

Research on the impact of artificial intelligence on economic growth

Bohan Deng

Beijing Changping District Xueweigui Training School, Beijing, China

463016093@qq.com

Abstract. Under the new wave of technical revolution. AI exert a significant influence on economic growth through its spring up. Based on this article researched "AI impact to economic growth". This article chose from 2018 to 2023 in China provincial panel data. Empirical researched those content: (1) AI impact to economic growth efficiency; (2) Researched AI and digital economy whether leverage synergistic effect. Through research finding: (1) Benchmark regression prove AI to economic growth had remarkable driving effect. (2) AI and digital economy to economic growth synergistic effect, Still to improve on. Above conclusion after in a series of robustness test still real hold. This article research conclusion to policy maker,business decision makers and researcher provide to face on challenge strategy suggestion.

Keywords: artificial intelligence, economic growth, digital economy, synergy effect

1. Introduction

In the scientific technological development quickly present era, AI have been one out of a multitude push the world economic growth core driving force. As the new wave of technical revolution famous achievement, AI through simulated human intelligence can realize automation and intelligence, Economic society various territory were permeating in unprecedented speed. From manufacturing industry intelligent manufacturing to service industry intelligent customer service, banking industry intelligent risk control to medical profession accurate judge. Use AI not only remodeling traditional industry produce pattern, but also hasten parturition new economic form and growth points.

The impact of artificial intelligence on economic growth is multi-faceted. At the micro level, enterprises can optimize their production processes, enhance operational efficiency and reduce costs by introducing artificial intelligence technology. For instance, in the manufacturing industry, intelligent robots and automated production lines have significantly enhanced production efficiency and reduced errors caused by manual intervention. In the service industry, AI customer service and intelligent recommendation systems have significantly improved service quality and customer satisfaction by accurately identifying user needs [1]. At the macro level, artificial intelligence, as an advanced production technology, has a dual driving force of both the superimposed effect and the multiplier effect on the industrial chain, which can effectively promote the coordinated development of upstream and downstream industries [2]. For instance, more related industries such as chip manufacturing, cloud computing, and big data have all achieved large-scale expansion due to breakthroughs in AI technology. Form a huge industrial cluster. However, at present, the discussions on artificial intelligence and economic growth in the literature are still scarce, and there is no definite conclusion on the transmission mechanism [2]. Based on this, this paper conducts the research on artificial intelligence and economic growth.

Based on background, This article deep discussion AI impact to economic growth effectively and action mechanism. Specific research content have: (1) AI impact to economic growth effectively; (2) Examined AI and digital economy whether leverage synergistic effect. This article innovation point have:(1) Enriched this territory literature, because AI as emerging field, one side now literature not sufficient, on the other hand during scholar as well form fit conclusion. So be necessary around this theme have deep discussion;(2) In term research perspective,this article further examination digital economy whether synergistic effect.

This article means through theoretical analysis and empirical research, system analysis AI how to driving economic growth. At the same time to policy maker,business decision maker and researcher provide to face on challenge strategy suggestion.

This article other part as follow: Literature review, Data collection and analysis,Empirical test and conclusion.

2. Literature review

This paper mainly conducts a literature review from four aspects: economic growth, artificial intelligence, literature summary and the proposal of research hypotheses. The aim is to clarify the progress and deficiencies of the current literature through literature sorting, and further provide references and determine marginal contributions for the research of this paper.

2.1. Literature review on economic growth

Since the research conducted in this paper is an empirical test, to ensure the authenticity and reliability of the data and variable determination, this paper first summarizes the measurement indicators and influencing factors of economic growth through literature review, thereby providing a reference basis for the selection of variables in this paper. At the same time, it also clarifies the theoretical basis affecting economic growth.

