Quantifying the Economic Benefits of Artificial Intelligence Technology

Fu Xian[1, a]
[a]e-mail: xianfu800@163.com

[1]School of Economics, Sichuan University Jinjiang College, Sichuan, China

Abstract——Artificial intelligence technology has been hailed as the driving force behind the fourth industrial revolution, and its widespread application has given the economy a boost. However, in the AI era, more research into the sources of innovation and economic growth models is required, as these are critical to addressing long-term economic growth and accelerating the transformation of economic growth models. This study uses the improved Cobb-Douglas production function (C—D function) model to quantify the economic benefits of AI technology, and empirically demonstrates using Chinese panel data from 2010 to 2019. The findings show that AI can directly drive economic growth, while AI indirectly promotes economic growth by increasing the level of technological innovation and human capital in the market. Finally, policy proposals for AI development in China are suggested based on the research findings.

Keywords——computers; artificial intelligence technology; economic benefits; direct effect; indirect effect

1 Introduction

The development of artificial intelligence, which is a crucial driving force of the next wave of industrial transformation and technological revolution, is the key to constructing a co-creation and sharing, human-machine cooperation, cross-border integration, and data-driven intelligent economic form [1]. AI has been reformed to modify the new production model, improve the exchange model, and increase distribution efficiency, and has emerged as a key driver of economic growth in the context of intelligent integration and development, digitalization, and networking, as well as the concept of innovative development.

Since 2015, China has made AI's usage and growth a national priority, steadily strengthening and pushing AI-related policies, providing supportive resources and suitable governmental backing for AI development. Artificial intelligence is linked to future economic and social growth in the 14th Five-Year Blueprint, which establishes science and technology as the country's future development plan [2].

In fact, China's AI market grew significantly between 2016 and 2020, rising from 15.4 billion yuan in 2016 to 128 billion yuan in 2020, and it is expected that the AI market will continue to grow significantly in the future, reaching 196.3 billion yuan in 2021. According to a report published by the Chinese Academy of Information and Communications Technology, China's AI core industry is expected to grow at a compound annual growth rate of 58 percent to 157.3 billion yuan by 2022. The International Data Corporation also predicts that by 2024, China's AI

MSIEID 2022, December 09-11, Chongqing, People's Republic of China

DOI 10.4108/eai.9-12-2022.2327579

technology investment spending will be at the top of the world, accounting for 26.7 percent of global spending. The application of AI will form economies of scale and contribute to the construction of China's economy.

China's economy has depended on low-cost energy, labor, and other production aspects, as well as policy dividends, which have remained at around 9.5 percent for the past 30 years, to achieve fast development [3]. With the gradual increase in environmental and resource pressures, the decline in labor supply of production factors, and the heavy pressure of local government debt, the crude growth model based on the traditional resource, capital, and labor factor-driven model can no longer sustain economic growth, and the growth rate of China's fixed asset investment began to decline due to issues such as real estate overheating and domestic production capacity process. China's sustained economic growth will need the adoption of sustainable development techniques and a reduction in reliance on traditional energy sources in the future. As a result, artificial intelligence's emergence has shed light on China's economic development, and China's economy can make full use of artificial intelligence to achieve long-term steady and high-quality growth. Traditional functional and specialized technologies have a smaller and shallower influence on the economy than AI as a general-purpose technology revolution [4]. How artificial intelligence affects economic growth and how to fully exploit the potential of artificial intelligence technology in driving economic growth are brand new topics that need to be researched in the context of the new era; this paper's analysis of the principles of artificial intelligence driving economic growth aids in identifying the key reasons for artificial intelligence driving economic growth and fully exploiting the potential of artificial intelligence technology in driving economic growth. Therefore, this paper first analyzes the principles of AI-driven economic growth from the theoretical and empirical viewpoints, then puts forward policy proposals for fostering AI-driven economic growth in China.

2 Materials and Methods

The primary goal of artificial intelligence's development is to raise labor productivity in society and support economic prosperity. Artificial intelligence expands the entire labor supply, decreases the physical input of people in production, raises the automation standard, and boosts labor productivity directly through the integration of human and machine intelligence [5].

