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The Impact of Smart City Construction on China's Urban Economic Development: Empirical Tests based on DID

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Abstract

Based on the data of 161 prefecture-level cities in China from 2006 to 2020, the smart city pilot is used as a quasi-natural experiment, and the DID is used to test the impact of smart city construction on the economic development of China's cities. It is found that smart city construction significantly improves the level of urban economic development in China. For the control variables, the promotion effect of fixed asset investment on economic growth is weakened; population density contributes to urban economic development; the degree of openness to the outside world improves the core competitiveness of the city; and the level of financial development and transport accessibility have inhibitory and promotional effects on the urban economic development, respectively, but none of them is significant.

Keywords

Smart City; Urban Economy; Double Difference; Policy Effect.

1. Introduction

With the development of the times and social progress, the construction of smart cities has gradually come into people's view. This is mainly due to the popularity of network technology, which enables people to achieve the satisfaction of various life needs through the Internet. For example, smart parking, smart home, etc., these smart lifestyles have begun to take shape in various cities[1]. Smart city is a new type of urban development with intelligent, digital and information characteristics, the core of which lies in the use of big data, the Internet of Things, cloud computing and other information technologies to promote the development of the city in the direction of digitalisation and intelligence, and to improve the operational efficiency of the city[2].

Since IBM put forward the concept of "Smart Earth" in 2008, countries around the world have gradually promoted the construction of urban intelligence, including China's pilot smart city policy formally launched in 2012. Academics have conducted a lot of discussions and put forward constructive ideas around the construction of smart cities[3].

Although the construction of smart cities in China is only in the primary stage, and it is difficult to form an effective connection between many smart technologies and real life, it is believed that the effective integration of the two can be achieved in the near future, when the construction of smart cities will further drive and help the high-quality development of urban economy.

As an emerging model of urban development, smart city not only puts forward requirements and goals for China's urban development, but also provides an emerging power for urban economic growth. In nearly ten years of development, practice shows that smart city pilot construction is of great significance to the development of urban economy, but up to now, the research on the relationship between smart city construction and urban economic development in the academic world is still in the theoretical stage, and there is a lack of quantitative research, such as the assessment of policy effects. Therefore, it is of great practical significance to take smart city pilot construction as a quasi-natural experiment to empirically assess its policy effects[4].

2. Literature Review

In the past decade, with the rapid development of industrialisation and urbanisation, the ensuing discussion on smart city construction has been increasing. Academic research involving smart cities mainly includes two aspects: the definition of the connotation of smart cities and the assessment of the policy effects of smart city construction.

Smart city is a multidisciplinary field, and there are different views on its definition in academia. Zhang et al. (2013) consider smart city as an evolutionary process of urban development. They divided smart cities into four stages: e-city, digital city, smart city and intelligent city, arguing that the development of information technology promotes the urbanisation process[5]. Shi et al. (2018) believe that smart cities mainly apply information and communication technologies, such as the Internet of Things, the Internet and artificial intelligence, to integrate social resources and factors of production, and to promote the development of various fields, such as enterprise production, government governance and residents' lives[6]. They emphasise that the core of smart cities is the application of technology and the integration of resources. Through a study of smart city literature, Fu (2019) argues that smart cities combine innovative management concepts and sustainable development strategies, and are committed to building cities that are efficient in the use of resources, ecologically livable and sustainable[7]. In summary, although there is no clear definition of a smart city in academia, it can be viewed as an evolutionary process of urban development that uses modern technological means to create a new urban pattern and promote the high-quality development of the urban economy. The key to smart cities is the application of information technology, resource integration and sustainable development concepts to enhance urban management, quality of life and economic vitality.

