefficient, based on the traditional proportions of the three industries, to assess the degree of advancement.

Mediating Variables: For the human factor (L), this paper adopts the research framework of Lin Likui (2025), selecting the ratio of university students to the total registered population in each city as the core measurement indicator. For the capital factor (K), the study follows the method of Li Xiaolong et al. (2021), introducing the degree of capital price distortion (DISK) as the core measure. For the technology factor (IP), the research approach of Yao Weihan et al. (2021) is referenced, with the ratio of R&D expenditure to regional GDP in each city chosen as the core metric.

Control Variables: To effectively control for the potential impact of other factors on industrial structure upgrading, this paper introduces five key control variables based on prior studies (Du et al., 2021; Cheng et al., 2018; Han Yonghui et al., 2017; Wang Wei et al., 2015). Employment scale (enm) is measured by the logarithm of the total number of employed persons in the region, reflecting the fundamental role of labor market supply in industrial restructuring. Financial development level (fdp) is represented by the ratio of total loans from financial institutions to regional GDP, indicating the supporting capacity of the financial system for industrial transformation. Fiscal support intensity (fsp) is gauged by the proportion of general budgetary fiscal expenditure to regional GDP, revealing the guiding effect of government intervention on industrial upgrading. Information infrastructure development level (ltr) is measured by the logarithm of regional telecommunications revenue, reflecting the technological empowerment of the digital economy on industrial structure optimization. Input level (lee) is measured by the logarithm of regional educational expenditure, providing intellectual support and innovative impetus for industrial transformation and upgrading.

The specific variable definitions and measurement methods are shown in Table 1

Table 1: Names and Definitions of Variables

Variable Type	Variable Name	Variable Code	Variable definitions
Dependent Variables	Industrial Structure Rationalization	Risit	$Risit = Ln(\frac{1}{TL})$ $TL = \sum_{i=1}^{n}(\frac{Y_i}{Y})\, ln(\frac{Y_i}{L_i}/\frac{Y}{L})$
	Industrial Structure Advanced	Indh	$Indh_{it} = \sum_{m=1}^{3}(Y_{i,m,t}/Y_{i,t}) \cdot m$
Explanatory Variables	Digital Finance Index	DIF	Logarithm of the Digital Financial Inclusion Index
Mediating Variables	Human Capital Factor	L	Number of students enrolled in higher education per household registration in each region
	Capital Factor	K	$K = \frac{1}{DIST}$ $DIST = MP/r$
	Technology Factor	IP	Proportion of urban R&D expenditure to regional GDP
Control Variables	Employment Scale	enm	Logarithm of total employment in the region
	Financial Development Level	fdp	Ratio of financial institution deposits to regional GDP
	Fiscal Support Intensity	fsp	Ratio of general public budget expenditure to regional GDP
	Information Infrastructure Development Level	ltr	Logarithm of telecom revenue in the region
	Input Level	lee	Logarithm of educational expenditure in the region

4.3 Descriptive Statistics

Table 2: The table of descriptive statistics

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
DIF	4060	5.238	0.518	3.582	5.855
Risit	4060	13.995	15.856	-48.906	63.315
Indh	4060	23.080	1.705	0	28.799
L	4060	0.021	0.026	-0.043	0.220
K	4046	0.622	0.487	-2.089	14.110
IP	4060	0.011	0.032	-0.925	0.936
enm	4060	3.833	0.906	2.004	6.583
fdp1	4060	1.136	0.630	0.361	3.569
fsp1	4060	2.048	0.996	0.790	6.002
ltr	4060	3.337	0.956	0.742	6.084
lee	4060	4.036	0.786	2.182	6.444

5. Empirical Analysis

5.1 Data Stationarity Test and Cointegration Test

The results of the stationarity test indicate that conclusions drawn from different testing methods vary. Overall, the dataset exhibits a mixed pattern of stationarity, with some variables being stationary and others non-stationary.

Three panel cointegration testing methods—Kao, Pedroni, and Westlund—are employed to systematically examine the long-term equilibrium relationships among the variables. In the Kao test, the statistics for the Modified Dickey–Fuller t, Dickey–Fuller t, Augmented Dickey–Fuller t, Unadjusted Modified Dickey–Fuller t, and Unadjusted Dickey–Fuller t are −12.909***, −18.431***, −0.648***, −8.417***, and −16.855***, respectively. All these statistics reject the null hypothesis of "no cointegration" at the 1% significance level, indicating that a cointegrating relationship exists among the variables.