Artificial intelligence modifies the structure of production elements and enhances the quality of a product when it is used. Simple labor in manufacturing is replaced by AI, resulting in a rise in the need for human capital, i.e. high-end labor. To begin with, the creation of AI technology necessitates the involvement of top-tier talent; to continue, the deployment of AI needs the use of special employees to manage and maintain it. Human capital with specialized skills and knowledge is a highly productive component in order to develop better value-added wealth as compared to plain physical labor [6]. It is clear that the adoption of AI may boost human capital while also indirectly increasing economic growth.

Artificial intelligence has prompted the construction of new infrastructure, or foundation, known as digital infrastructure, which organically connects industry, academia, and research using data as a link to support the integration and development of the real and digital economies. The data infrastructure development segment eliminates the information asymmetry between enterprise production and consumption, enhances innovation efficiency, and lowers the cost of

enterprise innovation [7]. Artificial intelligence, in the end, improves technical efficiency and so indirectly improves the workforce and supports economic growth [8].

A model is built to experimentally evaluate the influence of artificial intelligence on economic growth using panel data from our economy.

2.1 Model creation

Because the Cobb-Douglas production function is commonly employed in economic growth analysis, this study investigates the use of an enhanced Cobb-Douglas production function (C—D function) and examines the dynamics of Chinese economic growth. Artificial intelligence is immediately included into the model since it can directly drive economic growth, and the model formulation is as follows.

$$Y_{i,t} = A_{i,t} K_{i,t}^{\alpha} L_{i,t}^{\beta} AI_{i,t}^{\delta} \mu \tag{1}$$

where Y represents total output, A represents total factor productivity, K represents physical capital, L and AI represent labor and AI inputs, α, β and δ represent the output elasticity coefficients of physical capital, labor, and AI, respectively, μ is the random disturbance term, i represents the region, and t represents the year. When the natural logarithm is applied to both sides of the C—D function, the outcome is.

$$LnY_{i,t} = LnA_{i,t} + \alpha LnK_{i,t} + \beta LnL_{i,t} + \delta LnAI_{i,t} + \mu \tag{2}$$

Because factors such as technology and human capital have a significant impact on economic growth, the levels of technology and human capital are introduced into the model rather than total factor productivity.

$$LnY_{i,t} = \alpha LnK_{i,t} + \beta LnL_{i,t} + \delta LnAI_{i,t} + \gamma LnT_{i,t} + \eta LnH_{i,t} + \mu \tag{3}$$

T signifies the level of technology, and H denotes the level of human capital in equation (3).

Because AI can indirectly affect economic growth by increasing technological innovation and human capital, equations (4) and (5) below use the cross product term approach to assess whether AI promotes technological innovation and human capital for economic growth.

$$\begin{aligned} LnY_{i,t} = {} & \alpha LnK_{i,t} + \beta LnL_{i,t} + \delta LnAI_{i,t} + \gamma LnT_{i,t} + \eta LnH_{i,t} \\ & + \lambda LnAI_{i,t} \times LnT_{i,t} + \mu \end{aligned} \tag{4}$$

$$\begin{aligned} LnY_{i,t} = {} & \alpha LnK_{i,t} + \beta LnL_{i,t} + \delta LnAI_{i,t} + \gamma LnT_{i,t} + \eta LnH_{i,t} \\ & + \rho LnAI_{i,t} \times LnH_{i,t} + \mu \end{aligned} \tag{5}$$

2.2 Variables Description

Economic growth is indicated by total output indicator Y. GDP deflator is represented by regional GDP index, and regional GDP is measured in constant 2010 prices. The capital stock K indicator is calculated using the perpetual inventory method, the labor L indicator is calculated using the average years of education of our population, and the AI indicator is calculated using the number of AI patent applications in China.

Because the development of artificial intelligence in China was limited before 2010, and its economic impact was insufficient, all data in this study, with the exception of artificial

intelligence data, comes from China's 2010-2019 China Statistical Yearbook.

Table 1 Descriptive statistics results

Variable	Observ-ed value	Unit	Mean	Std	Min	Max
GDP	300	Hundre-d million Chinese yuan	23645.8	18136.14	1350.43	101461.07
K	300	Hundre-d million Chinese yuan	16072.4	11627.13	1045.05	54632.7
L	300	Ten thousan-d	1412.3	1141.2	112.98	54632.7
AI	300	Pieces	37.2	112.4	0	1396
T	300	Hundre-d million Chinese yuan	302.18	630.8	0.57	4970.28
H	300	Years	9.23	0.91	7.23	13.4

3 Results

First, a regression of equation (3) is run to see if AI has a direct driving effect on the economy, and the results are presented in Table 2. Table 2 shows that the test coefficients for capital (LnK) and labor (LnL) are positive at the 1% significance level, while the test coefficients for technology (LnT) and human capital (LnH) are insignificant, indicating that capital and labor factors continue to drive our economy's growth [9]. The driving effect of artificial intelligence on the economy is positive at the 5% level of significance, indicating that artificial intelligence has a direct and significant impact on economic growth.

