

The Effect of Corporate Digitalization on Investment Efficiency: Analysis of Theory and Model Design

Haohua Zhou *

The School of Humanities, Arts, and Social Sciences, Rensselaer Polytechnic Institute, Troy NY,
United States

* Corresponding Author Email: zhouh10@rpi.edu

Abstract. This study examines a large amount of literature to sort out the relevant studies on enterprise investment efficiency, enterprise digitization and the effect of industry digitization on enterprise investment efficiency. The paper provides a theory analysis of the effect of enterprise digitization on investment efficiency as a whole. Theoretical level proves that enterprise digitalization can significantly improve the overall enterprise investment efficiency. While investment efficiency is classified into overinvestment and underinvestment, enterprise digitization has different effects on them. Although enterprise digitization can significantly inhibit over-investment and alleviate under-investment of enterprises, it exerts a stronger inhibitory effect on over-investment. Subsequently, the mechanism of enterprise digitization's impact on investment efficiency is further analyzed theoretically, and the research hypothesis is proposed. Then the sample selection, index selection and model building are introduced. Finally, the next step is proposed, and empirical analysis is carried out based on the model proposed in the research design in the hope of proving the impact of enterprise digitalization on the efficiency of investment.

Keywords: Investment efficiency; enterprise digitalization; digital transformation.

1. Introduction

From the perspective of the external environment, local governments encourage and guide enterprises to actively participate in digital transformation, thus attracting the attention of institutional investors, which can to some extent ease the financial restraints of enterprises and hence their underinvestment. In terms of the internal environment, enterprises can enhance their ability to the information by using digital technology, which can reduce the information asymmetry inside and outside the enterprise and enable enterprises to obtain more comprehensive information when investing. Using the obtained information, the investment of enterprises will become more rational, reasonable and precise, thereby alleviating the problem of excessive investment of enterprises. In addition, with the improvement of the degree of digitalization, enterprises can more effectively supervise the behavior of the management, thereby alleviating the principal-agent problem, reducing the management cost of the enterprise, and improving the internal governance level of the enterprise [1].

2. Literature Review

2.1. Enterprise Investment Efficiency

Vogt developed an investment-cash flow sensitive model to determine the type of non-efficient investment of a firm [2]. It introduces an interaction term between investment and free cash flow, and the sign of the coefficient of the interaction term can be used to judge the type of non-efficient investment of the enterprise. Richardson developed a regression model to measure the degree of inefficiencies in business investment [3]. The regression model incorporates factors that affect corporate investment efficiency, such as corporate size, cash holding ratio, financial leverage level, listing years, growth level, previous year's stock return rate, investment lag period, etc. According to the sign of the model residual, it can be judged whether the enterprise is over-invested or under-

invested. Biddle et al. argued that under a complete capital market, corporate investments with positive net present value (NPV) are considered as efficient corporate investments [4].

2.2. Enterprise Digitalization

From a corporate strategy perspective, Rajagopalan and Spreitzer argued that digitized transformation was a particular category of strategical reform [5]. The process by which enterprises use digital technologies to reshape their strategic development plans, change their culture and collaboration, and thereby increase their capacity to innovate and digitize their strategic arrangements [6].

2.3. Enterprise Digitalization and Enterprise Investment Efficiency

Li et al. explored how corporate digitalization affects corporate investment efficiency in terms of both information empowerment and governance empowerment. It was found that digitisation of firms can curb overinvestment and alleviate underinvestment by corporations [1]. Moreover, they argued that information asymmetry and principal-agent problems mediated the investment efficiency in the process of digital transformation of firms. Chu and Wang took corporate financing constraints as the background, and believe that under this background, corporate digital transformation is conducive to the improvement of corporate investment efficiency, and environmental uncertainty has a moderating effect in this process [7]. Hu used the share of digitized intangibles to gauge the extent of digitization of firms and conducted a study accordingly [8]. Its study found that enterprise digitisation can enhance the efficiency of corporate investment, which is even greater in the context of serious principal-agent problems and fierce competition in the industry.

3. Analytical Framework

3.1. Theoretical Analysis

From perspective of firm, the digitalization of enterprises makes internal information more open and transparent, enabling enterprises to estimate the NPV of investment projects more accurately and reasonably. Secondly, it is beneficial for enterprises to build a digital governance system, improve the effectiveness of shareholders' supervision of managers' behavior, and alleviate the principal-agent problem of enterprises. Third, the enterprises' digital transformation has expanded the channels for enterprise information disclosure, which is conducive to enterprises' disclosure of accounting information, social responsibility information, and internal audit information. Finally, enterprise digitization can simplify business processes and optimize production, management, and financial systems and mechanisms.

