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The Impact of Artificial Intelligence Adoption on Productivity and Economic Growth in the Industry 5.0 Era

Alaika Zinatul Hayat
Universitas Batanghari, Indonesia

Email: zinatulalaika@gmail.com

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ABSTRACT

The rapid advancement of artificial intelligence (AI) technologies has become a key driver of economic transformation in the Industry 5.0 era, where human–machine collaboration plays a central role in improving efficiency and innovation. AI adoption is increasingly recognized as a strategic factor that enhances productivity and supports sustainable economic growth across various sectors. This study aims to analyze the impact of AI adoption on productivity and economic growth within the framework of Industry 5.0. This research employs a quantitative approach using secondary data obtained from economic databases, industry reports, and statistical publications related to technology adoption and economic performance. Data were collected through documentation techniques and analyzed using descriptive statistics and multiple regression analysis to examine the relationships between AI adoption, productivity indicators, and economic growth. The results indicate that AI adoption has a positive and significant effect on productivity improvement, particularly through enhanced operational efficiency, technological upgrading, and improved workforce performance. Furthermore, productivity improvements resulting from AI adoption contribute significantly to economic growth by increasing industrial output and strengthening competitiveness in the digital economy. In conclusion, AI adoption plays a crucial role in enhancing productivity and supporting economic growth in the Industry 5.0 era. However, maximizing these benefits requires complementary investments in digital infrastructure, workforce skills, and supportive policy frameworks

Keywords: *Artificial Intelligence Adoption, Economic Growth, Industry 5.0, Productivity, Technological Innovation*

INTRODUCTION

The rapid advancement of digital technologies has fundamentally transformed the structure of modern economies. Over the past decade, the integration of advanced technologies such as artificial intelligence (AI), big data analytics, the Internet of Things (IoT), cloud computing, and robotics has

reshaped production systems, organizational structures, and economic activities worldwide. These technological developments have marked the transition from the Fourth Industrial Revolution toward the emerging paradigm of Industry 5.0, which emphasizes the collaboration between human intelligence and advanced technologies to achieve more sustainable, human-centered, and resilient production systems. Unlike Industry 4.0, which primarily focused on automation and cyber-physical systems, Industry 5.0 seeks to balance technological efficiency with human creativity and sustainability. In this context, artificial intelligence has become a central technological driver that enables organizations to process large volumes of data, automate complex tasks, and support intelligent decision-making processes across various sectors of the economy (Maddikunta et al., 2021; Žižić et al., 2022).

Industry 5.0 represents a significant shift in the philosophy of industrial development, where technological innovation is integrated with human-centered values and sustainable economic growth. The concept promotes the development of intelligent systems that enhance human capabilities rather than replace them entirely. In this framework, AI functions as a key enabling technology that supports flexible production systems, personalized manufacturing processes, and efficient resource utilization. Emerging technologies such as IoT, blockchain, cobots (collaborative robots), cloud and edge computing, and next-generation communication technologies like 6G are increasingly integrated with AI to create more adaptive and intelligent industrial ecosystems (Maddikunta et al., 2021; Alojaiman, 2023; Ciucu-Durnoi et al., 2024). These technological advancements enable companies to improve operational efficiency, optimize supply chains, and develop innovative products and services tailored to evolving market demands.

In many developing economies, including Indonesia, the adoption of Industry 5.0 technologies is increasingly viewed as a strategic pathway for strengthening national competitiveness and fostering sustainable economic development. Governments and industry stakeholders recognize that advanced digital technologies can enhance industrial productivity, support green economic transitions, and stimulate innovation-driven growth. The integration of AI with sustainable development strategies has the potential to accelerate the adoption of circular economy models, renewable energy systems, and environmentally responsible production processes. Consequently, AI-driven technological transformation is increasingly positioned as a key driver of innovation, industrial modernization, and global competitiveness in emerging economies (Fitriani et al., 2025; Alfarizi, 2025; Nugroho et al., 2023).

One of the most important economic implications of AI adoption lies in its capacity to improve productivity across various sectors. Productivity growth is widely recognized as a fundamental determinant of long-term economic development because it reflects the efficiency with which resources are utilized to generate economic output. Artificial intelligence enhances productivity by automating repetitive tasks, improving data-driven decision-making, and enabling real-time optimization of operational processes. In manufacturing industries, AI-powered technologies can significantly improve production efficiency through predictive maintenance, automated quality control, and intelligent process optimization. These technologies enable firms to reduce operational costs while simultaneously improving product quality and production speed. As a result, AI adoption has become an essential strategy for firms seeking to enhance competitiveness and operational efficiency in increasingly dynamic markets (Karunia et al., 2025; Hadi et al., 2025; Siska et al., 2023).

