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Can Artificial Intelligence Enhance Urban Economic Density: Evidence from 276 Cities

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ABSTRACT

This paper explores the impact of artificial intelligence (AI) technologies on urban economic density, conducting an empirical analysis based on evidence from 276 cities. The article first describes how AI technology, as a key driver of economic growth, has a profound impact on the global economic landscape by optimizing production processes, improving decision-making efficiency and creating new business models. As the center of economic activities, the improvement of urban economic density is closely related to the improvement of urban infrastructure, talent agglomeration and policy support. Through quantitative analysis, this paper studies the relationship between AI technology development and urban economic density, and puts forward the hypothesis that AI technology can significantly improve urban economic density by promoting the optimization of industrial structure and the improvement of talent concentration. By constructing a fixed effect model and using Stata software to conduct multiple regression analysis, the results show that AI technology has a significant positive promotion effect on urban economic density. Therefore, this paper puts forward policy suggestions such as building an urban innovation ecosystem with AI as the core, promoting industrial intelligent upgrading, strengthening data governance and privacy protection, and strengthening international cooperation, aiming to maximize the positive effect of AI technology and promote the sustainable development of urban economy.

KEYWORDS

Artificial Intelligence; Urban Economic Density; Industrial Upgrading

1. INTRODUCTION

In today's world, artificial intelligence (AI) has become one of the key technologies driving economic growth, moving faster and reaching farther than any other technological revolution in history. AI technology is profoundly changing the global economic landscape by optimizing production processes, improving decision-making efficiency and creating new business models. As the center of economic activities, the development of cities is directly related to the level of national and even global economic development. Urban economic density, as an indicator to measure the concentration of urban economic activities, not only reflects the prosperity of urban economy, but also is an important symbol of urban competitiveness and sustainable development ability.

The advancement of economic globalization has accelerated the global flow of capital, technology, information and talents. With the acceleration of urbanization, more and more people pour into cities, the scale of cities keeps expanding, and the economic density keeps increasing. However, urbanization also brings a series of problems, such as traffic congestion, environmental pollution, and resource constraints, which pose challenges to the sustainable development of cities.

The rise of artificial intelligence technology provides a new solution to solve the problems in the process of urbanization. The application of AI technology in traffic management, environmental

monitoring, resource allocation and other fields can help improve the efficiency of urban management and alleviate the negative impact of urbanization. At the same time, the development of AI technology also provides new impetus for the transformation and upgrading of urban economy. Through intelligent transformation, traditional industries can improve production efficiency, reduce costs and enhance competitiveness; Emerging industries, such as intelligent manufacturing and intelligent services, have injected new vitality into urban economic development.

The increase of urban economic density is the result of the joint action of many factors. In addition to the development of AI technology, it also includes the improvement of urban infrastructure, the agglomeration of talents, and policy support. The improvement of urban infrastructure provides a material basis for the development of economic activities; The gathering of talents provides intellectual support for urban economic development. The policy support of the government has created a good external environment for the prosperity of the urban economy. These factors influence each other and jointly promote the improvement of urban economic density.

Although the influencing mechanism of AI technology on urban economic density is not fully clear, previous studies have shown that there is a positive correlation between the development of AI technology and urban economic density. The application of AI technology can improve production efficiency, promote industrial upgrading, attract the agglomeration of capital and talents, and thus improve urban economic density. However, the development of AI technology may also bring some negative effects, such as labor substitution and widening income gap, etc. These problems need to be fully considered and solved while promoting the development of AI technology.

At present, there are still relatively few studies on the impact of AI technology on urban economic density, and the existing studies mostly focus on theoretical discussion and qualitative analysis, lacking large-scale empirical analysis. In this study, 276 cities were selected as samples to explore the relationship between AI technology development and urban economic density through quantitative analysis, aiming to provide scientific basis for relevant policy making, which has important theoretical and practical significance for promoting the sustainable development of urban economy.

