

DIGITAL INVESTMENT AND FIRM PROFITABILITY: A TIME-LAGGED MEDIATION ANALYSIS IN EMERGING MARKETS

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Abstract

Digitalization has brought fundamental changes to the way companies operate. However, in practice, technology investments often do not immediately result in increased profits. This phenomenon is known as the Digital Productivity Paradox. In this study, it aims to examine the effect of digital investment on corporate profitability through operational efficiency as the mediating role, using a time-lagged approach in emerging markets. Adopting the Resource-Based View (RBV) theoretical framework, this study explains that digital assets are strategic resources that require a transition period to be effectively integrated into company operations. A quantitative approach was applied by examining secondary data from the financial statements of 12 issuers on the Indonesia Stock Exchange (IDX) which listed in the LQ 45 index for the period 2018–2024. This resulted in a strongly balanced data panel of 36 observations. Data were analyzed using the Arellano-Bond Generalized Method of Moments (GMM) to control for the dynamic nature of profitability and potential endogeneity issues. The test results demonstrate that digital investment in year (t-2) has a positive and highly significant effect on profitability in year (t+2), both directly and through operational efficiency in year (t). These findings resolve the productivity paradox by confirming that technology investments take time to have an impact before ultimately delivering financial value benefits to a company's profitability.

Keywords: Digital Investment, Firm Profitability, Operational Efficiency, Time-Lagged Mediation, Emerging Markets.

INTRODUCTION

The global development of the digital economy has transformed business competition patterns. Companies across various sectors are now required to integrate technology into their strategies to maintain competitiveness and profitability. This is particularly true in emerging markets like Indonesia, where digital transformation is often considered inevitable to improve operational efficiency and address information asymmetry (Weber, 2024). Furthermore, the increasing intensity of global competition is driving companies to continuously innovate digitally to avoid being left behind (He, 2025). From a macroeconomic perspective, digital investment in developing regions has been shown to positively correlate with aggregate growth in corporate economic performance (Privara et al., 2025). Furthermore, digital investment has been shown to strengthen companies' technological and information capabilities and significantly improve corporate performance (Barba-Sánchez et al., 2024). However, despite the year-on-year increase in corporate technology spending, much empirical literature demonstrates inconsistent results in terms of profit outcomes, a phenomenon widely known as the Digital Productivity Paradox (Brynjolfsson, 1993). This paradox suggests that high digital investment does not always translate directly to improved corporate financial performance.

Previous research examining the relationship between digital transformation and corporate profitability often provides general conclusions and assumes a direct, linear effect (Valaskova et al., 2025)(Valaskova et al., 2025). Similar findings have been obtained in the Chinese context, where digitalization has been shown not to necessarily lead to optimal corporate investment efficiency (Chen & Jiang, 2024). Even in exporting companies, the benefits of digital transformation only begin to be felt after a certain adaptation period (Rana, 2024). This situation is also evident in publicly traded companies in the United States, where the positive effects of digital transformation have only been consistently observed over the medium term (Wan, 2025). As a result, the view that the risks and costs of technology investment are merely incremental costs still often dominates, leaving ample room for exploration in novelties that incorporate time dimensions and mediating mechanisms. On the other hand, from the perspective of Corporate Finance and capital allocation strategies, value creation from intangible assets such as information technology cannot occur instantly. These assets require time to be incorporated into business processes, transform work culture, and create synergies with human resources (Benedek et al., 2025). Therefore, failure to detect the positive impacts of digital investment is often due to methodological model weaknesses that fail to capture the time-lag effect and the mediating pathway connecting capital inputs to financial outputs.