Empirical studies have provided substantial evidence supporting the productivity-enhancing effects of AI adoption. Micro-level studies in manufacturing sectors demonstrate that even modest increases in AI penetration can significantly improve firm productivity. For example, research indicates that a one percent increase in AI adoption can lead to a substantial increase in total factor productivity (TFP), primarily through improvements in value-added production, technological upgrading, and workforce skill enhancement (Gao & Feng, 2023). These findings highlight the transformative potential of AI in improving production efficiency and technological capability within modern industries.

The productivity benefits of AI adoption extend beyond manufacturing industries to various service sectors, including finance, logistics, marketing, and healthcare. AI-driven technologies enable organizations to process complex datasets, predict consumer behavior, and optimize service delivery processes. For instance, AI algorithms can analyze large volumes of financial data to improve risk assessment and investment strategies, while AI-powered logistics systems can optimize transportation routes and supply chain management. Similarly, AI-based marketing tools allow companies to develop personalized customer experiences and improve market targeting strategies. These capabilities demonstrate that AI adoption can significantly enhance operational efficiency and innovation capacity across multiple sectors of the economy (Karunia et al., 2025; Hadi et al., 2025; Siska et al., 2023).

Systematic reviews of AI applications across industries further confirm that AI technologies contribute to productivity improvements through several key mechanisms. These mechanisms include process automation, predictive analytics, predictive maintenance, and intelligent supply chain management systems. By leveraging AI-powered predictive capabilities, organizations can anticipate equipment failures, optimize resource allocation, and reduce operational downtime. In addition, AI technologies support more efficient decision-making processes by providing real-time insights derived from large-scale data analysis. As a result, AI-driven technologies enable firms to achieve higher levels of efficiency, flexibility, and innovation in production and service delivery processes (Naqbi et al., 2024; Siska et al., 2023).

Another important dimension of AI-driven productivity improvement relates to human capital development. Although AI technologies automate certain tasks, they also create new opportunities for workforce development by increasing the demand for advanced technical skills and digital literacy. Studies indicate that AI adoption can enhance employee performance when organizations invest in workforce training and digital skill development. Employees who possess strong digital competencies are better able to collaborate with intelligent technologies and leverage AI tools to improve work performance and productivity (Mujtahidin et al., 2025; Gao & Feng, 2023). Therefore, the successful implementation of AI technologies depends not only on technological infrastructure but also on the availability of skilled human resources capable of utilizing these technologies effectively.

Beyond firm-level productivity improvements, AI adoption also has broader macroeconomic implications for economic growth. Economic growth is strongly influenced by technological innovation because technological progress increases production efficiency, stimulates innovation, and creates new economic opportunities. In the context of Industry 5.0, AI technologies play a crucial role in driving economic transformation by enabling the development of new industries, enhancing global competitiveness, and attracting foreign investment. Emerging sectors such as robotics,

intelligent automation, and data-driven services are increasingly contributing to economic growth in many countries (Fitriani et al., 2025; Maria et al., 2024; Žižić et al., 2022; Nugroho et al., 2023).

Recent research highlights that organizations with strong dynamic capabilities are more likely to adopt AI technologies successfully and achieve better economic performance. Dynamic capabilities refer to the ability of organizations to adapt to changing technological environments by integrating new knowledge, technologies, and business models. Studies examining innovative startups demonstrate that firms with higher levels of dynamic capabilities are more capable of adopting AI technologies and achieving improved economic, social, and environmental performance outcomes (Cimino et al., 2025). These findings suggest that AI adoption not only enhances productivity but also contributes to broader organizational performance and sustainable economic development.

At the macroeconomic level, the adoption of Industry 5.0 technologies is expected to generate significant economic benefits for developing economies. In Indonesia, the implementation of AI-driven technologies is projected to increase industrial output, improve production efficiency, and enhance product quality. Furthermore, AI adoption can stimulate the development of new technology-based industries and create employment opportunities that require advanced technical skills. However, the successful implementation of AI technologies also requires supportive institutional conditions, including digital infrastructure development, regulatory frameworks, and investments in human capital development (Fitriani et al., 2025; Karunia et al., 2025; Putra, 2023; Nugroho et al., 2023).