Table 2 How artificial intelligence boosts economic growth directly

Variable	
LnK	0.052*** (3.22)
LnL	0.199*** (4.74)
LnAI	0.018** (2.42)
LnT	0.003 (0.33)
LnH	0.401 (1.3)
Adjustment of R^2	0.9951
Observed value	300
Year fixed effects	controlled
Individual fixed effects	controlled

F-value	15.21

Notes: The t value is in parentheses; ***, **, * indicate statistically significant at the 1%, 5%, and 10% levels, and the constant term is not presented. The following table is identical to the previous one and will not be reproduced.

The cross product term is used to illustrate that AI may indirectly contribute to economic growth in order to assess the indirect influence of AI on economic growth. Table 3 shows that the coefficient of AI indirectly affecting the economy by increasing the market's efficiency of technological innovation is positive at the 1% level of significance, and the coefficient of AI indirectly affecting the economy by increasing the level of human capital is positive at the 5% level of significance. This suggests that artificial intelligence (AI) can indirectly boost economic growth by boosting technical innovation and human capital.

Table 3 How artificial intelligence contributes to economic growth in a non-direct way

Variable	Improving the efficiency of technological innovation	Upgrading human capital
LnK	0.054*** (3.81)	0.056*** (3.83)
LnL	0.185*** (4.50)	0.192*** (4.63)
LnAI	0.013* (1.63)	0.015** (2.13)
LnT	0.006 (0.71)	0.005 (0.68)
LnH	0.321 (1.31)	0.282 (1.12)
LnAI×LnT	0.006*** (3.21)	
LnAI×LnH		0.082** (2.50)
Adjustment of R^2	0.9953	0.9952
Observed value	300	300
Year fixed value	control	control
Individual fixed values	control	control
F-value	14.99	14.23

In order to prove the robustness of the above results, the stock of industrial intelligent robots is used instead of artificial intelligence variables to perform regression, so as to verify that artificial intelligence has direct and indirect benefits in driving economic growth. The results in Table 4 show that the benefits of artificial intelligence directly driving economic growth are positive at the 1% significance level, and the benefits of artificial intelligence improving technical efficiency and human capital indirectly promoting economic growth are positive at the 5% significance level. The robustness test result shows that the result of the main regression is robust.

Table 4 Artificial intelligence index benefits after replacement

Variable	Direct benefit	Indirect benefits	
		(1)	(2)
LnAI	0.071*** (3.11)	0.0.049** (2.10)	0.043* (1.59)
LnAI×LnT		0.007** (2.15)	
LnAI×LnH			0.103** (2.09)
Other control variables	contained	contained	contained
Adjustment of R^2	0.9952	0.9953	0.9953
Observed value	300	300	300
Year fixed value	controlled	controlled	controlled
Individual fixed values	controlled	controlled	controlled
F-value	15.12	14.70	14.57

4 Conclusions

According to the findings, AI may directly contribute to economic growth by replacing labor and increasing market technology innovation and human capital [10]. AI can also indirectly contribute to economic growth by enhancing market technological innovation and human capital. As a result, boosting AI infrastructure may help to raise economic levels, and developing AI-related skills can help to boost economic growth.

Technology research and development, which are the foundation for boosting labor productivity and an important component of the associated industrial chain, is at the heart of artificial intelligence technology [11]. AI's fundamental technology is the foundation for artificial support development, which has a big spillover effect and necessitates government-led R&D technology investment. The government should plan ahead for AI Basic Research, focus on the cutting edge of AI core technology, and expand financial investment, platform development, and policy assurance for AI infrastructure.