In terms of assessing the policy effects of smart city construction, academics mainly use DID as a research method. Using data from 282 prefecture-level cities in China, Fu et al. (2019) used the double difference (DID) model and found that smart city construction can promote regional innovation and development[8]. They found that this effect has a high correlation with regional human capital, administrative rank and location differences. Zhang et al. (2020), based on a sample of 212 prefecture-level cities, used a double-difference (DID) model and found that smart city construction can enhance regional green efficiency, but there is regional heterogeneity in this green efficiency[9]. Zhao(2020) assessed the impact of smart city construction policies on the quality of urban development based on a multi-period double-difference (DID) approach and found that smart city policies have a significant impact on the quality of urban development[10]. Therefore, this paper aims to study the impact of China's smart city construction on the high-quality development of urban economy by applying the DID method to provide theoretical reference for smart city construction. These studies can provide policymakers with important insights about the effects of smart city construction policies to guide future urban development and policymaking.

3. Theoretical Framework

In the current highly open economy, smart cities offer great advantages for economic development. The following are the advantages demonstrated by smart cities empowering economic development:

First, smart cities promote urban economic development through resource allocation effects. The construction of smart cities has given rise to new forms of digital development, promoting the integration and interconnection of digital platforms such as the Internet and the Internet of Things. This enables enterprises to better grasp market information and solve problems such as resource mismatch, thus improving the efficiency of resource allocation. Second, the construction of smart cities has a significant innovation effect. The construction of smart cities cannot be separated from the support of the information technology industry, which in turn promotes the intelligence of city management and operation, which is conducive to the long-term development of the city. At the same time, smart city construction also cultivates new economic growth drivers and provides favourable conditions for the emergence of innovative industries. Thirdly, smart city construction has improved government openness in areas such as government management and organisational coordination through technologies such as big data and cloud computing. This helps avoid problems such as rent-seeking power and promotes the free flow of innovative factor resources, thus creating a fairer and more open environment for economic development.

In conclusion, smart cities make use of advanced information technologies such as artificial intelligence, the Internet of Things and the Internet to reshape the power structure and effectiveness of urban economic development. Through resource allocation effects, innovation effects and improved openness in government administration, smart cities provide a powerful impetus for high-quality economic development.

4. Research Design

4.1. Model Setting

Smart cities apply new-generation information technology to various fields, which is of great significance for new urbanisation and city construction. The purpose of this paper is to assess the impact of smart city construction on urban economic development through double difference modelling (DID) based on the first batch of smart city pilot cities announced by the Ministry of Housing and Construction (MOHURD) in 2012. In this paper, the smart city pilot cities are taken as "quasi-natural experiments", and the smart cities announced in 2012 are defined as the experimental group, while the non-pilot cities are defined as the control group. This paper refers to the method of Wang and Zhou[4] (2021), and constructs the following double-difference model:

$$\ln gdp_{it} = \beta_0 + \beta_1 treat_{it} \times post_{it} + \sum_{i=1}^{n} \beta_j X_{it} + u_i + \lambda_i + \varepsilon_{it}$$

Using did_{it} to replace the cross term $treat_{it} \times post_{it}$, the equation can be transformed:

$$\ln gdp_{it} = \beta_0 + \beta_1 did_{it} + \sum_{i=1}^{n} \beta_j X_{it} + u_i + \lambda_1 + \varepsilon_{it}$$

where i and t are individual and time, respectively, u_i and λ_i are individual and time fixed effects, ε_{it} is a time perturbation term, and X_{it} is a control variable. $\ln gdp_{it}$ is an explanatory variable, expressed in terms of the real GDP of the city, representing the level of economic development of city i in year t. did_{it} is a policy interaction term that takes the value of 0 or 1. When city i determines to establish a smart city in year t, $did_{it} = 1$ in year t and subsequent years of its determination, and 0 otherwise. With reference to the existing literature, this paper

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chooses the level of fixed asset investment, population density, degree of openness to the outside world, level of financial development and transport accessibility as control variables. The level of fixed asset investment is expressed as the proportion of fixed asset investment to GDP; population density is expressed as the proportion of resident population to urban area at the end of the year; the degree of openness to the outside world is expressed as the proportion of the total amount of imports and exports to GDP; the level of financial development is expressed as the proportion of the balance of loans from financial institutions to GDP at the end of the year; and the degree of transport access is expressed as the amount of goods transported by road per square kilometre.