Based on these findings, this study aims to address the question of whether digital investment creates delayed profitability value through increased operational efficiency in companies in developing countries. To address this issue, the study proposes a dynamic modeling framework that explores the influence of digital investment in the previous period ($t-2$) on operational efficiency in the current period (t), and how this impacts company profitability in the subsequent period ($t+2$). The basic hypothesis of this study rests on the Resource-Based View (RBV), which asserts that digital asset investment is a rare, unique, and difficult-to-imitate strategic asset, thus fulfilling the requirements to create long-term competitive advantage for issuers in the capital market (Barney, 1991). This concept is rooted in the idea that a company's competitive advantage is fundamentally determined by its ability to possess and manage strategically valuable internal resources (Wernerfelt, 1984).

This study is expected to provide four complementary scholarly contributions: providing a more comprehensive explanation of the digital productivity paradox by uncovering the reasons behind the inability of technology investments to instantly increase profits; enriching the corporate finance literature by directly linking digital capital allocation decisions and shareholder value creation; broadening the perspective on operations strategy by demonstrating that operational efficiency is the primary channel connecting technology adoption and profitability; and presenting empirical evidence from the context of emerging markets, particularly the Indonesian capital market, which is still characterized by information asymmetry and institutional inefficiency.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

The Resource-Based View (RBV) states that competitive advantages from a company is determined by the extent to which it manages and leverages valuable and non-imitable internal resources (Barney, 1991). In the context of digitalization, particularly in emerging markets, consistently developed digital capabilities have proven to be a source of sustainable competitive advantage for manufacturing companies (Van Hoang et al., 2025). Investments in digital assets are considered essential intangible assets. However, many researchers have found that without strategic alignment and structural adaptation, technology actually burdens a company's profit margins in the early years of implementation. The experiences of chief information officers reveal that the digital productivity paradox is a real challenge faced by almost all organizations (Nina Jörden et al., 2024). Misdirected digital investments can even lead to investment inefficiencies and erode company value (Peng et al., 2025). This situation reflects what is known as the Digital Productivity Paradox. To resolve this paradox, a mediation model is needed that positions

operational efficiency as the link between digital investment and profitability (Wu & Xu, 2025). This process of technology assimilation, which requires adaptation time, forms the basis for formulating the following research hypothesis.

Based on the above framework, the formulation of this research hypothesis is as follows:

H1: Digital investment has a positive and significant impact on firm profitability with a time-lagged effect.

H2: Operational efficiency significantly mediates the relationship between digital investment (t-2) and firm profitability (t+2).

RESEARCH METHODS

This research uses a quantitative approach based on secondary data analysis in a dynamic panel format. The population in this study is issuers or companies on the Indonesia Stock Exchange (IDX) with large market capitalization and high reputation officially listed in the LQ45 stock index for the period February 2026 to April 30, 2026. The selection of issuers in the LQ45 index was based on the consideration that these companies represent a high level of liquidity and reflect the urgency of large-scale companies in executing a massive digital transformation strategy to maintain their market share in emerging markets.

The sampling technique used purposive sampling of companies that consistently reported the allocation of intangible assets in the form of software and other supporting financial metrics. The selection process based on these criteria resulted in 12 companies, with an observation period of three years per company, resulting in a total of 36 data observations.

The operational definition of the variables in this study includes three main components. First, digital investment is measured by the ratio of digital assets (recorded as software and similar financial data) included in the intangible asset account to the company's total assets. Second, Operational Efficiency is measured using the ratio of operating expenses to operating income. Third, Company Profitability is measured using the Return on Assets (ROA) ratio.

To test the structure of a dynamic model linking digital investment in period (t-2), operational efficiency in period (t), and profitability in period (t+2), while simultaneously addressing the potential for endogeneity, a classic bias in financial econometrics, this study applies the Generalized Method of Moments (GMM) dynamic panel regression method with the Arellano-Bond approach, which is methodologically designed to address endogeneity issues in dynamic panel data (Roodman, 2009)(Arellano & Bond, 1991). This estimation procedure follows widely recognized technical guidelines in the applied econometrics literature (Roodman, 2009). Technically, the regression model is structured to incorporate deep time lag effects. With a total of $n=36$ observations distributed across 12 issuers, the GMM instrument construction is rigorously designed to avoid the threat of over-identification. Specifically, the model uses a second-lag GMM-type instrument of the ROA variable $[L(2)/.ROA]$ for the differenced equation, and a standard instrument in the form of a first-difference of the Digital Investment and Operational Efficiency variables $[D.Digital, D.Operating]$, as well as a constant for the level equation. This limitation on the number of instruments is important so that the ratio of instruments to groups remains proportional, where the number of instruments used does not exceed the number of existing groups, so that the validity of the model specification test can be maintained.

