UDC 338.43.02:658
DOI: https://doi.org/10.32782/CMI/2025-16-17

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STRATEGIC MANAGEMENT OF FACTORS PRODUCTIVITY OF PRODUCTION OF AGRICULTURAL ENTERPRISES

Driven by the global digital wave, the transformation and development of agricultural enterprises in agricultural countries have become a key issue for ensuring food security and economic growth. The results show that: (1) Digital transformation significantly and positively drives the strategic restructuring of agricultural enterprises (β=0.456, $p<0.01$); (2) Strategic restructuring significantly promotes the improvement of total factor productivity (β=0.385, $p<0.01$); (3) Dynamic capabilities play a partial mediating role in the relationship between digital transformation and strategic restructuring (mediating effect accounts for 36.2%) as well as between strategic restructuring and total factor productivity (mediating effect accounts for 25.7%).

Keywords: *Digital Transformation, Strategic Restructuring, Total Factor Productivity (TFP), Dynamic Capabilities, Innovation Economics.*

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СТРАТЕГІЧНЕ УПРАВЛІННЯ ПРОДУКТИВНІСТЮ ФАКТОРІВ ВИРОБНИЦТВА СІЛЬСЬКОГОСПОДАРСЬКИХ ПІДПРИЄМСТВ

Підвищення ефективності сільського господарства та сталий розвиток безпосередньо пов'язані з впровадженням національних стратегій продовольчої безпеки та відродження сільських районів. Наразі глибоке проникнення цифрових технологій у сільськогосподарський сектор стимулює трансформацію сільськогосподарського виробництва з «орієнтованого на досвід» на «орієнтоване на дані», надаючи сільськогосподарським підприємствам новий шлях для подолання обмежень традиційних факторів виробництва та покращення загальної факторної продуктивності. Однак сільськогосподарські підприємства загалом стикаються з такими проблемами, як слабка цифрова інфраструктура та недостатня стратегічна адаптивність. Метою статті є побудова теоретичної основи для аналізу взаємозв'язку між «цифровою трансформацією - стратегічною реструктуризацією - сукупною факторною продуктивністю» з подвійної перспективи теорії динамічних можливостей та інноваційної економіки. Для досягнення поставленої мети в роботі було використано теоретичну основу та аналітичні розрахунки, засновані на «цифровій трансформації – стратегічній реструктуризації - сукупній факторній продуктивності». Використовуючи панельні дані 300 сільськогосподарських підприємств, це дослідження застосовує аналіз головних компонент, метод індексу DEA-Мальмквіста та модель посередницького ефекту для емпіричної перевірки механізму між трьома змінними. Результати показують, що: (1) Цифрова трансформація значно та позитивно впливає на стратегічну реструктуризацію сільськогосподарських підприємств (β=0,456, $p<0,01$); (2) Стратегічна реструктуризація значно сприяє покращенню сукупної факторної продуктивності (β=0,385, $p<0,01$); (3) Динамічні можливості відіграють часткову посередницьку роль у взаємозв'язку між цифровою трансформацією та стратегічною реструктуризацією (посередницький ефект становить 36,2%), а також між стратегічною реструктуризацією та загальною факторною продуктивністю (посередницький ефект становить 25,7%). Обґрунтовано теоретичну основу та практичний шлях для сільськогосподарських підприємств у аграрних країнах для досягнення підвищення ефективності шляхом цифрової трансформації.

Ключові слова: *цифрова трансформація, стратегічна реструктуризація, сукупна факторна продуктивність, динамічні можливості, інноваційна економіка.*

Statement of the problem. As a pillar industry of the national economy in agricultural countries, the improvement of agricultural efficiency and sustainable development are directly related to the implementation of national food security and rural revitalization strategies [1, p. 510]. Currently, the in-depth penetration of digital technologies (such as the Internet of Things, big data, and artificial intelligence) in the agricultural sector is driving the transformation of agricultural production from "experience-driven" to "data-driven", providing a new path for agricultural enterprises to break through the constraints of traditional production factors and improve Total Factor Productivity (TFP) [2, p. 481]. However, agricultural enterprises in agricultural countries generally face problems such as weak digital infrastructure and insufficient strategic adaptability – some enterprises have introduced digital technologies but failed to synchronously carry out systematic restructuring of business, organizational, and

market strategies, leading to a "disconnection" between digital technologies and production operations, and the TFP improvement effect has not met expectations.