4.2. Data Sources and Descriptive Statistics

The data used in this paper come from China Statistical Yearbook and China Urban Statistical Yearbook, spanning from 2006 to 2020. In order to ensure the consistency of the data, this paper deletes the cities that have undergone administrative division adjustments, and retains 161 of China's first batch of smart city pilot cities and control cities as research objects. For the existence of missing data, this paper adopts the method of mean interpolation to fill in in order to get balanced panel data. The following are the basic statistical results of each variable:

Table 1. Descriptive statistics of variables

Variable	Obs	Mean	Std	Min	Max
lnGDP	240	6.4271	1.0088	4.1257	9.2149
lnIFA	240	-0.3312	0.4856	-1.7810	0.6163
lnPD	240	5.9918	0.8337	3.6807	7.1242
lnTV	240	-2.4748	0.9677	-4.6776	-0.3503
lnFLB	240	-0.1469	0.3164	-1.1340	0.7317
lnRFV	240	-0.1735	1.1934	-3.8381	1.8966

5. Empirical Analysis

5.1. Common Trend Hypothesis Test

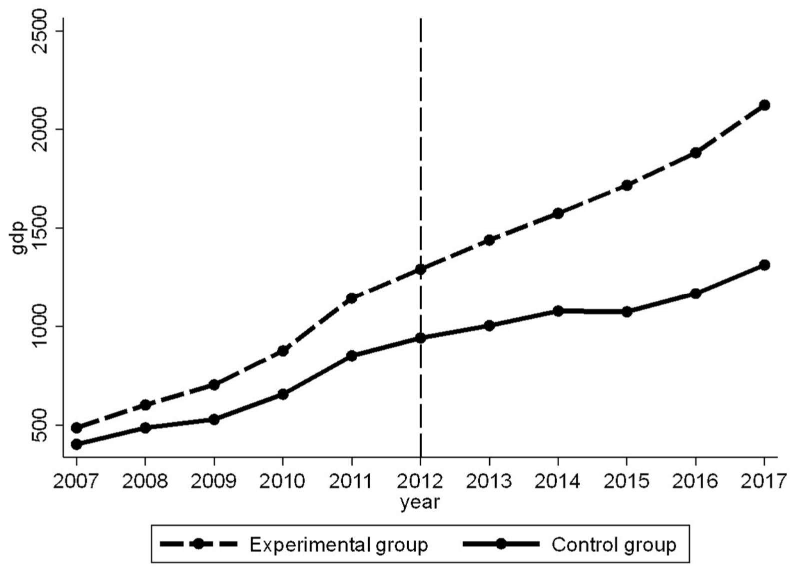

Figure 1. Parallel trend test

In order to satisfy the common trend hypothesis premise of DID, this paper draws a parallel trend graph to test whether the experimental group and the control group have the same trend of change before the start of the smart city pilot. According to the results of the parallel trend test, before the promulgation of the smart city pilot list in 2012, the experimental group and the control group showed a clear trend in the level of urban economic development. However, from 2012 onwards, the trends of the two groups are no longer parallel and the gap gradually widens. This indicates that the difference in the level of urban economic development in China is indeed caused by the construction of smart cities.