The joint verification through the Kao, Pedroni, and Westlund tests all significantly reject the null hypothesis of "no cointegration," indicating that a long-term stable equilibrium relationship exists among the variables. This conclusion provides a reliable econometric foundation for conducting dynamic analysis, and also ensures the validity and robustness of subsequent research within the framework of long-term relationships.

Table 3: The table of data stationarity test

Variable	*LLC*	*IPS*	*PP-Fisher*
DIF	28.662	-18.544***	19300.000***
Indh	-8.096***	8.147	236.761
Risit	-280.000***	-	779.462***
IP	66.870	5.821	310.301
K	-40.045***	-9.805***	323.374
L	-54.022***	-	642.536**

Table 4: The table of cointegration test

Statistic	*Kao Te st*	*Statistic*	*Pedro ni Test*	*Statisti c*	*Wester lund T est*
Modified Dicke y–Fuller t	-12.90 9***	*Modified Phill ips Perron t*	22.484 ***	*Varian ce ratio*	8.4570 ***
Dickey–Fuller t	-18.43 1***	*Phillips–Perr on t*	-28.61 5***		
Augmented Dic key–Fuller t	-0.648 ***	*Augmented Di ckey-Fuller t*	-17.08 2***		
Unadjusted mo dified Dickey–F uller t	-8.417 ***				
Unadjusted Dic key–Fuller t	-16.85 5***				

5.2 Determination of the Optimal Lag Order

To avoid spurious regression resulting from non-stationarity and to improve the statistical validity and consistency of model parameter estimation, first-differenced data are employed in subsequent tests to form stationary series, thereby enhancing the interpretability and robustness of empirical results for subsequent analyses such as impulse response functions. The test results for the optimal lag order show that the AIC reaches its minimum value of -8.484* at lag 4, the BIC also achieves its minimum value of -4.250* at lag 4, and the HQIC similarly attains its minimum value of -6.950* at lag 4. The consistency across these three information criteria indicates that a lag order of 4 best balances model goodness-of-fit and parameter parsimony, making it the optimal choice for constructing the dynamic model.

Table 5: The table of the optimal lag order

Lag Order	*AIC*	*BIC*	*HQIC*
1	-2.429	0.711	-1.308
2	-6.121	-2.676	-4.886
3	-4.788	-0.984	-3.417
4	-8.484*	-4.250*	-6.950*
5	-5.681	-0.924	-3.947

5.3 Impulse Response Analysis

Figure 1 illustrates the impulse response results of various variables to shocks in digital finance. The response of digital finance to its own shock exhibits a pattern of "short-term rapid decay and medium-term stable fluctuation," with an initial sharp decline followed by stabilization. The rationalization of industrial structure shows a "sharp drop followed by rebound and long-term stabilization," reaching its lowest point in the second period before gradually recovering. The upgrading of industrial structure displays a "time-lagged transmission" effect, with a significant negative impact in the first period, followed by a rebound and convergence toward zero. Capital factors experience a notable negative response in the first period, peak in the medium term, and then stabilize. The responses of human and technological factors are generally weak, both showing minor fluctuations in the medium term before returning to stability. Overall, the responses of all variables to digital finance shocks are characterized by short-term volatility and long-term stabilization, consistent with the theoretical expectation that impulse responses converge to zero.

