



Digital Finance and Total Factor Productivity: Evidence from China

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Abstract. This study investigates the effect of digital finance and ESG performance on total factor productivity. Using a large sample of Chinese listed firms over the period 2011–2020, we find that the deepening and improvement of digital finance can have a positive impact on the total factor productivity of enterprises. Digital finance improves total factor productivity by improving ESG performance. Further inspection shows that digital finance and ESG performance have greater impact on total factor productivity of private enterprises. From the perspective of digital finance and ESG performance, this study provides theoretical support and empirical evidence for improving China's total factor productivity and high-quality development path.

Keywords: Digital finance · ESG · Total factor productivity

1 Introduction

As the core of modern economy, finance is also the lifeblood of the real economy. Giving full play to the role of finance will undoubtedly help improve the quality and efficiency of the economy. In recent years, digital technologies, such as artificial intelligence, big data and blockchain, have been continuously integrated with the financial industry, which promote the emergence of new digital financial formats, bring opportunities to make up for the shortcomings of traditional finance and better serve the development of enterprises. ESG conveys the concept of sustainable development. That is, enterprises actively assume social responsibility, implement green strategy, fulfill governance responsibility, and optimize corporate governance system. Obviously, this coincides with the theme of high-quality development. The essence of promoting the high-quality development of enterprises is to improve the total factor productivity of enterprises. Therefore, it is particularly important to study the impact of digital finance on the total factor productivity of enterprises, which is conducive to improving the total factor productivity of enterprises and maintaining high-quality development.

Many studies have focused on the economic impact of digital finance at the macro level, such as manufacturing development [1], the employment of financial industry [2], and financial stability [3], and on the micro level, such as corporate bankruptcy risk [4], corporate value [5], corporate resilience [6], and corporate financial constraint [7], corporate innovation [7]. In addition, there is also an article that has studied the positive

impact of digital finance on ESG [8], but no one to study the impact of digital finance on total factor productivity of enterprises based on ESG performance.

In view of this, this study selects the data of 20,167 A-share listed companies from 2011 to 2020 as a sample, and uses the fixed effect model to empirically study the relationship between digital finance and enterprise total factor productivity. Through mechanism testing, the transmission path of this positive effect is that digital finance improves enterprise ESG performance, thereby improving the total factor productivity of enterprises. Furthermore, this study examines the relationship between digital finance and total factor productivity under different property rights.

Here are the contributions of this paper. First, from the perspective of enterprise ESG performance, the paper studies the impact of digital finance on enterprise total factor productivity, expands the relevant research content, and provides new empirical evidence for promoting enterprise total factor productivity. Second, the intermediary mechanism based on the enterprise's ESG performance clarifies the impact of digital finance on the enterprise's total factor productivity. Third, based on different property rights, the paper discusses the relationship between digital finance and total factor productivity of enterprises. Therefore, the paper provides important practical guidance for listed enterprises in China to seize digital financial opportunities and improve total factor productivity.

The remainder of this paper is arranged as follows. Section 2 covers the theoretical analysis and hypotheses development. Section 3 provides empirical design. Section 4 provides empirical evidence of the impact of digital finance on TFP. Section 5 concludes the paper and outlines the policy implications.

2 Theoretical Analysis and Hypotheses Development

Digital finance has developed rapidly in recent years. Many efforts have been made on the benefits of digital finance in improving corporate financial performance [5], enhancing corporate resilience [6], mitigating corporate bankruptcy risk [4], and promoting corporate risk-taking [9]. Nevertheless, there has been no research to investigate the effect of digital finance on total factor production based on enterprise ESG performance. Therefore, this study seeks to fill this gap in the literature.

The development of digital finance could reduce corporate financial constraints, which will help firms engage in ESG activities. Digital finance could relieve information asymmetry, diversify the corporate financing channels and conduce firms to participate in more ESG activities by improving corporate sales cash inflow [8].

ESG performance is a comprehensive evaluation of enterprises based on the concept of sustainable development, guiding enterprises to actively implement the concept of innovative development, enhancing their innovation ability [10], and encouraging enterprises to strengthen R&D and innovation investment. Firstly, according to the signaling theory, good ESG performance reduces information asymmetry, eases financing constraints, and promotes enterprise innovation [11, 12]. The positive ESG performance has improved the trust of investors, government department and other stakeholders in the enterprises, and then enterprises obtain more financial support, reset the internal resource allocation relationship of the enterprises and alleviate the lack of investment [13]. The

efficiency of capital investment will directly affect the level of total factor productivity of enterprises. The development of digital finance has enabled financial markets and financial intermediaries with technology, effectively reducing market friction and easing the problem of information asymmetry. Therefore, digital finance can help optimize the financing environment of enterprises and improve their total factor productivity. Based on this, hypothesis 1 proposed.