Despite the significant potential benefits of AI adoption, several challenges remain in realizing its full economic potential. First, the adoption of AI technologies is often uneven across industries and regions due to differences in technological infrastructure, organizational readiness, and workforce skills. Second, concerns regarding job displacement and technological unemployment remain significant policy challenges associated with AI-driven automation. Third, many developing economies face limitations in digital infrastructure and technological capabilities, which may hinder the effective implementation of AI technologies in industrial and economic systems. These challenges highlight the importance of comprehensive policy frameworks that support technological adoption while ensuring inclusive economic development.

In addition to these challenges, the existing literature also reveals several research gaps related to the economic implications of AI adoption. While many studies have examined the productivity effects of AI adoption at the firm level, relatively fewer studies have explored the broader relationship between AI adoption, productivity improvements, and macroeconomic growth within the emerging Industry 5.0 framework. Moreover, most empirical studies have focused on developed economies, leaving limited evidence regarding the economic implications of AI adoption in emerging economies such as Indonesia. Understanding the role of AI adoption in shaping productivity and economic growth within developing economies is therefore essential for designing effective digital transformation strategies.

Another important research gap concerns the integration of productivity and economic growth perspectives within AI adoption research. Many studies focus either on firm-level productivity outcomes or macroeconomic growth effects without examining how productivity improvements resulting from AI adoption translate into broader economic growth. A more integrated analytical approach is therefore necessary to understand how technological adoption influences both micro-level efficiency and macro-level economic development.

Based on these considerations, this study offers a research novelty by examining the relationship between AI adoption, productivity improvement, and economic growth within the context of Industry 5.0. Unlike previous studies that focus primarily on individual aspects of technological adoption, this research integrates technological, productivity, and economic growth perspectives within a unified analytical framework. By exploring how AI adoption influences productivity and economic performance simultaneously, this study provides a more comprehensive understanding of the economic implications of technological transformation in the Industry 5.0 era.

Therefore, the objective of this study is to analyze the impact of artificial intelligence adoption on productivity and economic growth in the Industry 5.0 era. By examining the relationship between technological adoption, productivity improvement, and economic development, this research aims to provide empirical insights that can support policy development and strategic decision-making in digital transformation initiatives. The findings are expected to contribute to the growing literature on Industry 5.0 and provide practical implications for governments, industries, and policymakers seeking to leverage AI technologies to promote sustainable economic growth and technological innovation.

METHOD

This study employs a quantitative research approach to examine the impact of artificial intelligence (AI) adoption on productivity and economic growth in the Industry 5.0 era. The quantitative approach is selected to enable systematic analysis of the relationships between technological adoption, productivity improvement, and macroeconomic performance using measurable indicators. The population of this study consists of industrial sectors and economic entities that have begun integrating AI-based technologies into their operational processes. The research sample is determined using purposive sampling based on criteria such as industries that have adopted AI technologies, the availability of productivity and economic performance data, and the relevance of the sector to digital transformation initiatives. Data used in this study are secondary data obtained from national statistical reports, economic databases, technology adoption surveys, and industry performance reports published by government institutions, international organizations, and economic research agencies. The main variables in this study include artificial intelligence adoption as the independent variable, productivity indicators such as total factor productivity and operational efficiency as mediating variables, and economic growth indicators such as output growth and sectoral economic performance as dependent variables. Data collection is conducted through documentation techniques by compiling statistical reports, digital economy databases, and relevant research publications related to technological adoption and economic performance.

The collected data are analyzed using quantitative statistical methods to evaluate the relationships among AI adoption, productivity, and economic growth. The analysis begins with descriptive statistical analysis to describe the characteristics and distribution of the research variables, including the level of AI adoption, productivity indicators, and economic growth performance across sectors. Prior to hypothesis testing, classical assumption tests are conducted to ensure the reliability of the regression model, including tests for normality, multicollinearity, and heteroscedasticity. Subsequently, multiple regression analysis is employed to determine the extent to which AI adoption influences productivity improvements and economic growth. In addition, correlation analysis is conducted to identify the strength of the relationships among the variables. In

order to examine the indirect effect of productivity as a mediating variable between AI adoption and economic growth, mediation analysis is also applied. Statistical analysis is performed using software such as SPSS or STATA to ensure accurate data processing and interpretation. The results of the analysis are expected to provide empirical evidence regarding how AI adoption contributes to productivity enhancement and supports sustainable economic growth in the Industry 5.0 era.