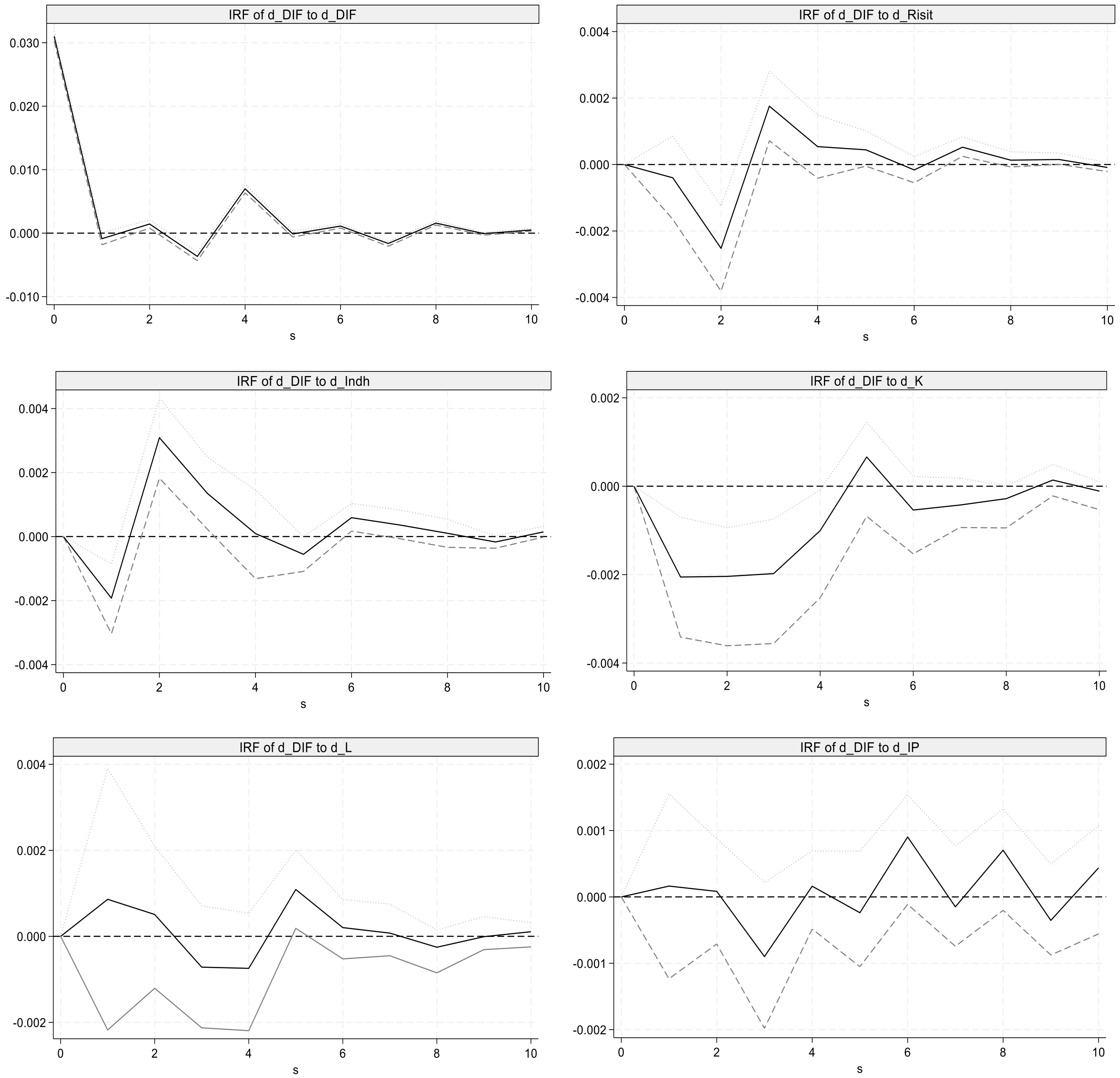

Figure 1: The Figure of DIF Impulse Response

Figure 2 illustrates the impulse response characteristics of industrial structure rationalization to various shocks. The response to a digital finance shock initially shows a weak positive effect, peaking in the first period before rapidly declining and converging around the zero axis, indicating that the short-term promotional effect of digital finance is limited, with no long-term cumulative impact. In response to its own shock, industrial structure rationalization exhibits a strong initial positive effect, followed by a stepwise decline and stabilization, reflecting the rapid attenuation of a "risk contagion" effect. The response to a shock from industrial structure advancement is initially negative, turns positive in the first period, and then converges, suggesting that industrial upgrading may cause short-term fluctuations in rationalization. The response to capital factor shocks is predominantly negative, while the response to technological factor shocks remains negative over the medium to long term before eventually converging to zero, indicating that the inhibitory effects of both factors gradually diminish. The response to human capital shocks shows an initial positive boost, but weakens and converges thereafter. Overall, the effects of all shocks on industrial structure rationalization are characterized by short-term volatility and long-term convergence, consistent with the theoretical expectations of impulse response analysis.