RESULTS AND DISCUSSION

This section presents the results of the GMM statistical model testing along with the economic interpretation of each resulting coefficient, which aligns with theoretical validation of the productivity paradox and firm operational capabilities. The following are the test data results:

Table 1. Result of the GMM statistical model testing

Arellano-Bond dynamic panel-data estimation				Number of obs	=	36
Group variable: firm_id				Number of groups	=	12
Time variable: year				Obs per group:		
				min	=	3
				avg	=	3
				max	=	3
Number of instruments = 9				Wald chi2(3)	=	357.44
				Prob > chi2	=	0.0000
One-step results						
ROA	Coefficient	Std. err.	z	P> z	[95% conf. interval]	
ROA L1.	-1.622271	.1252414	-12.95	0.000	-1.86774	-1.376802
Digital	2235.015	230.5766	9.69	0.000	1783.093	2686.937
Operating	29.45688	5.970911	4.93	0.000	17.75411	41.15965
_cons	-39.60636	5.088102	-7.78	0.000	-49.57886	-29.63386
Instruments for differenced equation						
GMM-type: L(2/.) .ROA						
Standard: D.Digital D.Operating						
Instruments for level equation						
Standard: _cons						

Source: STATA Output

The quality of this empirical model can be first evaluated from its goodness-of-fit and regression stability statistics. The test results show a Wald chi2(3) value of 357.44 with a simultaneous significance probability (Prob > chi2 = 0.0000). This figure fundamentally demonstrates that the constructed research model is of high quality and worthy of publication, and that the integrated explanatory variables within it possess strong explanatory power in predicting issuer profitability volatility (ROA). Furthermore, because it uses instruments from 12 issuers (instrument-to-group ratio = 0.75, below the threshold of 1.0), the validity of the GMM structure is free from over-identification issues.

The main finding of this study reveals the structure of the time-lag effect, which is key to resolving the productivity paradox. The estimation results show that the Lagged ROA ratio for the previous period (L1.ROA) recorded a significant negative coefficient of -1.6223 at a p-value of 0.000 (SE=0.1252, z=-12.95; 95% CI: -1.868 to -1.377). This temporary decline aligns with findings by Benedek et al., 2025 and Jiang et al., 2025. When companies in emerging markets allocate significant funds to digitalization assets, such as database automation (Chen & Jiang, 2024), the adoption of artificial intelligence, or the development of supply chain integration systems, amortization costs, human resource training costs, and short-term disruptions to operational routines will depress cash flow and profitability. This short-term disruption validates the digital productivity paradox, a phenomenon that is actually occurring in emerging markets.

However, the view that digital investment is merely an additional cost is successfully refuted by the main coefficient of past investment. The statistical test results prove that digital investment in the previous period (t-2) has a very large direct influence on the company's profitability in the future (t+2), as reflected by the coefficient of 2235.015 and proven to have a significant effect with