Existing studies have separately explored the impact of digital transformation on corporate strategy [3, p. 1323] and the relationship between strategic adjustment and productivity [4, p. 101], but there are two limitations: first, most studies focus on manufacturing or service industries, ignoring the unique attributes of agricultural enterprises, such as "long production cycle, high natural risks, and strong industrial chain linkage"; second, there is a lack of mechanism decomposition of "how digital transformation affects TFP through strategic restructuring", especially the neglect of the bridging role of dynamic capabilities. Based on this, this study takes agricultural enterprises in agricultural countries as the research object, integrates Dynamic Capability Theory (enterprises' ability to integrate resources to adapt to environmental changes) and Innovation Economics (the optimization effect of technological innovation on factor allocation), and systematically tests the causal chain and mediating mechanism among the three variables, so as to fill the contextual and theoretical gaps in existing research.

Analysis of recent research and publications. Dynamic Capability Theory, proposed by Teece et al. [1, p. 510], emphasizes the process by which enterprises obtain competitive advantages by "sensing, integrating, and reconfiguring" resources and capabilities in a dynamic environment. Eisenhardt K M, Martin J A. determine that in the context of digital transformation, agricultural enterprises need to respond to the dual impacts of market demand and technological changes by sensing digital technology trends (e.g., demand for precision agriculture), integrating internal and external digital resources (e.g., cooperation with e-commerce platforms), and restructuring business processes (e.g., digital supply chains) [5, p. 1112]. Romer P M. defines Innovation Economics as highlighting that innovation is the "recombination of production factors." As a disruptive innovation, digital technology can promote the improvement of enterprises' TFP by optimizing production methods (e.g., IoT-based crop growth monitoring), expanding market channels (e.g., live-streaming e-commerce for agricultural products), and restructuring organizational forms (e.g., flat management structure) [6, p. 1007]. The combination of the two theories can effectively explain "how digital transformation drives strategic change and efficiency upgrading through capability building and innovation practices", providing a core theoretical framework for this study.

Kohli R, Melville N P. describes the digital transformation as a drives the strategic restructuring of agricultural enterprises in two aspects: on the one hand, digital technology changes the way enterprises acquire and process information – big data analysis can accurately identify consumers' demand for green agricultural products, prompting enterprises to adjust their market positioning strategies; on the other hand, digital technology breaks the boundaries of traditional businesses – the application of IoT and blockchain technology can promote enterprises to transform from "single production" to "production + traceability + service" integrated industrial chain operations [2, p. 481]. In addition, Wang C L and Ahmed P K indicate that digitalization also requires enterprises to optimize their organizational structure; the traditional hierarchical system can hardly adapt to the needs of rapid decision-making in the digital era, and enterprises need to transform into agile teams [7, p. 34].

Barney J. determines the importance of influence strategic restructuring improves TFP through two paths: resource allocation optimization and innovation implementation. At the resource allocation level, business restructuring can shift resources from low-efficiency traditional planting businesses to high-efficiency deep processing businesses, and organizational restructuring can reduce management levels to lower communication costs [4, p. 101] at the innovation implementation level, market positioning restructuring can promote enterprises to carry out technological innovation around the needs of target customers (e.g., developing functional agricultural products), thereby improving product added value and production efficiency proposed by Zollo M, Winter S G. [8, p. 343]. The calculation results of the DEA-Malmquist index indicate that the average annual growth rate of TFP for agricultural enterprises with a higher degree of strategic adjustment is 12.3% higher than that of enterprises with a lagging adjustment (as calculated by the authors).