With the continuous development and application of AI technology, its impact on urban economic density will become more and more significant. This study will comprehensively analyze the influence mechanism of AI technology on urban economic density from multiple dimensions, and provide new ideas and strategies for the sustainable development of urban economy. We expect that through the deepening of this research, we can contribute to the prosperity of urban economy and the sustainable development of the city.

2. LITERATURE REVIEW AND ARTICLE HYPOTHESES

2.1. Artificial Intelligence

Artificial intelligence (AI), as an interdisciplinary research field, traces its development history back to the middle of the 20th century. Early AI research mainly focused on logical reasoning, problem solving and knowledge representation. Over time, machine learning (ML), an important branch of AI, enables computers to learn from experience and make decisions through data-driven methods. In recent years, deep learning (DL), as a subset of ML, has greatly promoted the application of AI in image recognition, natural language processing and other fields by simulating the neural network structure in the human brain.

The development of AI technology has had a profound impact on the economy. Some scholars have pointed out that AI technology has become a key factor driving economic growth by increasing productivity, reducing costs and creating new products and services. At the same time, AI technology

is also triggering major changes in the labor market, with the trend of automation and intelligence likely to replace some jobs while also creating new ones.

2.2. Urban economic Density

Urban economic density refers to the concentration degree of economic activities in a certain area, which is an important indicator to measure the vitality and competitiveness of urban economy. The increase of urban economic density is usually closely related to factors such as the city's innovation ability, industrial agglomeration and talent concentration. The study shows that the improvement of urban economic density helps to promote knowledge spillover, improve production efficiency and attract external investment.

The measurement of urban economic density usually involves multiple economic indicators, such as GDP, employment rate, number of enterprises and innovation output. The increase of urban economic density is considered as an important phenomenon in the process of urbanization, which reflects the quality of urbanization and the level of urban development.

2.3. Relationship Between Artificial Intelligence and Urban Economic Density

Although the impact of AI technology on economic growth is widely recognized, there is relatively little research on how AI affects urban economic density. Some studies have shown that AI technology helps to increase urban economic density by promoting industrial upgrading and innovation. The application of AI technology can improve production efficiency and reduce production costs, thus attracting more enterprises and capital to concentrate in cities.

However, some studies have pointed out that the development of AI technology may have a negative impact on urban economic density. For example, AI technology may replace certain low-skilled labor, leading to a rise in unemployment and a widening income gap, which in turn affects the economic and social stability of cities. In addition, the development of AI technology may exacerbate the economic differentiation within cities, making the economic density of technology-intensive areas further increase, while non-technology-intensive areas may face the risk of economic recession.

To sum up, the relationship between AI technology and urban economic density is complex and multidimensional. Future research is needed to further explore the specific impact of AI technology in different cities, different industries, and different social groups, as well as how to maximize the positive effects of AI technology while reducing its potential negative effects through policy interventions. Accordingly, this paper proposes hypotheses

Hypothesis H1: AI can improve urban economic density

3. EMPIRICAL ANALYSIS

3.1. Descriptive Statistical Analysis

In order to more intuitively show the mathematical characteristics of all variables and indicators used in this paper, descriptive statistical analysis will be carried out in this section. This paper selects the panel data from 2010 to 2019 as the data of the empirical part. The explained variable is the urban economic density, which is characterized by the ratio of the gross regional product to the land area of the administrative region. This paper holds that the higher the ratio is, the higher the economic density of the city is; The core explanatory variable is "ai." The more industrial robots there are, the higher the level of artificial intelligence development in the local area that year. Due to the large amount of data, this paper uses "ten thousand units" as the unit of this variable.Table1 is the descriptive statistical analysis of the above two variables.