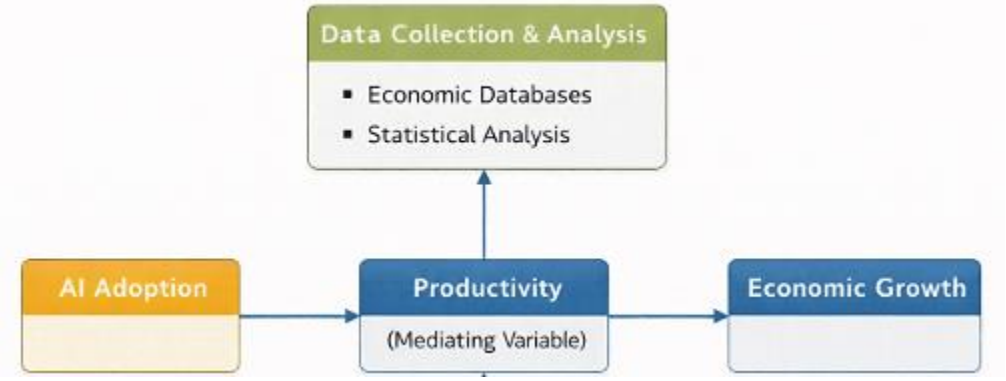

Figure 1. Diagram Conceptual Research

RESULTS AND DISCUSSION

The first stage of the analysis presents descriptive statistics to provide an overview of the characteristics of the main variables used in this study, namely artificial intelligence (AI) adoption, productivity improvement, and economic growth. Descriptive statistical analysis is conducted to identify the general distribution of the variables and to provide an initial understanding of how AI adoption is associated with productivity performance and economic outcomes in the Industry 5.0 era. The variables are measured using indicators such as the level of AI technology integration, operational efficiency, total factor productivity, and sectoral economic output growth. The results of the descriptive statistical analysis are presented in Table 1.

Table 1. Descriptive Statistics of Research Variables

Variable	N	Minimum	Maximum	Mean	Std. Deviation
AI Adoption	120	2.10	4.85	3.94	0.53
Productivity (Operational Efficiency & TFP)	120	2.25	4.78	3.88	0.55
Economic Growth (Sectoral Output Growth)	120	2.30	4.90	4.01	0.49

The descriptive results indicate that the average level of AI adoption across the observed sectors is relatively high, with a mean value of 3.94. This suggests that many organizations and industries have begun integrating AI technologies into their operational systems. Productivity indicators show a mean value of 3.88, indicating that firms adopting AI technologies tend to

experience improvements in operational efficiency and technological performance. Meanwhile, the economic growth variable has the highest mean value of 4.01, reflecting positive economic performance within sectors that actively adopt advanced digital technologies. Overall, these findings suggest that AI adoption is associated with increased productivity levels and improved economic performance within the Industry 5.0 environment.

Following the descriptive analysis, regression analysis is conducted to evaluate the influence of AI adoption on productivity and economic growth. This analysis aims to determine whether AI adoption significantly contributes to improvements in operational efficiency and economic output. The regression results are presented in Table 2.

Table 2. Regression Analysis Results

Relationship	Beta Coefficient	t-value	Sig.
AI Adoption → Productivity	0.452	5.216	0.000
Productivity → Economic Growth	0.389	4.072	0.000
AI Adoption → Economic Growth	0.271	3.104	0.002
Constant	1.184	3.020	0.003
R^2	0.604		
Adjusted R^2	0.596		

The regression results indicate that AI adoption has a positive and statistically significant effect on productivity, with a beta coefficient of 0.452 and a significance level of 0.000. This finding suggests that higher levels of AI adoption contribute to improvements in operational efficiency and technological productivity. In addition, productivity has a significant positive effect on economic growth, indicating that productivity improvements generated through AI adoption contribute to increased economic output. The direct relationship between AI adoption and economic growth is also positive and significant, although the magnitude of the effect is smaller than the indirect effect through productivity. The R^2 value of 0.604 indicates that approximately 60.4% of the variation in economic growth can be explained by AI adoption and productivity improvements. These results highlight the important role of AI technologies in enhancing productivity and supporting economic growth in the Industry 5.0 era.

Discussion

The purpose of this study is to analyze the impact of artificial intelligence (AI) adoption on productivity and economic growth in the Industry 5.0 era. The empirical findings presented in the regression analysis demonstrate that AI adoption has a positive and statistically significant influence on productivity, which subsequently contributes to economic growth. The results show that higher levels of AI adoption are associated with improved operational efficiency and total factor productivity, which in turn support higher levels of economic performance. These findings indicate that AI technologies function as an important technological driver that enhances productivity and

economic competitiveness within modern economic systems. In the context of Industry 5.0, AI is not only used for automation but also as a collaborative technology that enhances human capabilities and supports more flexible and efficient production systems.