Teece et al. are also defined that dynamic capabilities play a mediating role between digital transformation and strategic restructuring: enterprises with strong sensing capabilities can take the lead in identifying digital technology opportunities (e.g., the application of satellite remote sensing in pest monitoring), transform technological achievements through cooperation with research institutions via integration capabilities, and then integrate technologies into business strategies through reconfiguration capabilities [1, p. 510]. At the same time, according to Helfat C E, Finkelstein S, Mitchell W, et al. dynamic capabilities also play a mediating role between strategic restructuring and TFP: in the process of strategy implementation, enterprises need to continuously optimize resource allocation (e.g., adjusting production plans according to market demand) and iterate innovative technologies (e.g., upgrading digital management systems) through dynamic capabilities to ensure that strategic effects are converted into efficiency improvement [9, p. 207].

Formation of the objectives of the article (task statement). The purpose of the article is to construct a theoretical framework for analysing the relationship between "digital transformation – strategic restructuring – total factor productivity" from the dual perspectives of Dynamic Capability Theory and Innovation Economics.

Summary of the main research material. This study selects 300 agricultural enterprises from three major agricultural countries: Brazil (coffee and soybean planting and processing enterprises), India (cotton and rice enterprises), and China (grain, fruit, and vegetable enterprises). The data spans from 2015 to 2024, forming a balanced panel dataset (3,000 observations).

The data sources include: enterprise-level data (e.g., financial data of agricultural enterprises disclosed by the Agricultural Development Bank of China); macroeconomic and industry data (national agricultural digital policies, crop yield and price data); supplementary data (interviews with senior executives of 50 enterprises).

The sample selection criteria [11] are: main business focuses on agricultural production, processing, or

Table 1

Definition, Symbol and Measurement Method of Variables

Variable Type	Variable Name	Measurement Method
Dependent Variable	Total Factor Productivity (TFP)	DEA-Malmquist Index Method: Input variables (number of employees, net fixed assets, raw material costs); Output variables (operating income, agricultural product output). An index > 1 indicates productivity improvement.
Independent Variable	Digital Transformation (DT)	Synthesized by Principal Component Analysis (PCA): Digital technology application degree (number of digital technologies applied in production/management/marketing, e.g., IoT sensors, ERP systems); Digital investment intensity (digital expenses/operating income); Digital business proportion (online revenue/total revenue). Cronbach's α=0.82.
Mediating Variable	Dynamic Capabilities (DC)	Extracted by Factor Analysis: Sensing capability (market research investment, frequency of technological trend forecasting); Integration capability (number of cross-departmental cooperation projects, closeness of cooperation with external partners); Reconfiguration capability (speed of resource adjustment, frequency of strategic iteration). Cronbach's α=0.79.
Mediating Variable	Strategic Restructuring (SR)	Synthesized by PCA: Business restructuring (number of new/discontinued businesses/total businesses); Organizational restructuring (dummy variable, 1=implementation of hierarchical streamlining/departmental reorganization); Market restructuring (sales in new market segments/total sales). Cronbach's α=0.81.
Control Variables	Firm Size (Size)	Natural logarithm of total assets
	Firm Age (Age)	Observation year – founding year
	Industry Competition (HHI)	Herfindahl-Hirschman Index, HHI=Σ (firm market share)². A higher value indicates weaker competition.
	Macroeconomic Environment (GDP)	Annual GDP growth rate of the country where the enterprise is located

Grouped by author according to data [1–4]

circulation; engaged in digital-related business for more than 5 consecutive years; Data integrity ≥ 90%.

To test Hypotheses H1-H4, the following regression models are constructed (panel data fixed-effect model, controlling for individual and time fixed effects):

1.Test H1 (Digital Transformation → Strategic Restructuring):

$$SR_{i,t} = \alpha_0 + \alpha_1 DT_{i,t} + \sum_{j=1}^{4} \alpha_{j+1} Control_{j,i,t} + \mu_i + \lambda_t + \in_{i,t},$$

2.Test H2 (Strategic Restructuring → TFP):

$$TFP_{i,t} = \beta_0 + \beta_1 SR_{i,t} + \sum_{j=1}^{4} \beta_{j+1} Control_{j,i,t} + \mu_i + \lambda_t + \nu_{i,t},$$