H1: Digital finance brings positive impact on total factor productivity of enterprises.

The financing constraints of state-owned enterprises are relatively small. Therefore, digital finance plays a limited role in helping the development of state-owned enterprises. On the contrary, private enterprises have relatively high financing costs and especially serious problems of difficult and expensive financing [14]. Therefore, when the continuous development of digital finance brings benefits, such as the convenience of information review, the expansion of capital channels, and the accuracy of information communication, private enterprises will be more sensitive to it [15]. At this time, private enterprises will adjust their business strategies in a timely manner. Under the goal of maximizing profits, they will make better allocation of financial resources for enterprise product research and development, improve the efficiency of enterprise scientific and technological innovation, and ultimately promote the total factor productivity of enterprises. Based on this, hypothesis 2 proposed.

H2: Digital finance has greater impact on total factor productivity of private enterprises.

3 Empirical Design

3.1 Regression Model Design

To estimate the relationship between digital finance and Total factor productivity, we construct the following regression model:

$$TFP_{i,t} = \beta_0 + \beta_1 DF_{i,t} + \beta_2 ESG_{i,t} + \beta_3 Control_{i,t} + year_t + ind_i + \varepsilon_{i,t}$$

The subscripts i and t represent firm and year, respectively. TFP is estimated by LP method. DF is the total digital finance index in year t in the city, which is measured by the degree of city-level digital finance. ESG is measured by the Hua Zheng ESG rating index, that is, the corporate ESG performance of firm i in year t . Control denotes other control variables. We control the year fixed effect ($year_t$) and industry fixed effect (ind_i), and ε is the random error term. Table 1 reports the main variables.

3.2 Data and Summary Statistics

We obtain the digital finance data from the Institute of Digital Finance and corporate ESG data from the Hua Zheng ESG rating of Wind Database, and other data from the China Stock Market & Accounting Research (CSMAR). Based on the principle of sample standardization, the data shall be processed according to the following standards: (1) delete samples lacking digital finance and total factor productivity data; (2) exclude the sample data of financial and insurance industries, STs or * STs and exceptions; (3)

Table 1. Variable definitions.

Type	Name	Symbol	Definition
Dependent variables	Total factor productivity	TFP_LP	Total factor productivity calculated by LP method
Explanatory variables	Digital Finance	DF	Logarithm of Peking University's digital inclusive financial index
	Corporate ESG	ESG	The nine grades of C-AAA are assigned to 1–9 successively
Controls variables	Firm profitability	GP	Gross profit/main business income
	Growth ability	Tobin's Q	Tobin Q value over the years
	Firm size	Size	Logarithm of the corporate total assets at the end of the year
	Asset liability ratio	Lev	The ratio of total liabilities to total assets
	Firm age	Age	The firm age
	Industry growth	Lnd_Q	Median Tobin Q value of each industry in each year
	Executive compensation	COMP	Logarithm of the total remuneration of the top three executives

except for ESG rating and logarithmic variables, the rest are shrunk at 1% quantile. Finally, we obtain a total of 20,167 observations from 2011 to 2020. Table 2 shows the summary statistics of the main variables.

4 Empirical Results

To investigate the relationship between digital finance and total factor productivity, we examine the above Eq and report the results in Table 3.

Column (1) in Table 3 shows that the coefficient of DF is significant at the level of 1%, that is, the deepening of digital finance can have a positive impact on the total factor productivity of enterprises. Column (2) of Table 3 shows that the coefficient of DF is 0.177, which is significant at the level of 1%, that is, the increase of digital finance will increase the ESG performance of enterprises. The results of column (1) in Table 3 show that the increase of enterprise's ESG performance will increase the enterprise's total factor productivity, indicating that the enterprise's ESG performance is an important channel for digital finance to promote the enterprise's total factor productivity, and the

Table 2. Summary statistics.

variable	N	mean	sd	min	p50	max
TFP_LP	20167	9.10	1.12	5.57	9.00	13.53
ESG	20167	4.09	1.04	1.00	4.00	8.00
DF	20167	5.32	0.41	3.10	5.44	5.82
GP	20167	0.05	0.56	-36.40	0.06	20.91
Tobin's Q	20167	2.14	2.93	0.67	1.61	259.15
Size	20167	22.29	1.31	15.58	22.11	28.54
LEV	20167	0.44	0.21	0.01	0.43	1.96
Age	20167	12.17	6.97	3.00	11.00	31.00
Lnd_Q	20167	1.73	0.60	0.90	1.59	25.11
COMP	20167	14.41	0.80	0.00	14.39	18.05

Table 3. Baseline results.