5.2. Benchmark Regression

The rejection of the original hypothesis was determined by the Hausman test before the benchmark regression, so this paper chooses the two-way fixed-effects model for double differencing to examine the impact of the smart city pilot on the city's economic development. As can be seen from the regression results in Table 2, the regression coefficient in Column (1) is 0.0774 and significant at the 5% level when no control variables are added, while the coefficient of the smart city pilot term changes from 0.0667 to 0.0756 and basically stays significant in the process of adding the five control variables one by one, such as the level of investment in fixed assets, population density, the degree of openness to the outside world, the level of financial development and the degree of accessibility to the outside world. The coefficients of the core explanatory variables after adding the control variables are close to the magnitude of the coefficient values of the univariate analysis, indicating that the regression results are highly robust. Meanwhile, from the statistical significance of the regression results, compared with the cities not included in the smart city construction, the economic development level of the smart city pilot cities increased by an average of 7.56%, which indicates that there is a significant positive correlation between the construction of the smart city and the city's economic development, i.e., the construction of the smart city promotes the development of the city's economy.

Table 2. Benchmark regression

variable	(1)	(2)	(3)	(4)	(5)
did	0.0774**	0.0667*	0.0328	0.0721**	0.0756**
	(2.34)	(1.92)	(0.95)	(2.48)	(2.25)
lnIFA		-0.2531***	-0.2657***	-0.2576***	-0.2512***
		(-5.41)	(-6.23)	(-6.33)	(-6.21)
lnPD			0.3165***	0.1742***	0.1841***
			(6.05)	(3.25)	(3.25)
lnTV				-0.1451***	-0.1333***
				(-6.26)	(-5.31)
lnFLB					-0.0479
					(-0.65)
lnRFV					0.0244
					(1.34)
_cons	5.4413***	6.3781***	4.5573***	4.6584***	4.7826***
	(432.21)	(323.35)	(13.23)	(14.67)	(14.53)
time effect	*YES*	*YES*	*YES*	*YES*	*YES*
individual effect	*YES*	*YES*	*YES*	*YES*	*YES*
N	2415	2415	2415	2415	2415

Note: *, **, ***, indicate passing the 10 per cent, 5 per cent and 1 per cent significance tests, respectively.

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From the perspective of control variables, the regression coefficient of the level of fixed asset investment is significantly negative at the 1% level, which may be due to the fact that the promotion effect of fixed asset investment on economic growth is weakened in the new stage of development, and too much fixed asset investment has brought about problems such as ineffective investment and resource mismatch; the regression coefficient of the population density is significantly positive at the 1% level, which may be due to the fact that an increase in the labour supply brought about by the increase in population density has played a boosting role for the The regression coefficient of population density is significantly positive at the 1% level, which may be due to the increase in labour supply brought by the increase in population density, which is a boost to the economic development of the city; the regression coefficient of the degree of openness to the outside world is significantly positive at the 1% level, which indicates that the investment of foreigners in the city brings a large amount of capital, technology and talents, which improves the core competitiveness of the city, and creates a good external environment for the economic development; the regression coefficients of the level of financial development and the degree of accessibility to the traffic are negative and positive, and are insignificant.

6. Robustness Tests

6.1. Placebo Test

In the process of smart city construction, in addition to the impact of smart city pilots, there may be some unmeasured factors that lead to the widening of the gap in the level of urban economic development. In order to verify whether the widening of the gap in urban economic growth by smart city construction is indeed due to smart city construction, this paper conducts a placebo test, drawing on the research methodology of Liu et al[11]. In this test, a sample of 161 cities in 2001 was retained, and eight cities were randomly selected as the experimental group, and this operation was repeated 400 times, and the coefficients of the placebo results were extracted and graphed as shown in Fig. 1, which indicates that the role of smart city construction on urban economic development is relatively robust, and it does indeed contribute to the development of the urban economy.