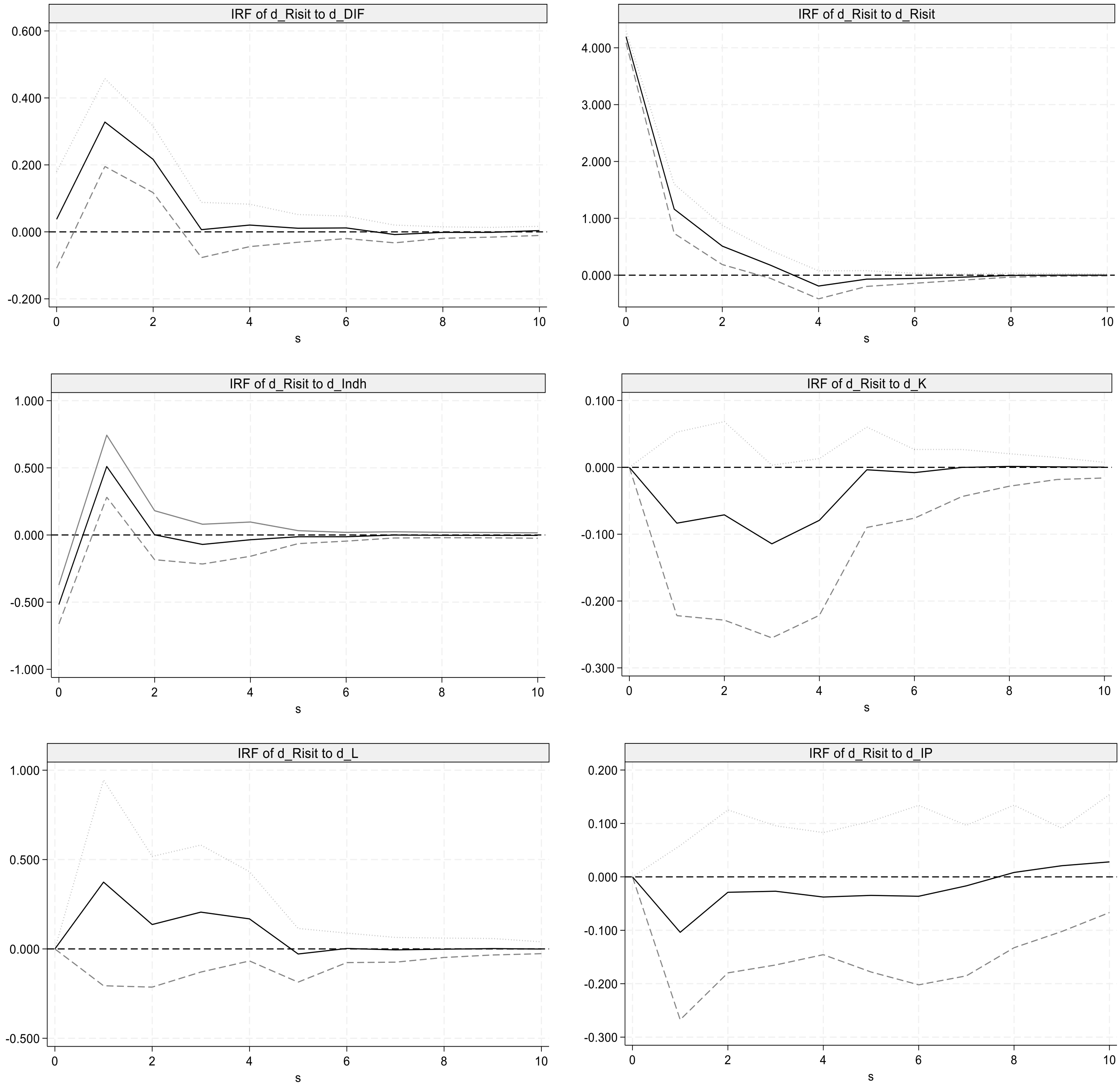

Figure 2: The Figure of Risit Impulse Response

Figure 3 illustrates the impulse response characteristics of industrial structure rationalization to various shocks. The response to a digital finance shock initially exhibits a weak positive effect, peaking in the first period before rapidly declining and converging, indicating a limited short-term promotional effect with no long-term cumulative impact. The response to its own shock shows a strong initial positive effect, followed by a stepwise decline and stabilization, reflecting the rapid attenuation of a “risk contagion” effect. In response to a shock from industrial structure advancement, the initial reaction is negative, turning positive in the first period before converging, suggesting that industrial upgrading has a short-term volatile impact on rationalization. The response to a capital factor shock is overall negative, while the response to a technological factor shock remains negative in the medium to long term, both gradually converging and signaling a weakening inhibitory effect. The human capital factor shock initially shows a positive promotional effect, which subsequently weakens and stabilizes. Overall, the impacts of all shocks on industrial structure rationalization are characterized by short-term volatility and long-term convergence, consistent with the theoretical expectations of impulse response analysis.