	(1) TFP_LP	(2) ESG	(3) TFP_LP	(4) TFP_LP	(5) ESG	(6) TFP_LP
ESG	0.329*** (27.06)		0.060*** (7.42)	0.139*** (16.01)		0.017*** (1.24)
DF	0.286*** (10.32)	0.177*** (6.93)	0.007*** (5.63)	0.423*** (17.18)	0.039*** (1.51)	0.013*** (0.18)
GP			0.043* (1.95)			0.088*** (10.45)
Tobin's Q			-0.007 (-1.32)			0.013*** (8.17)
Size			0.000 (.)			0.000 (.)
LEV			0.662*** (15.02)			0.655*** (19.85)
Age			0.008*** (5.89)			-0.009*** (-9.06)
Lnd_Q			0.099*** (6.24)			-0.069*** (-7.61)
COMP			0.171*** (16.77)			0.138*** (16.41)

(continued)

Table 3. (continued)

	(1) TFP_LP	(2) ESG	(3) TFP_LP	(4) TFP_LP	(5) ESG	(6) TFP_LP
_cons	6.584*** (43.80)	3.306*** (24.63)	-6.322*** (-36.48)	6.037*** (43.93)	4.214*** (43.93)	-7.579*** (-53.08)
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes
Ind-FE	Yes	Yes	Yes	Yes	Yes	Yes
N	7871	7871	7871	12296	12296	12296
Adj.R2	0.101	0.006	0.658	0.042	0.000	0.658
F	443.761	48.020	1686.273	272.014	2.285	2623.948

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

impact of digital finance on the enterprise's total factor productivity is positive. Thus hypothesis 1 is true.

After the enterprise sample is divided into state-owned enterprises and private enterprises, it can be seen from columns (3) and (6) that under the control of variables, the impact coefficients of the digital financial index on total factor productivity of state-owned enterprises and private enterprises are 0.007 and 0.013 respectively, which are significant at the level of 1%. That is, digital finance has a greater impact on total factor productivity of private enterprises. Thus hypothesis 2 is true.

5 Conclusion and Suggestion

With the deep integration of digital technology and finance, the problem of traditional financial information asymmetry has been alleviated, transaction costs have been reduced, financial institutions have improved their risk management capabilities, and enterprises can obtain more effective financial services. It is important to ensure the long-term development of the economy by enabling finance with science and technology and developing digital finance. This paper takes the panel data of Chinese A-share listed companies from 2011 to 2020 as a sample, and analyzes whether the development of digital finance can improve the total factor productivity of enterprises through theoretical analysis and empirical test. The main conclusions are as follows: first, the development of digital finance can effectively improve the total factor productivity of enterprises; second, digital finance can improve the enterprise's total factor productivity by improving the enterprise's ESG performance; third, in terms of heterogeneity, it is found that digital finance has a greater impact on total factor productivity of private enterprises.

Based on the above research conclusions, the following suggestions are obtained:

First, the government should continue to promote the development of digital finance, strengthen financial supervision, and further promote the integration of digital finance and the real economy with the help of modern information technologies, such as big

data and the Internet, and achieve the goal of improving the total factor productivity of enterprises.

Second, ESG performance is a path for digital finance to affect the total factor productivity. Enterprises should pay attention to ESG performance, improve the ESG governance mechanism, increase investment in environmental protection, actively fulfill social responsibilities, improve the internal governance mechanism, and shape a good corporate image.

Third, for small and medium-sized enterprises, they should fully seize the opportunities of the vigorous development of digital finance and solve their own problems.

Fourth, regulators should deepen the reform of financial supervision, improve the efficiency of financial supervision, innovate the supervision mode, clarify the responsibilities of each supervision subject, and establish an efficient and coordinated supervision mechanism.

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