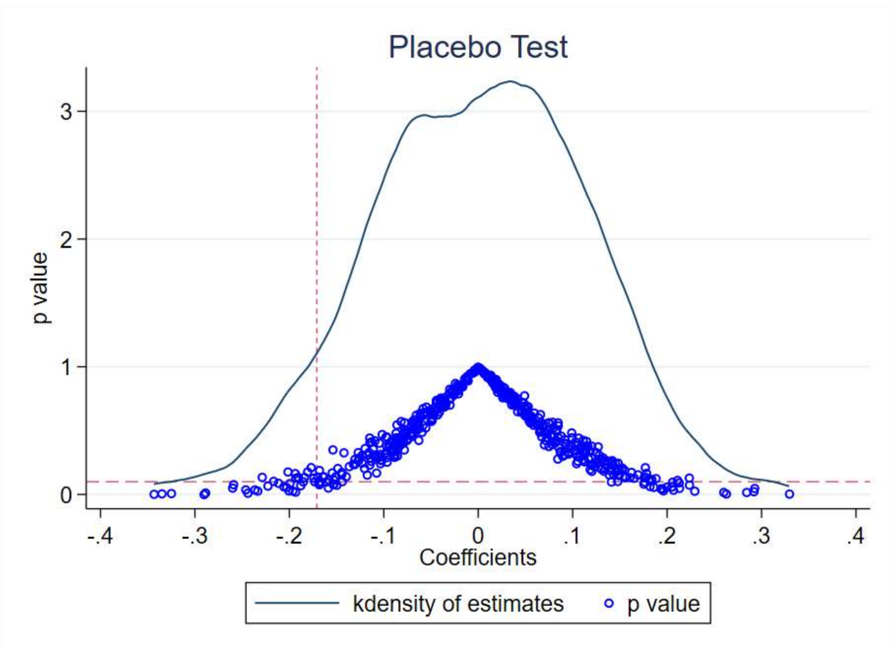

Figure 2. Placebo test

6.2. Tailoring

This paper draws on the method of Yang et al[12]. to carry out the 1 per cent tailing treatment for the explanatory variables and the core explanatory variables, replacing the "singular values" outside the 1st and 99th percentiles with the data in the 1st and 99th percentiles, and then carrying out the DID baseline regression to test the robustness of the model again, which is not difficult to find out from the Column (1) of Table 3. From column (1) in Table 3, it is easy to find that the estimated coefficients of the smart city pilot are still positive at the 5% significance level after the shrinking treatment, and the magnitude of the regression coefficients is similar to that of the benchmark regression results, which verifies the robustness of the regression results and conclusions in the previous section.

6.3. Lagging All Explanatory Variables by One Period

Given that smart city construction may have a time lag effect and does not immediately have an impact on the widening of the city's economic development gap, this paper draws on Li Qiang [13]and Zhang Hua's[14] approach to mitigate the endogeneity problem by re-running the DID differentials with one period lag for all explanatory variables. The results are shown in column (2) in Table 3. As can be seen from the results, the regression coefficient of the smart city pilot is 0.0755 and passes the 5% significant level test, which indicates that the smart city construction has a significant promotional effect on the city's economic development, and also verifies the conclusion of the previous paper.

Table 3. Robustness test

variable	(1)	(2)
did	0.0668**	0.0755**
	(2.07)	(2.16)
lnIFA	-0.2424***	-0.1823***
	(-5.73)	(-3.92)
lnPD	0.1781***	0.1099*
	(3.35)	(1.87)
lnTV	-0.1449***	-0.1222***
	(-5.51)	(-4.31)
lnFLB	-0.0201	0.0321
	(-0.35)	(0.52)
lnRFV	0.0234	0.0239
	(1.07)	(1.00)
_cons	4.9014***	5.4639***
	(16.52)	(16.70)
time effect	*YES*	*YES*
individual effect	*YES*	*YES*
N		

Note: *, **, ***, indicate passing the 10 per cent, 5 per cent and 1 per cent significance tests, respectively.