The results of this study support the growing theoretical perspective that AI functions as a key enabler of productivity improvement in the emerging Industry 5.0 paradigm. Unlike previous technological revolutions that emphasized full automation, Industry 5.0 emphasizes the collaboration between intelligent machines and human workers. AI technologies assist human workers in performing complex tasks, analyzing large volumes of data, and optimizing operational processes. As a result, the combination of human creativity and machine intelligence creates a more efficient and adaptive production system. Studies on human–machine collaboration in Industry 5.0 indicate that AI technologies significantly improve production efficiency, product quality, and customization capabilities within industrial systems (Anang et al., 2024; Waqas & Naseem, 2025). The regression results showing a strong relationship between AI adoption and productivity improvement in this study are consistent with these findings.

One of the most important findings of this research is the strong positive effect of AI adoption on productivity indicators. The regression results demonstrate that AI adoption significantly improves operational efficiency and technological productivity. This finding aligns with empirical evidence from manufacturing sector studies indicating that AI technologies contribute significantly to productivity improvements. For instance, micro-level studies in manufacturing industries reveal that a one percent increase in AI penetration can increase total factor productivity by approximately 14.2 percent. This productivity improvement occurs through several mechanisms, including increased value-added production, greater utilization of skilled labor, and technological upgrading within firms (Gao & Feng, 2023). These findings highlight the role of AI as a transformative technological tool that enhances both operational performance and technological capability within firms.

Beyond improvements in production processes, AI adoption also influences workforce productivity and organizational performance. AI technologies assist employees in performing complex tasks more efficiently by providing real-time data analysis and intelligent decision-support systems. Studies examining human-centered AI applications show that the integration of AI into organizational processes can significantly improve employee productivity, job satisfaction, and skill development. Empirical evidence indicates that AI adoption can increase worker productivity by approximately 35.5 percent, while also improving job satisfaction by 20.6 percent and enhancing skill development by nearly 29.6 percent (Shchepkina et al., 2024). These findings suggest that AI technologies do not necessarily replace human workers but instead enhance their capabilities and productivity when properly integrated into organizational systems.

Another important dimension of AI-driven productivity improvement relates to the efficiency gains achieved through automation and predictive analytics. AI technologies enable firms to implement predictive maintenance systems, optimize production schedules, and improve supply chain management. These capabilities allow organizations to reduce operational costs and minimize production downtime. Systematic reviews of AI implementation across industries confirm that AI significantly improves production efficiency through intelligent automation and predictive decision-making tools. At the same time, however, several challenges remain, including the complexity of integrating AI technologies into existing systems, high implementation costs, and the need for skilled human resources capable of managing advanced technological systems (Fawwaz et al., 2025). These challenges indicate that the productivity benefits of AI adoption depend not only on technological investment but also on complementary organizational and institutional factors.

The productivity-enhancing effects of AI adoption are not limited to large industrial firms but also extend to business sectors such as services and small and medium enterprises (SMEs). In digital business environments, AI technologies enable firms to analyze customer preferences, automate business operations, and improve market responsiveness. SMEs adopting AI-driven technologies often experience improvements in operational efficiency, decision-making speed, and competitive positioning in digital markets. Research on AI adoption in business sectors indicates that AI technologies help firms adapt to rapidly changing consumer preferences and enhance their competitiveness in increasingly digitalized economies (Anggraeni et al., 2025; Cimino et al., 2025). These findings support the empirical results of this study, which indicate that AI adoption contributes significantly to productivity improvements across economic sectors.

In addition to firm-level productivity improvements, AI adoption also has broader implications for workforce dynamics and labor productivity. The integration of AI technologies into production systems can transform labor markets by changing the types of skills required in modern workplaces. While some routine tasks may become automated, AI adoption also generates new employment opportunities in areas such as data science, AI system management, and digital technology development. Research suggests that AI adoption often leads to a structural shift in labor demand, increasing the need for highly skilled workers capable of working with advanced digital technologies (Masih, 2023; Nafees et al., 2025). As a result, workforce education and digital skill development become critical components in maximizing the productivity benefits of AI adoption.