Table 1. Descriptive statistical analysis

VarName	Obs	Mean	SD	Min	Median	Max
density	3311	0.3393	0.806	0.00	0.14	15.36
ai	3311	5.7675	1.293	1.10	5.71	10.57

3.2. Multiple Regression Analysis

In order to more accurately explore and present the relationship between explanatory variables and explained variables, after model testing, this paper decides to build the following multiple regression models:

$$\text{density}_{it} = \alpha + \beta ai_{it} + u_{it} + \varepsilon_{it} \quad (1)$$

The explained variables and explanatory variables in the above equation have been introduced in the previous paper, so this paper will only introduce the remaining part of the equation in this part. Since the formula fixed the time effect and the regional effect, "i" and "t" are marked in the subscript to represent the data of a variable in the "t" year of the "i" city. α is the intercept term of the equation, and β is the coefficient of explanatory variable, which represents the degree of influence of explanatory variable on explained variable; u is a dummy variable with double fixed effects and ε is a random disturbance term. Table 2 shows the results obtained after importing the equation and related data in the equation into stata software for multiple regression analysis.

Table 2. Multiple regression analysis

	(1)	(2)
	density	density
aipatent2	0.218***	0.073***
	(0.010)	(0.026)
_cons	-0.918***	-0.140
	(0.060)	(0.121)
N	3311	3311
F	460.413	23.871
r2	0.122	0.087

It can be seen from Table 2 that after the fixed time and regional utility model, the positive promoting effect of ai variable on structure variable is significant at the level of 1%, that is, improving the development level of AI can significantly promote the optimization of employment structure. Therefore, Hypothesis H1 is proved.

4. CONCLUSION AND POLICY SUGGESTIONS

Through empirical analysis, this paper concludes that artificial intelligence can improve urban economic density, and its mechanism may be that artificial intelligence can promote the optimization of industrial structure and improve the concentration degree of talents.

In view of the impact of artificial intelligence on the urban economic density, this paper puts forward the following policy suggestions:

Build an urban innovation ecosystem with artificial intelligence as the core. Policy makers should be committed to building an urban innovation ecosystem with AI at its core. This includes investing in AI research and development and encouraging universities and research institutes to partner with companies to jointly drive technological innovation. At the same time, the government should provide policy support and tax incentives to attract top talents and start-ups in the AI field at home and abroad,

and promote knowledge exchange and technology transfer. In addition, innovation incubators and accelerators will be established to provide AI start-ups with necessary resources and guidance to help them grow rapidly.

Promote the intelligent upgrading of industries and optimize the urban economic structure. City governments need to formulate clear industrial intelligent upgrading plans, especially for those cities where traditional industries are concentrated. It helps enterprises adopt AI technology to improve production efficiency and product quality by providing subsidies for technology upgrading, low-interest loans and professional consulting services. At the same time, the government should guide capital flow to high-tech industries and modern service industries to promote the optimization and upgrading of industrial structure. In addition, vocational training and lifelong learning systems should be strengthened to help the workforce adapt to new employment patterns and reduce social costs caused by technological change.

Strengthen data governance and privacy protection to ensure sustainable development. With the development of AI technology, data has become a key resource. The government needs to formulate strict data governance policies to ensure the safe, legal, and efficient use of data. At the same time, the protection of personal privacy should be strengthened to avoid data abuse and privacy leakage. Promote the establishment of a data sharing platform, promote the circulation and utilization of data in different industries and fields, and provide data support for the development of AI technology. In addition, enterprises are encouraged to adopt environment-friendly AI solutions to reduce energy consumption and environmental pollution, and promote the green development of the urban economy.

Strengthen international cooperation and enhance the global competitiveness of cities. In the context of globalization, city governments should actively participate in international cooperation to enhance the global competitiveness of cities. By establishing cooperative relationships with international partners, we will share the experience and achievements of AI technology development. Participate in the formulation of international standards and promote the global recognition and application of AI technology. At the same time, international platforms should be used to attract foreign investment and talents to enhance the international influence of the city. In addition, local enterprises are encouraged to "go global", participate in international market competition, and enhance the technological level and brand influence of local enterprises through international cooperation.

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