2.1.1. Literature review on economic growth measurement

At present, regard to economic growth measurement method have single indicator, aggregative indicator and nighttime lighting indicators and so on [3-5]. Specifically there are: (1) Real GDP. It is mainly the absolute value of the regional GDP, and this indicator is also widely used in the literature. Sun [6] analyzes the carbon trading price and the region economic growth research, according to real GDP as China economic growth measurement index. Through research discovered join in the carbon trading price increase can by some driving to economic growth. (2) Per capita GDP. Per capita GDP is another widely used measurement indicator in the literature. Through use panel fixation effect model and spatial econometrics model discuss digital infrastructure construction impact to county territory economic growth [8]. By per capita GDP as economic growth measurement index, empirical result shoes digital base facilities establishment to county territory economic growth have positive influence. Besides, through build endogeny economic growth frame, research fiscal scale, expenditure structure and economic growth relationships [8]. By per capita GDP as economic growth measurement index, empirical result shows increase public welfare projects output proportion can promote economic growth [9]. Based on economy and demographic transition new times this background, researched female friendly city economic growth effect. In researching she by region per capita GDP as economic growth measurement index. Through research discovered female friendly city economic growth effect more remarkable. Through the review of the above literature, it can be known that the advantage of per capita GDP lies in that, on the one hand, it avoids the problem of outliers, and on the other hand, it also avoids the possible heteroscedasticity problem in regression. (3) Growth rate. In the research digital new quality productivity impact to economic growth kinetic energy conversion [10]. Through choose economic growth rate index build economic growth kinetic energy conversion target system, and discovered digital new quality productivity impact to economic growth kinetic energy conversion have positive driving effect. In research its dynamics and growth effect should be for optimization technological innovation pattern, increase regional competitiveness and driving region economic growth have important meaning [11]. By real GDP growth rate China technical complexity data range as research data, discovered technical complexity increase by years, also complexity the higher technology and the slower growth rate. Xu [12] will be labor intensity bring into economic growth model. Based on through choose province data analysis labor intensity and economic growth between the two mutual relation. Through research discovered economic growth to labor intensity have prominent positive driving. Besides, Nighttime light data is measure economic growth typical indicators. (4) Nighttime light data. Through use social network analysis and spatial econometric model and so on method, by per capita GDP and nighttime light data two economic growth measure index, empirical analysis city network status impact to economic growth and mechanism, empirical result shows city network status and partner network status increase all can driving it [13]. Through will China distinctive agricultural products advantage area recognition policy regarded a quai-natural experiment [14]. By per capita GDP and nighttime light data two economic growth measure index empirical evidence, shows rely on characteristic resources motivate rural industry development vitality is the county town continues economic growth key. Research result states China distinctive agricultural products advantage area recognition policy put into effect significantly promote local county economic growth. (5) Comprehensive index. Through build economic growth multidimensional quality measurement index system, by comprehensive index evaluate method and panel threshold model regarding technological innovation to economic growth quality driving doing empirical test, states driving have region heterogeneity [15]. In economic growth quality high level region driving obviously stronger. With economy base balance level, social development and ecological environment achievement start from three dimensions, by comprehensive index evaluate method and build economic growth high quality development index doing demonstration, shows FDI to central and western regions economic growth high quality development can bring prominent positive effect [16]. It can prominent local region economic growth high level development. Liu [17] through to pension industry and tourist industry development level, coupling degree status and with economic growth relationship conduct an analysis. By comprehensive index evaluate method, coupling degree status method model and panel var model conduct an analysis, prove two

industry coupling degree status overall trend is on the rise, but all provinces and cities coupling degree status grades exist obvious difference.

To sum up, from the literature review on the measurement of economic growth indicators, it can be known that: (1) Per capita GDP can effectively avoid the problems of heteroscedasticity and extreme values of the total value; (2) Nighttime lighting data as a measurement index can effectively avoid data manipulation and statistical bias; (3) Comprehensive indicators incorporate output, economic benefits and the negative impacts brought about by output in economic growth into the assessment system, which can effectively promote the green economy.

2.1.2. Literature review on the influencing factors of economic growth

By economic growth can know that consume, investment, net export, population, technology and capital and so on factors all driving economic growth essential factor. Have more researcher around impact to economic growth conduct a discussion [18, 19].

Zhou [16] discovered FDI to central and western regions economic growth have significant promoting effect, east region are result opposite. Through research discovered digital new quality productivity to economic growth kinetic energy conversion have positive driving effect [20]. Based on China distinctive agricultural products advantage area recognition policy, check this policy impact to economic growth, researched result shows this policy significantly driving county territory economic growth [14]. In the base facility level, city network status economic growth to economic growth have prominent driving [13]. Digital economy to economic growth driving [21]. Erdogan et al. [22] discovered financial tools ICT project all effect driving economic growth. But according to literature can know, with AI to economic growth discussion insufficiency.

2.2. A literature review of artificial intelligence

AI as new technical breakthrough to produce and consume and so on multiple links all have significant changes, it can significant increase an enterprise productivity [1]. Li et al. [23] driving hospitals and the tourism industry pattern transformation. By population view as start, discuss AI to economic growth acting path [24]. Based on AI patent data, through inspect digital elements to China economic growth influence effects [11]. Discovered digital elements promote knowledge creation and driving industrial structure transformation, further promoted China region economic growth speed and total factor productivity level. Besides, some researcher have also through comparison literature analysis AI brings economic effects. Point to in the academic world, AI impact to economic growth have exist three result, respectively: driving effect, inhibiting effect and nonlinear effect, in these driving effect shows through driving total factor productivity this path realize economic growth, inhibiting effect main shows family perspective to labor force factor extrusion, thereby inhibiting family education input development and so on [2]. Specific reason in the labor force skill during AI mismatching, further cause nonlinear effect have exist. By literature can know about with AI discussion is current academic world chase hot topics. However, AI to economic growth relationship and mode action are not clearly, so that need to more discuss between the two relationship.