The results of this study also demonstrate that productivity improvements resulting from AI adoption significantly contribute to economic growth. Economic growth is strongly influenced by technological progress because technological innovation increases production efficiency and stimulates economic activity. AI technologies function as a general-purpose technology that affects multiple sectors simultaneously, thereby creating widespread productivity gains across the economy. When firms become more productive, they produce higher levels of output with the same or fewer resources, which contributes to overall economic expansion. Studies examining the macroeconomic effects of AI adoption indicate that AI technologies strengthen firm competitiveness and stimulate economic growth through innovation and technological diffusion (Chaudhary, 2024; Czarnitzki et al., 2022; Cimino et al., 2025).

Empirical evidence from cross-country studies further supports the positive relationship between AI innovation and economic growth. Panel data analyses covering several decades show that increases in AI-related innovation, measured through AI patents, are strongly associated with economic growth across countries. These studies suggest that AI-driven technological innovation contributes more significantly to economic growth than many other forms of technological innovation. Moreover, the economic impact of AI adoption tends to be stronger in countries with advanced technological infrastructure and higher levels of digital readiness (Gonzales, 2023). These findings suggest that the macroeconomic benefits of AI adoption depend on the ability of countries to develop supportive technological ecosystems.

The relationship between AI adoption and economic growth can also be explained through several economic transmission channels. The first channel relates to labor productivity improvements resulting from automation and enhanced worker performance. The second channel involves capital investment, as firms invest in advanced technological infrastructure to support AI integration. The third channel concerns productivity growth resulting from technological innovation and process optimization. Research indicates that AI technologies contribute to long-term economic growth by improving productivity across these three channels simultaneously. However, some studies also suggest that short-term economic adjustments may occur during the transition toward

AI-driven economic systems, particularly as labor markets adapt to new technological environments (Xu, 2022). These short-term adjustment costs may temporarily slow economic growth before the long-term benefits of technological adoption are fully realized.

In developing economies such as Indonesia, the adoption of AI technologies and Industry 5.0 innovations presents both opportunities and challenges for economic development. On one hand, AI adoption can significantly enhance industrial productivity, improve production efficiency, and strengthen global competitiveness. On the other hand, the successful implementation of AI technologies requires substantial investments in digital infrastructure, human capital development, and supportive regulatory frameworks. Research on the digital transformation of Indonesian industries indicates that the integration of AI, robotics, and IoT technologies has the potential to enhance industrial competitiveness, attract foreign direct investment, and create new high-skilled employment opportunities (Nugroho et al., 2023). However, achieving these outcomes requires coordinated efforts between government institutions, industries, and educational systems.

The findings of this study also highlight the importance of complementary investments and supportive policies in maximizing the economic benefits of AI adoption. Technological adoption alone is insufficient to generate productivity gains if organizations lack the necessary skills, infrastructure, and institutional support systems. Effective digital transformation strategies require investments in workforce education, digital infrastructure, and research and development. Governments also play an important role in establishing regulatory frameworks that support technological innovation while addressing potential social challenges such as labor displacement and digital inequality.

Overall, the results of this study confirm that AI adoption in the Industry 5.0 era significantly enhances productivity and contributes positively to economic growth. The empirical evidence demonstrates that AI technologies improve operational efficiency, strengthen workforce productivity, and stimulate technological innovation across industries. These productivity improvements subsequently contribute to higher levels of economic performance at both firm and macroeconomic levels. However, the economic benefits of AI adoption depend largely on the availability of complementary investments, including digital infrastructure, human capital development, and supportive policy frameworks. By integrating technological innovation with strategic investments and effective governance, economies can harness the full potential of AI technologies to promote sustainable economic growth and industrial transformation in the Industry 5.0 era.

CONCLUSIONS

This study aims to analyze the impact of artificial intelligence (AI) adoption on productivity and economic growth in the Industry 5.0 era. Based on the results of the analysis and discussion, it can be concluded that AI adoption plays a significant role in enhancing productivity and contributing positively to economic growth. The findings indicate that the integration of AI technologies into organizational and industrial systems improves operational efficiency, increases total factor productivity, and supports innovation and technological upgrading. These productivity improvements subsequently stimulate higher economic output and strengthen industrial competitiveness in the digital economy. Furthermore, the results highlight that the positive impact of AI adoption on economic growth is strengthened when supported by complementary investments in digital infrastructure, workforce skills, and supportive policy frameworks. Therefore, effective AI adoption strategies combined with appropriate institutional and policy support are essential to maximize productivity gains and promote sustainable economic growth in the Industry 5.0 era.

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