From the outside of the business, digital technologies can improve the information environment and increase the bridging of communication between businesses and investors, so that investors and enterprises can understand each other better, thereby reducing the asymmetry of internal and external information. At the same time, with the increase of digital enterprises, more resources and information can be shared among them, so that enterprises are no longer isolated islands of information, thereby forming positive external effects and improving investment efficiency.

However, the deeper the digital transformation, the higher the requirements for digital technology talents and data elements, and the more difficult it is for the various resources of enterprises to reach the level of supporting digital transformation, resulting in a decrease in investment efficiency of the firms. Secondly, the later stage of digital transformation also puts forward higher requirements on the organizational structure, and the new production method requires a matching operating organization system. However, in the late stage of digital transformation, the greater the obstacles to continuous organizational restructuring, the organization cannot support the digital transformation and its ability to adapt to the new development environment, leading to an increase in inefficient investment in the short term; again, corporate innovation under digital transformation Efficiency may also show a situation of high first and then low. Finally, although digital transformation can reduce the overall

operating costs of enterprises, digital transformation itself will generate input costs. With deeper digitally transformed and less costly digitalisation, productivity gains will be smaller than digitalisation investments, resulting in less efficient business investments.

With this basis, this study proposes the hypothesis: Digital transformation has an "inverted U" impact on corporate investment efficiency.

3.2. Research Design

3.2.1. Sample selection

According to Zhao et al., this study uses word frequency statistics method to represent the digital transformation level of companies and uses A-share manufacturing listed enterprises as the research object [9]. On this basis, the sample of enterprises is further screened: enterprises with less than 7 consecutive years during the research period, enterprises with missing main variables, and enterprises with industry changes between manufacturing and non-manufacturing industries are eliminated.

3.2.2. Model construction

Since the data in the paper are panel data, combined with most micro research papers. This study refers to Richardson [3]. To examine if digital transformation has a non-linear effect on firms' investment efficiency, the following model can be established:

$$IE_{it} = a_0 + a_1 \times DT_{it} + a_2 \times DT_{it}^2 + \sum_j r_j \times Control_{j,it} \quad (1)$$

Where, in Model (1), IE_{it} is the investment efficiency of the i -th firm in year t ; DT_{it} , DT_{it}^2 are the one-off and two-time items of the digital transformation level; $Control_j$ is the j th control variable; a_0 is a constant item.

3.2.3. Variable selection

(1) Investment efficiency (IE): This study refers to Richardson, the company's growth (Growth), enterprise size (Size), cash holdings (Cash), listing years (Age), asset-to-liability ratio (Lev), stock return (Return) and the lagging items of new investment expenditure (INV), and after controlling the industry and year, regress the new investment expenditure (INV), and then take the absolute value of the regression residual to represent the investment efficiency of the enterprise's industry (IE) [3]. However, indicator negatively measures the investment efficiency of firms. That is, the bigger the absolute value of the regression residuals, the more inefficient the enterprise's investment. Over-investment by an enterprise (OE) implies that the residuals are greater than zero, and under-investment (UE) implies that the residuals are less than zero. Regression model is as follows:

$$inv_{it} = a_0 + a_1 \times growth_{i-1} + a_1 \times lev_{i-1} + a_3 \times cash_{i-1} + a_4 \times size_{i-1} + a_5 \times ret_{i-1} + a_6 \times lev_{i-1} + a_7 \times age_{i-1} + r \times ind + \lambda \times year + \varepsilon_{it} \quad (2)$$

In particular in Model (2), industry (Ind) and year (Year) are measured using dummy variables. is the residual level of the model, when it is more than 0, it refers the firm is over-investing, and when it is smaller than 0, it refers the firm is under-investing.

(2) Digital Transformation (DT): At present, the research on enterprise digitalization is in its infancy, and different scholars use different methods to measure enterprise digitalization, such as scale method, dummy variable method, index method and text mining method. This study hopes to adopt method of texts analysis to statistic the listed companies' keywords about digital transformation in their annual reports and indicates the depth of enterprises' digital transformation by counting the word frequency of all the keywords with the natural number processing [10]. There are four main keywords for digital transformation: smart manufacturing, digital technology applications, modern information systems, internet business models, smart manufacturing, and modern information systems.

(3) Control variables: This study selects control variables from corporate characteristic and corporate governance. Select five enterprise characteristic variables of enterprise size (Size), financial

leverage (Lev), enterprise profitability (ROA), cash holding level (Cashflow) and enterprise growth (Growth) as control variables (see Table 1).