7. Conclusion and Recommendations

7.1. Research Conclusion

Based on the panel data of 161 prefecture-level cities in China from 2006 to 2020, this study evaluates the impact of smart city construction on China's urban economic development by using the double-difference model, taking the prefecture-level cities with smart city pilots as the experimental group and the cities without smart city pilots as the control group. The results of the study show that smart city construction has a significant promotional effect on China's urban economic development during the sample period. After controlling the effects of other variables, the inhibitory effect of fixed asset investment on carbon emissions is weakened in the new development stage, and excessive fixed asset investment brings problems such as ineffective investment and resource mismatch. Population density contributes to the increase in urban carbon emissions, indicating that an increase in population density may lead to an increase in urban industrial activities, which in turn increases carbon emissions. Increased openness to the outside world enhances the core competitiveness of cities and creates a favourable external environment for economic development. The level of financial development and transport accessibility do not have a significant effect on urban carbon emissions, i.e., they have no obvious influence on urban economic development and carbon emissions during the sample period.

7.2. Countermeasure Recommendations

Based on the findings of this paper, corresponding countermeasures are proposed to promote the high-quality development of urban economy. First, improve the policy system of smart city construction, vigorously develop the construction of smart cities, and promote the process of smart city construction through relevant policies to promote the high-quality development of the urban economy; second, the government should reduce the phenomenon of ineffective investment and resource mismatch, and promote the precise matching of resources and effective investment; third, it should improve the level of opening up to the outside world, and actively bring in foreign investment and high-end technical talents to inject new vitality into the urban economy. Vitality.

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References

[1] ZHANG Zhidong,ZHAO Biwu. The impact of smart city construction on the high-quality development of urban economy-an empirical analysis based on DID[J]. Soft Science,2021,35(11):65-70+129.

[2] ZHAO Huaping,TIAN Xiulin,ZHANG Shodi. Role mechanism and empirical test of the impact of smart city construction on high-quality economic development[J]. Statistics and Decision Making, 2022, 38(12):102-105.

[3] Wu Tingting. The impact of smart city construction on the high-quality development of urban economy[J]. Marketing world,2022(13):32-34.

[4] Wang Ying,Zhou Jianjun. Can smart city pilot promote economic growth? --An empirical test based on double difference model[J]. East China Economic Management,2021,35(12):80-91.

[5] Zhang Shaotong,Wang Fang,Wang Lida. Development characteristics and trends of smart cities[J]. E-government,2013(04):2-9.

[6] Shi Daqian,Ding Hai,Wei Ping, et. al. Can smart city construction reduce environmental pollution[J]. China Industrial Economy,2018(06):117-135.

[7] Fu Rongshu. Conceptual framework and promotion path of smart city[J]. Seeking,2019(05):153-162.

[8] Fu Ping,Liu Dexue. Research on the technological innovation effect of smart cities--an empirical analysis based on panel data of 282 prefecture-level cities in China[J]. Exploration of Economic Issues,2019(09):72-81.

[9] Zhang Jie,Li Qianhui. The impact of smart city construction on urban green innovation efficiency[J]. Statistics and Decision Making,2020,36(19):83-87.

[10] Zhao Caijing,Wu Bojun. Does smart city construction promote the quality of urban development? --An assessment of policy effects based on the multi-period DID method[J]. Economic Jingwei, 2020, 37(06):18-27.

[11] Liu Ruiming,Mao Yu,Kang Yankun. Institutional Unbundling, Market Vitality Stimulation and Tourism Economic Development-Evidence from China's Cultural System Reform[J]. Economic Research, 2020,55(01):115-131.

[12] Yang Jijun,Zhao Zichen. The impact of institutional environment and industry contract intensity on export domestic value added[J]. Nanjing Social Science,2021(10):35-44.

[13] Li qiang. Research on the impact of high-speed railway opening on urban-rural income gap in Yangtze River Economic Zone[J]. Journal of Nantong University (Social Science Edition),2021, 37 (02):32-42.

[14] Zhang Hua,Feng Feng. Green high-speed railway: Can the opening of high-speed railway reduce haze pollution? [J]. Economic Journal,2019(3):114-147.