This study demonstrates that artificial intelligence development requires talent support, and that the number of artificial intelligence talents in China is currently insufficient, the structure is asymmetric, and an artificial intelligence talent reserve is urgently needed. To cultivate talents, talent training should rely on major university disciplines, cultivate cross-disciplinary composite talents through collaborative disciplinary training and university talent training, and promote the cultivation of cross-disciplinary AI hybrid talents on a continuous basis [12]. At the same time, our country's industrial structure needs to be continuously optimized to continuously improve the absorbency of industrial employment; to further expand capital investment of Enterprise artificial intelligence and accelerate the upgrading of artificial intelligence technology [13]. At present, our country lacks professional and excellent talents in the field of artificial intelligence, and the independent innovation and research and development capabilities of core technologies need to be improved [14]. Enterprises must improve their independent

innovation capabilities and accelerate the resolution of key technology needs for the development of artificial intelligence if they want to break technical barriers and support the development of our country's artificial intelligence innovation and industrial intelligence industry.

Because artificial intelligence can improve market innovation efficiency, it requires the availability of big data, and because China has the world's highest density and the world's largest amount of data, more than 60% of China's data is currently in the hands of the government, and these data are large, of good quality, and available, but the degree of openness is low [15]. As a result, data accessibility may be improved so that individuals, and organizations can effectively use it, and necessary rules can be developed to ensure data openness and define the scope and process of open data [16]. Open data reforms are being undertaken on all fronts, allowing qualified institutions to reprocess, categorize, and combine government-published data, as long as people' interests and public security are not threatened. It also increases open data operability, optimizes open data quantity and quality, and generates unified standard data.

References

[1] Pradhan, R.P. (2020) The dynamics among entrepreneurship, innovation，and economic growth in the Eurozone countries. Journal of Policy Modeling, 42(5): pp. 1106-1122.

[2] Zhou, B. (2020) High-quality Economic Growth under the Influence of Technological Innovation Preference in China: A Numerical Simulation from the Government Financial Perspective. Structural Change and Economic Dynamics, 54: pp. 163-172.

[3] Castano, M.， Mendez, M., & Galindo, M. (2020) The effect of social, cultural, and economic factors on entrepreneurship. Journal of Business Research, 68(7), 1496–1500.

[4] Romer P M. (1990) Endogenous technological change. Journal of Political Economy[J], 98: 71-102.

[5] Chen Yanbin, Lin Chen, Chen Xiaoliang. (2019) Artificial Intelligence, Aging and Economic Growth [J]. Economic Research, (7): 47-63.

[6] Kuo, Kai-Ming. (2019) Artificial intelligence development, industrial structure transformation and upgrading and labor income share changes[J]. Management World, (7): 60-77.

[7] Guo Han. (2019) The theoretical logic and practical path of artificial intelligence to cultivate new dynamic energy for China's economic development [J]. Journal of Northwestern University (Philosophy and Social Science Edition), (5): 21-27.

[8] Acemoglu, D., Resterepo, P. (2018) The race between man and machine: implications of technology for growth, factor shares and employment [J]. American Economic Review, 108(6):1488-1542.

[9] Acemoglu, D., Restrepo, P. (2017) Secular stagnation? The effect of aging on economic growth in the age of automation [J]. American Economic Review, 107(5): 174-179.

[10] He X L. (2015) Knowledge innovation and diffusion，inter-regional technology absorption effect and environmental pollution [J]. Nankai Economic Studies, 182 (2): 94-117.

[11] Young A. (1991) Learning by doing and the dynamic effects of international trade[J]. Quarterly Journal of Economics, 106(2): 369-406.

[12] HSU, WANG. (2019) Social entrepreneurial intentions and its influential factors: A comparison of students in Taiwan and Hong Kong[J]. Innovations in Education and Teaching International, 56(3).

[13] Liu, C. and G. Xia. (2018) Research on the Dynamic Interrelationship among R&D Investment,

Technological Innovation, and Economic Growth in China. Sustainability, 10(11).
[14] Prettner, K. (2019) A Note on the Implications of Automation for Economic Growth and the Labor Share [J]. Macroeconomic Dynamics, (23): 1294-1301.
[15] Dong, F., Y. M. Guo, Y. C. Peng, and Z. W. Xu. (2019) Economic Slowdown and Housing Dynamics in China: A Tale of Two Investments by Firms[R]. SSRN Working Paper.
[16] Wu T, Zhang N, Gui L, Wu W J. (2018) Sustainable endogenous growth model of multiple regions: Reconciling OR and economic perspectives[J]. European Journal of Operational Research, 269(1): 218-226.