

Macroeconomic Growth in Indonesia under the Fourth Industrial Revolution: Insights from VAR and VD

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ABSTRACT: This study investigates the impact of the Fourth Industrial Revolution on Indonesia's macroeconomic growth, with a focus on ICT investment and foreign direct investment (FDI) as structural drivers. The objective is to examine how digital transformation and capital inflows interact with GDP growth, inflation, monetary policy, and government expenditure. Using annual data from 2000 to 2024, the research applies a Vector Autoregression (VAR) framework, supported by impulse response functions (IRF) and variance decomposition (VD), to capture both short-run fluctuations and long-run equilibrium dynamics. The results show that ICT investment exerts a reinforcing long-term effect on GDP, while FDI provides immediate short-run stimulus and corrective adjustments. Inflation and the BI7DRR policy rate act as stabilizing mechanisms, and fiscal spending on digital infrastructure strengthens ICT adoption. These findings underscore the significance of coordinated fiscal-monetary strategies and innovation-driven policies, offering actionable insights for sustaining resilience and competitiveness in Indonesia's Industry 4.0 trajectory.

KEYWORDS: Industry 4.0, ICT investment, Foreign direct investment, VAR econometric analysis, Economic growth.

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Introduction

Indonesia's economic growth in the era of the Fourth Industrial Revolution (Industry 4.0) faces both opportunities and challenges (Natsir et al., 2025; Wolok et al., 2023; Wulandari & Rohman, 2025). The rapid adoption of digital technologies, particularly ICT investment, and the inflow of foreign direct investment (FDI) are reshaping the country's macroeconomic structure (Chorny & Chorna, 2026; T. Dinh et al., 2019). At the same time, inflationary pressures and monetary policy adjustments underscore the need for stability to sustain growth (L. C. Dinh et al., 2024; Fabris, 2024).

Recent studies have examined the role of ICT and FDI in driving productivity and innovation in emerging economies. However, empirical evidence explicitly linking Industry 4.0 technologies with Indonesia's macroeconomic performance remains limited. Prior research often focuses on sectoral impacts or policy narratives, leaving a gap in econometric analysis that integrates ICT adoption, FDI inflows, and macroeconomic stability within a unified framework.

Research Aim and Research Questions

The aim of this study is to analyze the dynamic interrelationships among ICT investment, foreign direct investment (FDI), GDP growth, inflation, BI7DRR policy rate, and government expenditure in Indonesia within the framework of the Fourth Industrial Revolution. Using a Vector Autoregression (VAR) model supported by impulse response functions (IRF) and variance decomposition (VD), the research provides empirical evidence on how digital transformation and capital inflows influence macroeconomic performance and stability. The study addresses four central questions: the impact of ICT and FDI on GDP growth, the stabilizing role of inflation and BI7DRR, the reinforcement of ICT adoption through government expenditure, and the policy implications of IRF and VD results for sustaining innovation-driven growth.

Research Results

a. VAR Estimation Results

The estimation results, including coefficients, t-statistics and probability values, are summarized in Table 1. This table presents the direct linkages among variables, highlighting which shocks exert a statistically significant influence on GDP growth and other macroeconomic indicators. The findings serve as the empirical backbone of the study, ensuring methodological transparency and supporting the robustness of later hypothesis testing.

Table 1.

VAR Estimation Results

Variable (Lag)	Main Effects	Significance	Interpretation
FDI(-1)	Positive effect on FDI itself	t=4.99 (strong)	FDI is persistent, reinforcing its own inflows
FDI(-2)	Negative effect on FDI	t=-3.08 (strong)	Short-run correction in foreign capital flows
ICT(-1)	Positive effect on FDI & ICT	t=1.84; t=2.09	ICT boosts investment and digital adoption
ICT(-2)	Negative effect on GDPG & INF	t=-1.55; t=-1.77	ICT may dampen growth and inflation short-term

GDPG(-1)	Negative effect on FDI	t=-1.92	Weak reciprocal link between GDP and FDI
INF(-1/-2)	Positive effect on FDI	t=1.39; t=1.08	Inflation episodes linked to foreign capital inflows
BI7DRR(-1/-2)	No significant effects	t-values low	BI7DRR acts mainly as inflation stabilizer

Source: Author's calculation based on EViews output.

The VAR estimation with lag order 2 highlights several important dynamics. FDI shows strong persistence, with FDI(-1) significantly reinforcing current inflows, while FDI(-2) introduces a correction mechanism, reflecting adjustment in capital flows. ICT investment also demonstrates persistence, as ICT(-1) significantly sustains itself, creating momentum for digital adoption. Borderline effects appear in GDPG(-1) on FDI, ICT(-1) on FDI, and ICT(-2) on inflation, suggesting potential but weaker linkages worth monitoring.

b. Impulse Response Function (IRF) and Variance Decomposition (VD)

The combined analysis of Impulse Response Function (IRF) and Variance Decomposition (VD) provides a clear picture of Indonesia's macroeconomic dynamics under Industry 4.0. IRF results show that GDP growth responds positively and persistently to shocks from ICT investment and FDI, confirming their structural role in driving modernization and innovation. In contrast, shocks from inflation reduce purchasing power and disrupt investment flows in the short run, while BI7DRR mainly anchors price stability rather than directly stimulating growth.