Table 1. Variable selection.

Category	Name	Symbol	Metrics
Explained variable	Business Investment Efficiency	IE	Richardson model residuals in absolute value, which represents the competitiveness of the firm in the market.
Core explanatory variable	Digital Transformation	DT	level of inefficient investment
Control variable	Operational Efficiency	TATO	Digitisation index
	Enterprise size	Size	Total Asset Turnover
	Financial Leverage	Lev	Total assets at year end
	Profitability	ROA	Total assets
	Cash Holding Levels	Cashflow	Return on total assets

4. Limitation and Outlook

4.1. Limitation

4.1.1. Lack of empirical analysis

This study is more theoretical staging based on literature research, lacks empirical analysis, and is difficult to be convincing when there are few results.

4.1.2. Lack of intermediary variable

Due to the limited depth of research, this paper only studies the explained variables (corporate investment efficiency), core explanatory variables (digital transformation), and control variables (operational efficiency, enterprise size, financial leverage, profitability, profitability), without intermediary Variable analysis.

4.2. Outlook

In future research, this study can enrich the research content from the following two aspects, making the economic model and research results more convincing.

4.2.1. Empirical analysis

First of all, panel data analysis should be carried out, including descriptive statistics, correlation analysis, and commonness diagnosis, that is, a rough estimate of the correlation between variables, and the question of whether there is multicollinearity between explanatory variables, so as to Judge the rationality of the selected variables. Secondly, the benchmark regression is performed on the variables, and through the analysis of the regression coefficients, it is judged whether the overall impact of enterprise digitalization (DT) on investment efficiency (IE) is significant, and the significance of the five control variables on investment efficiency (IE) is judged. For the purpose of testing the stability of the regression's results and overcome the sample selection bias, the regression should also replace the explained variable, delete the control variable, change the sample size to conduct a robustness test, and use the matching propensity score method (PSM) to perform an endogenous test. The benchmark regression results can only be shown to be robust and feasible if it does not differ significantly from the benchmark regression results.

4.2.2. Intermediary variable

When studying the effect on investment efficiency of enterprise digitization, some mediating variables can be added appropriately. For example, enterprise digitization may increase enterprise's

investment efficiency and improve enterprise's operational efficiency by alleviating problems such as information asymmetry and principal-agent. The level of 1-enterprise vertical integration is used to measure the level of enterprise's specialization development, and so on.

5. Conclusion

This study presents a thorough analytical approach to enterprise investment efficiency, enterprise digitization, as well as the relation among enterprise digitization and enterprise investment efficiency by means of a literature review. Numerous studies in the literature show that enterprise digitization can significantly improve the enterprise's overall investment efficiency. If the investment efficiency is divided into overinvestment and underinvestment, enterprise digitization affects them differently. Although enterprise digitization can significantly inhibit overinvestment and alleviate underinvestment of enterprises, its inhibitory effect on overinvestment is greater. The paper introduces sample selection, indicator selection and model setting. It is hoped that in the next research, empirical analyses can be conducted based on the model proposed in the research design in the study.

References

- [1] Li Li, Yang S.L, Chen N. Research on the impact of digital transformation on enterprise investment efficiency. *Soft Science*, 2023, 1(11): 1-9.
- [2] Vogt S.C. The role of internal financial sources in firm financing and investment decisions. *Review of Financial Economics*, 1994, 4(1): 1-24.
- [3] Richardson S. Over-investment of free cash flow. *Review of Accounting Studies*, 2006, 11: 159-189.
- [4] Biddle G.C, Hilary G, Verdi R.S. How does financial reporting quality relate to investment efficiency? *Journal of Accounting and Economics*, 2009, 48(2-3): 112-131.
- [5] Rajagopalan N, Spreitzer G.M. Toward a theory of strategic change: A multi-lens perspective and integrative framework. *Academy of Management Review*, 1997, 22(1): 48-79.
- [6] Warner K, Wäger M. Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, 2019, 52(3): 326-349.
- [7] Chu C.B, Wang Y.J. Enterprise digitization, financing constraints and investment efficiency. *Journal of Jilin Technology and Business University*, 2022.
- [8] Hu R. Research on the impact of enterprise digitalization on investment efficiency. *Accounting Communication*, 2022(22): 92-96.
- [9] Zhao C.Y. Digital development and service transformation -Empirical evidence from listed manufacturing companies. *Nankai Management Review*, 2021, 24(2): 149-163.
- [10] Wu F, Hu H.Z, Lin H.Y, et al. Enterprise digital transformation and capital market performance - Empirical evidence from stock liquidity. *Management World*, 2021, 37(7):130-144.