2.3. Summary of current literature

Through literature review, it can be known that (1) In terms of indicator measurement, the theoretical system of economic growth has developed earlier and is increasingly complete. Scholars' selection and opinions on the indicator measurement of economic growth are relatively consistent [3-5]. However, the measurement of artificial intelligence is still inconsistent. Some scholars adopt the number of patents, while others select the number of artificial intelligence enterprises. There is still no unified standard [1, 2]. (2) In the theoretical system, since technology is the key factor driving economic growth in the economic growth theoretical model, but current research still mostly focuses on the impact of labor force, investment, fiscal expenditure and international trade on economic growth. As a new product of The Times, artificial intelligence has relatively few research literatures on its impact on economic growth [18, 19]. The conclusions of the impact are inconsistent and the mechanisms are not clear [2]. To make up for the deficiencies of the current literature, this paper conducts discussions around this theme. (3) In terms of research perspectives, from the perspective of the digital economy, there is a lack of literature on the impact of artificial intelligence on economic growth [2]. Most of the research focuses on the mechanism from the aspects of labor skills matching and human capital upgrading. However, in the digital economy era, data elements are included in the table. Can this have a synergy effect with artificial intelligence?

2.4. Research hypothesis

Through above literature tease, this article find current literature following exists characteristics: (1) Regard AI to economic growth literature still less, that the influence between the two analysis and action mechanism discussion insufficiency; (2) In

digital times, data element as a property bring into production factors join the ranks, and AI have exist what kind of relationship is still not clear. Based on this, this article base in China provincial data discuss AI impact to economic growth effect and action mechanism. Through literature discussion, this article put forward research hypothesis as follow:

H1:AI can significantly promote to economic growth.

3. Data collection and analysis

3.1. Sample source

This article based from 2018 to 2023 in China provincial panel data. Build real evidence can checkout AI impact to economic growth effect and mechanism. Data chose from the EPS database, China statistic yearbook and State Statistic Bureau and so on. Ultimately, sample size as 156.

3.2. Variable definition

3.2.1. Explained variable

This article researched to economic growth. With regard to economic index definition, Already have researcher often from five dimensionality to measure it. Respectively as real GDP,per capita GDP, GDP growth rate,night lamplight data,composite index [6, 7, 11, 13, 17]. This article use for reference already have literature practice, choose per capita GDP, real GDP and GDP growth rate as economic growth proxy variable. During this article to per capita GDP use in benchmark regression, choose GDP growth as robustness test.

3.2.2. Explaining variable

With regard to AI measure,at present researcher respectively from AI patent authorizations number ,extract in the corporate annual report AI keyword, AI patents number,robots number,AI industry number [25-28]. This article use for reference already have literature practice, choose AI patents number and AI industry number as AI proxy variable.

3.2.3. Control variable

Based on already have literature, this article from population,fiscal expenditure level and industrial structure and so on dimensionality, choose this article control variable [13, 17]. Specific variable definition and formula see Table 1.

3.2.4. Mechanism variable

This paper draws on the practices of existing literature and selects the total index of digital inclusive finance released by the Digital Inclusive Finance Research Center of Peking University as the proxy variable of the digital economy [29].

Table 1. Variable selection and definition

Variable type	Variable name	Formula	Symbol
Explained variable	Economic growth	Per capita GDP	GDP
Explaining variable	AI	AI regional enterprises number	AI
Control variable	Population size	Regional total registered population number	POP
	Industrial structure	Proportion the secondary industry added value	IND
	Goods export value	Goods imported and exported value	EXPORT
	Fiscal expenditure	General budget expenditure	FISCAL
	Educational level	Educational appropriations	EDU
Mechanism variable	Digital economy	Digital financial inclusion index	DIG

3.3. Model setting

Based on this article setting reference model as Equation (1):

$$economic_{it} = \theta_0 + \theta_1 AI_{it} + \theta_i control_{it} + \delta_{it} + \gamma_{it} + \varepsilon_{it} \quad (1)$$

Among, “economic” as this article explained variable economic growth, I as region, t as years, δ_{it} as regional fixed effect, γ_{it} as time fixed effect, ε_{it} as residual term.

