



Exploring the Dual-Mediating Pathways of Digitalization on Agribusiness TFP in China: The Roles of Innovation Output and Administrative Burdens

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Abstract. For agricultural firms, digitalization is widely recognized as a vital strategy for pursuing high-quality growth and surmounting operational inefficiencies. This investigation employs a text-analytic approach coupled with an enhanced entropy weighting technique to construct a digital transformation index. Concurrently, it utilizes the refined Olley-Pakes (OP) semi-parametric estimator to derive the total factor productivity (TFP) of sample firms. The empirical analysis focuses on a panel dataset comprising Chinese A-share listed agricultural enterprises observed from 2015 to 2024. Results show that digital transformation significantly inhibits TFP of agricultural enterprises in the short term with a time-lag effect; corporate innovation and management expense ratio play dual negative partial mediating roles. This study enriches the technical measurement and mechanism research of agricultural enterprises' digital transformation.

Keywords: digital transformation; agriculture-related enterprises; total factor productivity; innovation investment; administrative expense ratio

1 INTRODUCTION

As the digital finance continues to advance and the rural revitalization strategy gains momentum, the digital upgrading of agricultural enterprises has become a key industry direction. Agriculture-related enterprises, which have long production cycles, high digital investment costs, and underdeveloped foundational capabilities, tend to follow transformation paths that are quite distinct from traditional industrial counterparts. However, the existing literature has yet to reach a unified conclusion regarding the digital transformation's influence on TFP. Conversely, some researchers confirm that digital upgrading can notably enhance a company's TFP by such as upgrading digital infrastructure¹, increasing innovation capabilities, refining human resource quality², and streamlining operational management efficiency³. Conversely, a number of researchers argue that digital transformation fails to yield a notable positive influence on firms' total factor productivity⁴, and in some cases, might even have a dampening effect in the early stages⁵.

Prior studies have predominantly centered on manufacturing and service industries, creating a notable lack of attention to agriculture-related enterprises in academic exploration. Against this backdrop, this study selects A-share agricultural enterprises as research subjects to empirically analyze how digital transformation affects TFP. It further identifies innovation and administrative expense ratios as key mediating pathways, thereby addressing the lack of relevant research in this domain.

2 THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

2.1 The Impact of Digital Transformation on Total Factor Productivity

During the early stages of digital adoption, agricultural enterprises are required to allocate large amounts of capital towards establishing digital infrastructure, enhancing technological capabilities, and developing staff skills. This results in a notable rise in non-operational expenses during the initial phase of digital transition, as these costs draw resources away from core production activities, hinder optimal resource distribution, and ultimately lower the overall productivity of factors of production.

H1: In the short run, digital transformation leads to a notable decline in the total factor productivity of businesses engaged in agricultural activities.

2.2 The Mediating Role of Innovation Investment

Digital transformation may boost a firm's capacity for innovation and raise the number of patents it files; however, the commercialization cycle for innovation outcomes in the agriculture sector is lengthy. In the short term, R&D investments fail to yield efficiency gains and instead tie up production resources, thereby indirectly suppressing total factor productivity.

H2: The influence from digital transformation to agricultural enterprises' TFP is mediated by innovation investment.

2.3 The Mediating Role of the Management Expense Ratio

The process of digital transformation escalates non-operational costs, including system upkeep, data administration, and talent acquisition and cultivation. This trend raises the management cost ratio while reducing the efficiency of resource deployment, thereby ultimately hindering the upgrading of TFP.

H3: The management expense ratio serves as a bridge linking digital transformation to the agribusinesses' TFP.

3 RESEARCH DESIGN

3.1 Sample Selection and Data Sources

The research initially selects Chinese A-share agricultural listed firms spanning the period 2015 to 2024. After excluding samples labeled as ST, *ST, and those with

missing core variables, a final sample consisting of 2,514 observations was generated. The data were collected from the CSMAR database and the Information Network.

3.2 Variable Definitions

Dependent Variable. TFP is calculated using the Olley–Pakes (OP) method. Labor input, capital input, and intermediate input serve as input indicators; operating income serves as the output indicator⁶.

Explanatory Variable. Digital Transformation (DIG). Following Zhao Huanyu (2021), the DIG index is constructed by mining keyword frequencies from annual reports, applying standardization, and aggregating via the entropy method⁷.

Intermediary variables. The study also examines two mediating factors: innovation investment (measured as the natural log of total patents granted plus one) and the management expense ratio (defined as management expenses divided by operating revenue).

Control variables. For control variables, we incorporated firm size, debt-to-asset ratio, operational cash flow, fixed asset proportion, growth potential, independent director representation, dual leadership structure, ownership concentration, managerial equity stake, and audit opinion.

3.3 Model Construction

To purpose the primary digital transformation's impact on the TFP of agricultural enterprises, a model is established:

$$TFP_{i,t} = \alpha_0 + \alpha_1 DIG_{i,t} + \alpha Controls_{i,t} + Y + F + \varepsilon_{it} \quad (1)$$

Here $TFP_{i,t}$ denotes the total factor productivity; $DIG_{i,t}$ represents the score of digital transformation; $Controls_{i,t}$ is the control variables; Y and F refer to the year and firm fixed effects; and ε_{it} is the random disturbance term.