3.Test H3 (Mediating Effect of DC: DT→DC→SR):

$$DC_{i,t} = \gamma_0 + \gamma_1 DT_{i,t} + \sum_{j=1}^{4} \gamma_{j+1} Control_{j,i,t} + \mu_i + \lambda_t + \xi_{i,t},$$

$$SR_{i,t} = \delta_0 + \delta_1 DT_{i,t} + \delta_2 DC_{i,t} + \sum_{j=1}^{4} \delta_{j+2} Control_{j,i,t} + \mu_i + \lambda_t + \omega_{i,t},$$

4.Test H4 (Mediating Effect of DC: SR→DC→TFP):

$$TFP_{i,t} = \theta_0 + \theta_1 SR_{i,t} + \theta_2 DC_{i,t} + \sum_{j=1}^{4} \theta_{j+2} Control_{j,i,t} + \mu_i + \lambda_t + \varphi_{i,t} \quad .$$

The results of Model 1 show that the coefficient of digital transformation (DT) is 0.456 and significant at the 1% level, indicating that for each 1-unit increase in digital transformation, the degree of strategic restructuring increases by 0.456 units, thus verifying H1.

The results of Model 2 show that the coefficient of strategic restructuring (SR) is 0.385 and significant at the 1% level, indicating that for each 1-unit increase in strategic restructuring, TFP increases by 0.385 units, thus verifying H2. Among the control variables, the coefficients of firm size (Size) and GDP growth rate are significantly positive, indicating that larger firm size and better macroeconomic environment contribute to more significant enterprise strategic adjustment and efficiency improvement [13]; the coefficient of industry competition (HHI) is significantly negative, indicating that more intense competition drives enterprises to gain advantages through strategic adjustment [14, 15].

Table 2

Descriptive Statistics and Correlation Analysis of Key Variables

Variable	Observations	Mean	Std.Dev.	Min	Max	DT	SR	TFP	DC
DT	3000	0.35	0.21	0.05	0.85	1			
SR	3000	0.28	0.18	0.02	0.75	0.58***	1		
TFP	3000	1.05	0.12	0.80	1.40	0.35***	0.42***	1	
DC	3000	0.42	0.25	0.10	0.90	0.62***	0.55***	0.48***	1
Size	3000	20.56	1.85	17.00	24.00	0.32***	0.28***	0.25***	0.30***

Note: ***p<0.01, **p<0.05, *p<0.1; All correlation coefficients are <0.8, and VIF values are <3, excluding multicollinearity.

Source: calculated by the authors

Table 3

Benchmark Regression Results

DependentVariable	SR(Model1)	TFP(Model2)
DT	0.456***(8.77)	-
SR	-	0.385***(8.02)
Size	0.125***(4.17)	0.108***(3.86)
Age	0.058**(2.32)	0.045*(1.96)
HHI	-0.186***(-4.13)	-0.152***(-3.80)
GDP	0.102***(2.91)	0.086**(2.69)
N	3000	3000
R^2	0.62	0.58
F-value	128.3***	115.7***

Note: T-values are in parentheses; ***p<0.01, **p<0.05, *p<0.1, the same below.

Source: calculated by the authors

The results of Model 3 show that the coefficient of digital transformation (DT) on dynamic capabilities (DC) is 0.523 and significant, indicating that digital transformation can significantly improve enterprises' dynamic capabilities. In Model 4, after adding DC, the coefficient of DT decreases from 0.456 to 0.238 (still significant), and the coefficient of DC is 0.316 (significant). The mediating effect value = 0.523×0.316 = 0.165, accounting for 36.2% of the total effect (0.165/0.456), thus verifying H3. In Model 5, after adding DC, the coefficient of SR decreases from 0.385 to 0.205 (still significant), and the coefficient of DC is 0.258 (significant). The mediating effect value = 0.385×0.258 = 0.099, accounting for 25.7% of the total effect (0.099/0.385), thus verifying H4.

Variable Replacement Method: Replacing DT with "proportion of digital employees" (number of employees in digital departments/total employees) and calculating TFP using the "Solow Residual Method". The regression results show that the coefficients of core variables remain significant (DT→SR: 0.412***; SR→TFP: 0.358***), and the conclusions remain unchanged.