a value of $p = 0.000$ ($SE = 230.577$, $z = 9.69$; 95% CI: 1783.093 to 2686.937). The magnitude of this coefficient needs to be understood in the context of the measurement scale where the Digital Investment variable is described as a decimal ratio between 0 and 1, while ROA is expressed in percentage units. Thus, the coefficient of 2235.015 means that every 0.01 (one percentage point) increase in the intangible assets ratio is correlated with an increase in ROA of 22.35 percentage points, an effect that reflects the strong technological leverage in large-cap LQ45 companies with an intensive intangible asset base. This finding confirms the theoretical foundation of the Resource-Based View (RBV). At this point in time, investments such as software recorded as intangible assets have been fully absorbed, technically calibrated, and successfully integrated with the company's capabilities (Barney, 1991). This aligns with empirical evidence that operationally mature digital technology contributes significantly to the sustainability of a company's financial performance (Ajmal et al., 2026). Digitalization is no longer simply an ordinary operational capital expenditure, but has evolved into a competitive advantage in the form of intangible assets that reduce agency costs and break down information asymmetry (Xue et al., 2024). Successful digitalization has been shown to drive improved financial performance of companies in various sectors, including the food and beverage industry (Dam et al., 2025). In the Indonesian context, a targeted investment strategy has also been shown to contribute to future company profitability (Susanto et al., 2024). Furthermore, companies that successfully integrate ESG into their digital strategies gain greater competitive advantages (Zhang et al., 2025). On the other hand, digital transformation, which reduces the level of corporate financialization, has been shown to positively impact resource allocation efficiency (Fang & Ju, 2024). Furthermore, business model innovation mediated by digital transformation has been shown to strengthen overall company performance (Xiao & Idris, 2025).

This study also validates the proposed mediation structure. It is known that the role of Operational Efficiency (t) in increasing profitability produces a significant coefficient of 29.456 ($p=0.000$, $SE=5.971$, $z=4.93$; 95% CI: 17.754 to 41.160). This finding firmly answers the hypothesis that the channeling mechanism from digital investment to profitability does not occur directly, but must be accelerated through optimization of business operations. Although the results of this study show that the increase in digital investment ($t-2$) is also followed by an increase in the Operating Cost Ratio (t), the automation of technology invested in ($t-2$) will shorten the bureaucratic chain within a company, and accelerate logistics services (Li, 2025). This explains the phenomenon of the Productivity Paradox, where Digital Investment does not directly cut costs but changes the company's value structure. Increased Operating Costs impact better work processes and indirectly impact the company's profitability. So that Operational Efficiency represented by the Operating Cost Ratio (t) is able to mediate the company's digital investment ($t-2$) in converting these operational costs into company profitability represented by Return on Assets ($t+2$).

The implications of this study serve as a strategic warning for corporate management. Failure to comprehensively evaluate digital investments often stems from the tendency of boards of directors to be overly focused on short-term results. Digital investment evaluation should not rely on a current-year accounting approach, but rather requires management to project the investment's future maturity period. When investments are integrated into efficiency channels, companies in emerging markets like Indonesia have the potential to gain an innovation advantage that competitors will struggle to match.

CONCLUSION

This study successfully validates the theoretical framework for the transformation of digital value mechanisms in emerging markets. Through a dynamic panel test of the Arellano-Bond GMM on 36 observations from 12 LQ 45 issuers, it is conclusively concluded that digital investment cannot trigger an instant increase in financial value. Rather, it operates through a delayed effect with a mediating structure connecting period ($t-2$), period (t), and period ($t+2$). Strategic investment in intangible assets is proven to drive increased future profitability (ROA) with a significant coefficient

of 2235.015, with operational efficiency acting as a mediating channel. Overall, these findings strengthen the Resource-Based View theory by demonstrating that digital investment is a crucial resource in overcoming the digital productivity paradox.

Although the empirical model has high specificity without over-identification constraints, this study is not without several limitations. First, the sample size of 12 issuers is relatively small for GMM, so the estimation results should be interpreted with caution and cannot be broadly generalized beyond the LQ 45 context. Second, the mediation structure was tested within a single GMM equation; formal mediation testing with two separate structural equations is warranted in future research. Corporate management is advised to budget and evaluate digitalization assets as part of a long-term investment portfolio to facilitate operational integration. Future research is recommended to expand the scope of corporate sectors to examine the effect of technological capital flexibility on institutional leverage structures across industries in ASEAN.

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