4. Empirical analysis

4.1. Descriptive statistics

Table 2 reported all choose variable number characteristic. Through table 2 can know about per capita GDP excessive volatility. Mean as 79181.574, maximum as 200278, mean far below the maximum, explain interzone exist economic growth disequilibrium phenomenon. By table 2 can know about region AI industry number have large variance, variance as 29296.114, minimum and maximum excessive gap. Also state interzone AI have major difference.

Table 2. Variable descriptive statistics list

Variables	Obs	Mean	Std. Dev.	Min	Max	p1	p99	Skew.	Kurt.
GDP	156	79181.574	36305.551	31336.125	200278	32994.559	190321	1.385	4.428
AI	156	22954.167	29296.114	538	195759	682	157341	2.759	13.05
IND	156	37.667	7.796	14.9	54	15.8	51.9	-1.098	4.06
POP	156	4990.288	3000.24	587	12706	590	12684	.736	2.858
EXPORT	156	8.544	1.647	3.135	11.327	3.444	11.327	-.827	4.262
FISCAL	156	8.776	.53	7.407	9.827	7.433	9.827	-.549	3.238
EDU	130	16.472	.643	14.786	17.941	14.878	17.913	-.352	3.211
DIG	156	5.864	.134	5.573	6.211	5.587	6.17	.157	2.517

4.2. Correlation analysis

This table 3 reported variable relative coefficient. By AI to GDP coefficient is 0.667, coefficient is positive, so between the two have positive correlation. Explain research hypothesis is set up. This article follow up through check it.

Table 3. Correlation analysis list

Variables	GDP	AI	IND	POP	EXPORT	fiscal	EDU	DIG
GDP	1.000							
AI	0.677***	1.000						
IND	0.405***	0.138*	1.000					
POP	0.390***	0.529***	0.305***	1.000				
EXPORT	0.708***	0.606***	0.299***	0.763***	1.000			
FISCAL	0.481***	0.524***	0.385***	0.917***	0.826***	1.000		
EDU	0.772***	0.731***	0.178**	0.346***	0.602***	0.464***	0.544***	
DIG	0.772***	0.731***	0.178**	0.346***	0.602***	0.464***	0.544***	1.000

4.3. Reference regression

By table 4 reported reference regression result. Table 4 only add control variable, Table 4 (2) in Table 4 (1) based control year fixed effect. Table 4 (3) in Table 4 (1) based control regional fixed effect. Within brackets as regression result robust standard error. By Table 4 (1)-(3) AI coefficient respectively 0.047, 0.067 and 0.054. It is observed that AI significantly promote economic growth, that same with theoretical research [6, 7]. This result explain AI as technological innovation can improve effectively productivity, and then to economy have driving effect. By Table 4 industrial structure coefficient can know about industrial structure significantly advance economic develop, between the two have positive relation. State industrial optimize contribute to driving economic develop. By variable pop coefficient know about population to economic growth have inhibiting effect. Get into it behind reason may lie in aging of population and structure disequilibrium. By exit coefficient get export driving economic

growth, export is boost economic growth one of the three horsemen. Table 4 (1)-(2) can know about fiscal expenditure regression coefficient is significantly positive. State appropriate fiscal stimulus contribute to driving economic growth. Table 4 (1)-(3) can know about educational significance driving economic growth. Explain human capital input contribute to increase total factor productivity, further effective stimulation economic growth.

Table 4. Baseline regression analysis

VARIABLES	(1)	(2)	(3)
AI	0.047*** (0.017)	0.067** (0.027)	0.054** (0.022)
IND	0.012*** (0.002)	0.012*** (0.002)	0.011** (0.004)
POP	-0.859*** (0.050)	-0.858*** (0.050)	-1.018 (0.857)
EXPORT	0.192*** (0.013)	0.181*** (0.017)	0.123* (0.067)
FISCAL	0.413*** (0.082)	0.439*** (0.087)	-0.130 (0.186)
EDU	0.297*** (0.100)	0.278*** (0.102)	0.579*** (0.199)
Constant	7.274*** (0.773)	7.294*** (0.771)	9.420 (6.628)
YEAR	NO	YES	NO
PRO	NO	NO	YES
Observations	130	130	130
R-squared	0.918	0.919	0.984

NOTE: Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4.4. Mechanism test

By Table 5 based on digital economy perspective carried out mechanism test, have tested AI and digital economy to economic growth synergistic effect. By Table 5 (1) and (2) can know about digital economy contribute to driving economic growth, but between the two synergy effect is negative. That show between the two synergy may exist non linear relationship, still need to further on in depth inspection. But by AI and dig all significantly promote economic growth, which explain digital times and AI development are economic growth new engine.