Endogeneity Treatment: Using the lagged one-period DT (DT_lag1) as an instrumental variable. The 2SLS regression results show that the coefficient of DT_lag1 on SR is 0.435***, indicating no endogeneity problem.

Sub-sample Regression: Dividing the sample by firm size (120 large enterprises, 180 small and medium-sized enterprises). The results show that the coefficient of DT→SR for large enterprises (0.512***) is larger than that for small and medium-sized enterprises (0.389***), indicating that larger firm size strengthens the driving effect of digital transformation on strategic restructuring, which is consistent with the logic of the Resource-Based View [16].

Conclusions. Digital transformation is the core driver of strategic restructuring. Digital technology promotes the systematic restructuring of agricultural enterprises in business, organization, and market by optimizing information transmission and breaking business boundaries, with particularly significant effects in the application of precision agricultural technologies and the expansion of e-commerce channels.

Strategic restructuring is the key path to TFP improvement. Business focus, organizational streamlining, and precise market positioning can optimize resource allocation efficiency and promote the implementation of technological innovation, thereby improving TFP. Among the sample enterprises, the average annual TFP growth rate of enterprises with the top 30% strategic restructuring degree is 18.5% higher than that of enterprises with the bottom 30%.

Dynamic capabilities serve as the bridge for efficiency conversion. Digital transformation needs to promote strategic adjustments by enhancing enterprises' sensing, integration, and reconfiguration capabilities. Meanwhile, during strategy implementation, enterprises must rely on dynamic capabilities to continuously optimize resource allocation, ensuring that strategic effects are converted into efficiency improvements.

Based on the results of the study, the following recommendations for the national level are justified:

✓ improve digital infrastructure: Prioritize the construction of 5G base stations and IoT sensing networks in major agricultural production areas to reduce the hardware threshold for agricultural enterprises' digital transformation (e.g., the agricultural IoT pilot under China's "Digital Rural" strategy);

✓ introduce targeted support policies: Provide tax credits (50% tax deduction for digital investment), financial subsidies, and credit support to encourage agricultural enterprises to increase digital investment; set up special subsidy funds for enterprises to purchase digital technology equipment and carry out digital R&D projects;

✓ establish agricultural digital standards: Organize experts and enterprise representatives to formulate unified agricultural digital standards that cover data collection, transmission, storage, and application in agriculture, thereby promoting data sharing and business collaboration

Table 4

Test Results of the Mediating Effect of Dynamic Capabilities

DependentVariable	DC(Model3)	SR(Model4)	TFP(Model5)
DT	0.523***(9.64)	0.238***(5.29)	–
SR	–	–	0.205***(5.13)
DC	–	0.316***(7.52)	0.258***(6.79)
Size	0.105***(3.98)	0.112***(3.86)	0.096***(3.69)
Age	0.042**(2.08)	0.051**(2.13)	0.038*(1.81)
HHI	-0.155***(-3.92)	-0.168***(-4.00)	-0.135***(-3.75)
GDP	0.088***(2.76)	0.095***(2.88)	0.072**(2.48)
N	3000	3000	3000
R^2	0.65	0.68	0.63
F-value	142.5***	136.8***	121.4***

Source: calculated by the authors

among agricultural enterprises and enhancing the overall efficiency of agricultural digital transformation.

The results obtained determined the importance of implementing such changes at enterprises:

- promote digital transformation in phases: Small and medium-sized enterprises should prioritize the construction of digital production monitoring systems, while large enterprises should focus on building full-industrial-chain digital platforms (e.g., COFCO's "Digital Grain Depot" system);
- focus on core business restructuring: Divest low-efficiency traditional businesses and focus on high-value-added links (e.g., transforming from single planting to "planting + processing + e-commerce" integration);
- systematically cultivate dynamic capabilities: Establish a "digital strategy department" to be responsible for sensing technological trends, establish cross-departmental collaboration mechanisms to improve resource integration capabilities, and conduct quarterly strategic evaluation and adjustment.

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Стаття надійшла: 24.10.2025
Стаття прийнята: 20.11.2025
Стаття опублікована: 05.12.2025