To examine lagged effects and mitigate reverse causality issues, we introduce a one-period lagged variable for digital transformation:

$$TFP_{i,t} = \alpha_0 + \alpha_1 DIG_{i,t-1} + \alpha Controls_{i,t} + Y + F + \varepsilon_{it} \quad (2)$$

Here $DIG_{i,t-1}$ represents digital transformation with one-period lagged, All other variables are consistent with those defined in Equation (1).

Building upon the analytical framework proposed by Wen Zhonglin (2014)⁸, the current study develops the subsequent mediation model:

$$M_{i,t} = \beta_0 + \beta_1 DIG_{i,t} + \beta Controls_{i,t} + Y + F + \varepsilon_{it} \quad (3)$$

$$TFP_{i,t} = \gamma_0 + \gamma_1 DIG_{i,t} + \gamma_2 M_{i,t} + \gamma Controls_{i,t} + Y + F + \varepsilon_{it} \quad (4)$$

Here, $M_{i,t}$ represents the mediating variable, and $\beta_1 \times \gamma_2$ reflects the mediating effect.

4 EMPIRICAL RESULTS

4.1 Descriptive Statistics

Table 1 shows the summary statistics for all primary variables. The average TFP in the paper is 6.877, with the mean digital transformation score is 0.009, indicating an overall low level of digitalization. The extreme values and dispersion of each variable are reasonable, with no abnormal fluctuations.

Table 1. Key Variables and Summary Data.

Variable Type	Variable Symbol	Measurement Method	Sample Size	Mean	Standard Deviation
Dependent variable	TFP	Calculated using the Olley-Pakes (OP) method	2514	6.877	0.803
Key explanatory variables	DIG	Analyze digital keyword frequency in annual reports + standardization + entropy method	2514	0.009	0.011
Intermediary variables	patent	Ln(Number of patents granted + 1)	2514	2.322	1.383
	fee	Management Expenses / Revenue	2514	0.071	0.053
	input	Natural logarithm of revenue	2514	21.747	1.398
	lev	Liabilities / Assets	2514	0.385	0.197
	cashflow	Net Cash Flow from Operating Activities / Assets	2514	0.072	0.071
	fixed	Net Fixed Assets / Total Assets	2514	0.253	0.149
	growth	Revenue Growth Rate	2514	0.107	0.272
Control variable	indep	Number of Independent Directors / Total Board Members	2514	0.371	0.077
	duality	1=Chairman also serves as General Manager; 0=otherwise	2514	0.293	0.455
	top5	Sum of shareholding percentages of top five shareholders	2514	0.536	0.149
	mshare	Management ownership percentage	2514	0.121	0.183
	audit	1=Unqualified audit opinion; 0=otherwise	2514	0.977	0.151

4.2 Regression Analysis and Robustness Tests

The findings from the baseline regression and robustness checks are summarized in Table 2. The baseline regression results show that, after controlling for covariates, the coefficient for digital transformation is significantly negative, supporting H1; the one-period lag test results are also significantly negative, indicating that the inhibitory effect exhibits time lag and robustness.

Table 2. Results of Benchmark Regression and One-Period Lags Test.

Variables	(1)TFP	(2)TFP	(3)TFP
DIG	6.358*	-2.897***	
	(3.738)	(0.813)	
L.DIG			-2.363**
			(1.200)
Control variables	No	Yes	Yes
Fixed effects for individual/year	Yes	Yes	Yes
_cons	6.495***	-5.065***	-4.900***
	(0.044)	(0.531)	(0.599)
N	2514	2514	2153
R ²	0.300	0.800	0.775

Note: *p < 0.1, **p < 0.05, ***p < 0.01; same as below.

4.3 Testing for Mediating Effects

This research employs the three-step approach put forward by Wen et al. (2014) along with Bootstrap sampling method for verification. The output of the mediation are shown in Table 3. Digital transformation significantly boosts a company's patent production, thereby hindering its total factor productivity. Digital transformation significantly drives up a company's administrative costs, thereby lowering its overall factor productivity. Hypotheses H2 and H3 are supported. The Bootstrap test results are robust.

Table 3. Testing for the Mediating Effects of Administrative Expense Ratio and Firm Innovation.

Mediating Variables	DIG→M	M→TFP	Indirect effect	Bootstrap95%CI
fee	0.335**	-1.440***	-0.482***	[-1.969,-0.913]
patent	11.441**	-0.017***	-0.199***	[-0.027,-0.007]

5 CONCLUSIONS AND IMPLICATIONS

Based on a panel dataset of A-share listed agribusinesses from 2015 to 2024, the study reveals that digital transformation, in the immediate term, significantly suppresses TFP growth., and this negative consequence is robust and exhibits a time lag. Both

innovation investment and the management expense ratio play mediating roles: Specifically, while digital transformation boosts innovation outcomes, the lengthy commercialization cycle of these innovations prevents rapid efficiency improvements in the short run. Additionally, the process of digital transformation raises operational expenses, which in turn hinder optimal resource allocation and subsequently reduce total factor productivity.

In light of these results, agriculture-related enterprises are advised not to recklessly increase their digital investments but rather to focus on integrating digital initiatives with their primary business functions. Meanwhile, companies need to better manage administrative expenditures, streamline operational workflows, and cut down on unproductive costs.

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