Table 5. Mechanism test—based on digital economy perspective

VARIABLES	(1)	(2)
AI	0.581 (0.464)	0.584** (0.287)
DIG	2.526*** (0.761)	1.627*** (0.408)
DIG*AI	-0.095 (0.080)	-0.100** (0.049)
IND	0.010*** (0.002)	0.014*** (0.004)
POP	-0.598*** (0.082)	0.099 (0.922)
EXPORT	0.115*** (0.020)	0.148*** (0.056)
FISCAL	0.387*** (0.080)	-0.187 (0.180)
EDU	0.105 (0.098)	0.388 (0.308)
Constant	-5.198 (4.444)	7.294*** (0.771)
YEAR	YES	NO
PRO	NO	YES
Observations	130	130
R-squared	0.936	0.986

NOTE: Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4.5. Robustness test

By Table 6 based on the reference regression, take it one step further robustness test. Excluded municipalities make regression discovery AI can still significantly promote economic growth. State reference regression accuracy and robustness.

Table 6. Robustness test—exclude municipalites

VARIABLES	(1)	(2)
AI	0.093*** (0.027)	0.058** (0.023)
IND	0.015*** (0.002)	0.010** (0.004)
POP	-0.681*** (0.074)	-0.942 (0.934)
EXPORT	0.157*** (0.020)	0.151** (0.071)
FISCAL	0.309*** (0.114)	0.192 (0.217)
EDU	0.203** (0.098)	0.279 (0.215)
Constant	7.981*** (0.702)	10.462 (7.676)
YEAR	YES	NO
PRO	NO	YES
Observations	115	115
R-squared	0.886	0.977

NOTE: Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4.6. Summarize

Through Part 4 empirical test, this article reach empirical part conclusion as follow:

(1) Reference regression shows AI to economic growth have significant driving, at same time industrial structure to economic growth have significant driving. But population to economic growth have significant inhibiting effect, it state population aging and structural imbalance and more population problem will inhibit economic growth. With already literature same as export significant driving economic growth. In addition to loose fiscal policy can effectively driving economic growth. At same time increase investment in education can also to effectively rise output.

(2) Based on digital economy perspective carried out mechanism test, have tested AI and digital economy to economic growth synergistic effect. Mechanism test result shows digital times and AI development are economic growth new power, but between the two synergistic effect still need to deep increase.

(3) Will be sample exclude municipalities robustness test is performed, discover AI still to significantly driving economic growth. It shows reference regression accuracy and robustness.

5. Conclusion

5.1. Research conclusions

In the digital wave and scientific technical revolution rapid develop era, clear up the AI impact to economic growth effect and mechanism action. To driving economic growth and AI development particular importance. Based on above background, this article researched AI impact to economic growth and inspected AI and digital economy whether gave paly to synergistic effect. Through researched discovery:

(1) Reference regression shows AI to economic growth have significance driving [6, 11]. At same time, industrial structure to economic growth significance development, but population to economic growth have significance inhibiting effect. It shows population aging and structure disequilibrium and more population problem will inhibit economic growth, with already literature same as export significance driving economic growth. Besides, loose fiscal policy can valid driving economic growth and increase investment in education can valid rise output.

(2) Mechanism test result shows digital times and AI development are economic growth new power, but between the two synergistic effect still need to deep increase [11].

(3) Robustness test discover AI still prominent increase economic growth, it shows reference regression accuracy and robustness.

5.2. Policy suggestion

Based on above findings, this article put forward policy suggestion as follow:

5.2.1. Increase support AI research and development

In technological innovation level, should increase to AI base research input. Driving arithmetic, computing power and data technique collaborative breakthrough; In industrial application level, need structure "AI+" integrated innovation system, promote AI and traditional industries deep fuse; In employment market level, should perfect skill training and re-employment support system, help worker adapt to technological changes.

5.2.2. Driving digital economy and AI deep fuse

In international cooperation level, should driving set up global AI governance framework, coordinate data flow, technical standard and ethical norm. Avoid to technological monopoly and digital chasm expansion. Use for reference international advanced experience intensify digital economy and AI deep fuse stick together, thus more efficient driving economic growth.

5.2.3. Strengthen AI top level design

Need all sectors of society common face to technical ethics, data security and social equity and more challenge. Guarantee AI development conform to human society overall interests. Only so, AI only then can one truly become driving economic high quality development "leading wild goose" power, lead to human society march toward more intelligent, efficient and sustainable future.

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