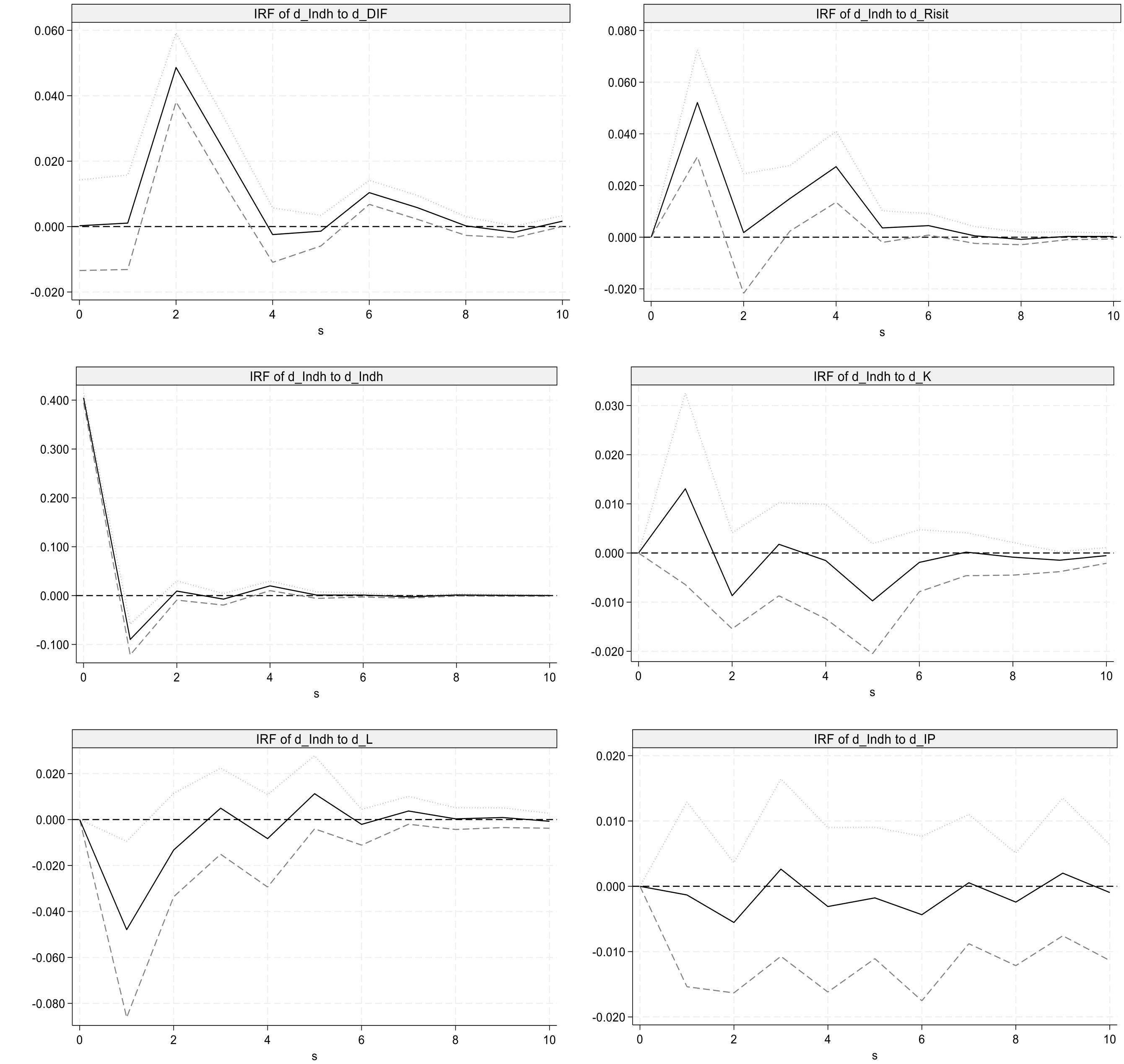

Figure 3: The Figure of Indh Impulse Response

6. Conclusions and Policy Recommendations

From the perspective of factors of production, digital finance significantly promotes industrial structure upgrading by optimizing the allocation efficiency of capital, technology, and human resources. The study finds that digital finance not only directly advances the rationalization and sophistication of the industrial structure but also enhances synergistic effects among industries through factor mobility mechanisms. In the short term, the impact of digital finance on the industrial structure exhibits volatility; however, in the long run, its positive effects gradually emerge and stabilize. Notably, by reducing information asymmetry and improving resource allocation efficiency, digital finance accelerates the transformation of traditional industries and the development of emerging ones, thereby driving the industrial structure toward a more advanced stage.

To further leverage the role of digital finance in industrial structure upgrading, the following measures should be taken: First, strengthen the development of digital financial infrastructure, enhance the application of technologies such as big data, artificial intelligence, and blockchain in the financial sector, and improve the precision and efficiency of financial services in serving the real economy. Second, promote coordination between financial and industrial policies, guiding digital financial resources toward high-technology and high-value-added industries, and supporting the growth of strategic emerging sectors. Third, enhance the regulation of digital finance to mitigate technological and systemic risks, ensuring the stability of the financial system. Fourth, reinforce the synergistic development of human capital and technological factors by improving labor quality through education and training, thereby fostering deep integration between technological innovation and industrial upgrading.

References