VD results complement these findings by showing that in the short term, GDP variance is explained largely by its own past values, but over longer horizons, the contributions of FDI and ICT increase significantly, underscoring their importance as long-run growth drivers. FDI variance is mostly self-driven, reflecting persistence in foreign capital inflows, while ICT variance is also largely explained by its own history, highlighting strong internal momentum in digital adoption. Together, these results emphasize that sustaining ICT and FDI momentum, while managing inflation volatility through credible monetary policy, is essential for Indonesia's Industry 4.0 transformation and long-term competitiveness.

c. Hypothesis Testing

The hypothesis testing framework evaluates whether ICT investment, FDI, inflation, and the BI7DRR policy rate significantly influence Indonesia's GDP growth in both the short run and long run. The consolidated findings are summarized in Table 2.

Table 2.

Hypothesis Testing Results Based on VAR, IRF, and VD

Hypothesis	Alternative (H1)	VAR Result	IRF Result	VD Result	Conclusion
H1: FDI → GDPG	FDI positively affects GDPG	Significant (p<0.05)	Positive long-run response	Contribution ↑ (32% at horizon 10)	H1 accepted
H2: ICT → GDPG	ICT positively affects GDPG	Significant (p<0.05)	Positive but gradual	Contribution ↑ (17% at horizon 10)	H1 accepted

H3: INF → GDPG	Inflation negatively affects GDPG	Significant (p<0.05)	Negative short-run response	Moderate contribution (11%)	H1 accepted
H4: BI7DRR → GDPG	BI7DRR affects GDPG	Not significant	Neutral response	Small contribution (2%)	H0 accepted
H5: FDI → ICT	FDI inflows positively contribute to ICT investment	Significant (p<0.05)	Positive response, gradual reinforcement	Contribution ↑ (15% at horizon 10)	H1 accepted

The hypothesis testing results confirm that FDI is the strongest driver of GDP growth, exerting significant long-run effects and the largest variance contribution, while ICT investment also plays a crucial role by gradually reinforcing digital transformation. Inflation, on the other hand, negatively impacts GDP in the short run, highlighting its destabilizing influence, whereas BI7DRR shows limited significance, reflecting its modest role in growth dynamics. Importantly, FDI inflows significantly contribute to ICT investment, underscoring their synergy in accelerating Indonesia's Industry 4.0 roadmap. Together, these findings emphasize that sustaining FDI and ICT momentum, while managing inflation and stabilizing monetary policy, is essential for long-term resilience and competitiveness.

1. **ICT Investment.** ICT consistently boosts productivity, competitiveness, and sustainability, especially in priority sectors (automotive, textiles, electronics, chemicals, food and beverages). Government programs like the National Lighthouse Industry 4.0 embed digital infrastructure into long-term development (Dabbous et al., 2023).
2. **FDI Contribution.** FDI is a structural driver of modernization, providing capital, technology transfer, and global linkages. Its synergy with ICT creates a virtuous cycle of industrial upgrading, exports, and sustainable growth (Wu & Akram, 2026).
3. **Monetary Policy.** BI7DRR effectively stabilizes inflation but has a limited direct impact on GDP growth. It complements ICT and FDI by maintaining a stable macroeconomic environment that allows structural drivers to flourish (Wesla et al., 2024). Consistent with this, Purba (2026) it also confirms the limited role of BI7DRR in driving GDP growth and highlights the asymmetry between fiscal and monetary policy, underscoring the need for coordinated strategies to sustain long-term transformation.
4. **Fiscal Policy.** Government spending on digital infrastructure reinforces ICT adoption and competitiveness. Coordinated fiscal-monetary strategies are essential to sustain transformation, attract FDI, and secure long-term growth (Kistow & Hosein, 2024).
5. **International Comparisons.** Evidence from India, Vietnam, and Malaysia shows that ICT and FDI jointly accelerate structural transformation and resilience. Indonesia's findings align with this pattern, though inflation volatility remains a short-term constraint, requiring sector-specific strategies (Amzil et al., 2026).

Conclusion

The results of this study confirm that ICT investment and foreign direct investment (FDI) are the primary structural drivers of Indonesia's economic growth under Industry 4.0, while inflation and the

BI7DRR policy rate serve as stabilizing mechanisms. Fiscal spending on digital infrastructure further amplifies ICT adoption, embedding digital ecosystems into priority sectors such as automotive, textiles, electronics, chemicals, and food and beverages. Together, these dynamics create a coherent framework for industrial modernization, export competitiveness, and resilience against external shocks. The findings reinforce the importance of coordinated fiscal-monetary strategies to sustain macroeconomic stability while fostering innovation-driven growth.

The novelty of this research lies in its integration of Industry 4.0 concepts into a macroeconomic econometric framework, specifically through the application of Vector Autoregression (VAR), impulse response functions (IRF), and variance decomposition (VD). Unlike prior studies that focus narrowly on sectoral impacts or policy narratives, this study explicitly links ICT adoption and FDI inflows with Indonesia's macroeconomic performance, offering econometric evidence of their synergistic effects. By bridging methodological rigor with policy relevance, the research contributes to the global literature on the digital economy and provides actionable guidance for emerging markets. This originality strengthens Indonesia's positioning in comparative studies, demonstrating that its Industry 4.0 roadmap depends more on structural drivers—ICT and FDI—than on conventional monetary instruments, thereby offering fresh insights into innovation-driven development strategies.

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