[1] Bakry W, Nghiem X H, Bhatti M I, et al. Digital finance and sustainable develop-ment: Evidence from developing nations[J]. Science Progress, 2024, 107(3): 00368504241278823.

[2] Farea M M, Aljofi A A. The Influence of External Market Drivers on Global Value Chain Participation in Saudi Arabia: The Mediating Role of Technological Advancements[J]. Sustainability, 2025, 17(9): 3946.

[3] Heinrich C, Knill C, Steinebach Y. Analyzing industrial policy portfolios[J]. Policy Sciences, 2025, 58(1): 87-109.

[4] Jiang Y, Han G, Yu D. Digital finance and agricultural green total factor productivity: The mediating role of digital village development[J]. Finance Research Letters, 2024, 67: 105948.

[5] Khera P, Ng S, Ogawa S, et al. Measuring digital financial inclusion in emerging market and developing economies: A new index[J]. Asian Economic Policy Review, 2022, 17(2): 213-230.

[6] Li Q, Zhong Z, Ge Q. Digital finance and sustainable development of commercial banks; insights from listed commercial banks[J]. International Review of Financial Analysis, 2025, 104: 104209.

[7] Offiong U P, Szopik-Depczyńska K, Cheba K, et al. FinTech as a digital innovation in microfinance companies–systematic literature review[J]. European Journal of Innovation Management, 2024, 27(9): 562-581.

[8] Shen X, Liang J, Cao J, et al. How population aging affects industrial structure upgrading: evidence from China[J]. International Journal of Environmental Research and Public Health, 2022, 19(23): 16093.

[9] Tang Y, Geng B. Digital finance development level and corporate debt financing cost[J]. Finance Research Letters, 2024, 60: 104825.

[10] Wu W, Ji Z, Liang H. The impact of new infrastructure construction on optimization and upgrading of industrial structure[J]. Buildings, 2023, 13(10): 2580.

[11] Zhang Q, Zhang S, Huang B, et al. Research on the impact of digital finance on the high-quality development of education[J]. Finance Research Letters, 2024, 70: 106188.

[12] Zheng M. Digital Finance, E-commerce Development, and Regional Trade Development[J]. Finance Research Letters, 2025: 107532.