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The Innovation Effect of Civilized City: Evidence from the Prefecture-Level Cities in China

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Abstract

At the beginning of the 21st century, in order to improve the degree of urban civilization, improve the environment, and life quality; the Chinese government launched the civilized city campaign in 1999, which is the highest honorary title. What are the driving forces for urban innovation in the context of high-quality development? Does the civilized city campaign promote urban innovation? This paper employs the difference in difference (DID) method to investigate the impact of civilized city campaigns on urban innovation. The results show that: 1) the campaign improves the urban innovation. 2) Further analysis shows that the campaign can promote the urban innovation through direct mechanism and indirect mechanism. Direct mechanism is agglomeration of high-skilled labor force and increase of public R&D expenditure, Indirect mechanism is urban agglomeration. 3) Heterogeneity analysis shows that the campaign has a better effect on those which has good economic foundation and high-level green development.

Keywords

Civilized City Campaign, Urban Innovation Effect, Agglomeration, High-Skilled labor Force, Public R&D Expenditure

1. Introduction

Since the implementation of reform and opening-up, China's economic development has attracted worldwide attention. However, the quality of urbanization in China is not optimistic, and urban "scars" have hindered social development[1].

[1]According to Zheng et al. (2011), four out of ten residents in "urban villages" in Beijing have a per capita rental area of less than 5 square meters, and more than 90% of houses lack independent toilets and kitchens. In the past six months, the proportion of communities with incidents in these areas has reached 81%, with 25% of cases involving personal injury or death.

As people's material and cultural needs continue to grow and the contradiction between unbalanced and insufficient production becomes more prominent, how can the needs of the people for a better life be met? To address these issues and increase people's sense of well-being while improving the quality of urban development, Chinese government launched the Civilization City Campaign Policy in 1999, which is the most influential urban honor evaluation activity in the country (Wu & Huang, 2022).

The Central Steering Committee for the Construction of Spiritual Civilization (hereafter referred to as the Civilization Committee) is responsible for designing the detailed National Civilized City Evaluation System, which includes ecological civilization and spiritual civilization construction. There are many benefits to being recognized as a civilized city. Firstly, the city's brand effect will push up land prices and increase the income of local residents. Secondly, successfully being recognized as a civilized city will increase the probability of local officials being promoted (Zhang & Wang, 2020). Under the incentive of official promotion, local governments will actively participate in the campaign of civilized cities, such as increasing investment in infrastructure construction, pollution treatment, and social publicity. Currently, China is in a stage of high-quality development. For example, through the construction of smart cities to enhance innovation capacity (Héraud & Muller, 2022). In the context of the turbulent international situation and the rise of anti-globalization sentiment, how can China improve its independent innovation capability? The campaign for civilized cities provides a perspective from the perspective of urban construction.

However, the campaign for civilized city also has some peculiarities, such as such as vanity projects and not continuously paying efforts into maintaining civilized city construction once being recognized as the civilized city (Yuan, 2015). Therefore, related research suggests that the campaign of civilized cities should focus on building integrity, cultivating a positive atmosphere, promoting education and propaganda, and preserving cultural heritage in order to truly benefit the country and the people (Du & Chen, 2016). Some studies have shown that the civilized city campaign affects urban housing prices and long-term economic growth through channels such as land prices (Gong et al., 2018). From the perspective of enterprises, some studies have found that the civilized city campaign will strengthen environmental regulations to improve the urban environment, enhance the innovation compensation effect of enterprises, and thereby improve total factor productivity (Wu & Huang, 2022). In addition, research has shown that the campaign of civilized city also has environmental governance effects. Due to the incentive of officials' promotion, the government will control pollution at the source, and local enterprises will reduce industrial emissions of pollutants. At the same time, the spillover effect of environmental governance will benefit adjacent areas.

Therefore, this paper (Lu et al., 2020) uses panel data from 285 prefecture-level cities in China from 2000 to 2018 and employs the difference-in-difference (DID) method to analyze the impact of civilized city cam-

paign on urban innovation. On the other hand, this paper contributes to the study of urban innovation factors from the perspective of urban governance, providing new empirical evidence for clarifying the relationship between urban brand and urban innovation. Moreover, using the difference-in-differences method can minimize the endogeneity problem in policy estimation (the possibility of bidirectional causality between urban brand and urban innovation).

2. Institutional Background and Theoretical Hypotheses

2.1. Institutional Background

Over the past 40 years, China's urbanization process has rapidly advanced, with the urbanization rate[2] rising from 20.6% in 1982 to 63.89% in 2020. However, in the process of urbanization, issues like air pollution, small social public space[3] and low sense of well-being have become increasingly apparent (Ribeiro, 2021). Urbanization in China can be divided into primary urbanization and secondary urbanization. During primary urbanization, urban growth was primarily driven by resources and factors of production. Despite rapid economic growth, primary urbanization has been accompanied by significant urban-rural disparities, inefficient resource utilization, and distorted allocation of production factors. Currently, China is gradually transitioning to secondary urbanization, driven by innovation, talent, and technology. The main characteristics of this secondary urbanization include: Firstly, the spatial pattern of urban development is shifting from small towns to metropolitan areas, city belts, and urban agglomerations. There is a focus on developing large and mega cities, while also considering the development of various small and medium-sized cities. Metropolitan areas and urban agglomerations have become the primary strategies for urban development in China. Secondly, in terms of urban construction, there is a greater emphasis on the integrated development of industries, cities, and populations. Primary urbanization overly emphasized economic development, leading to excessive urban sprawl and a lack of integration between industry and city. Migrant agricultural populations have struggled to access equal public services in healthcare, education, and social security. In contrast, secondary urbanization focuses on the integration of industry, city, and people, emphasizing the full utilization of agglomeration economies through sharing, matching, and learning mechanisms. This approach aims to enhance urban economic resilience and meet the development needs of various groups. Finally, regarding population flow, secondary urbanization in China is shifting from central aggregation to multi-point dispersion and aggregation. The population is no longer solely migrating to large cities and the eastern coastal areas but is increasingly moving towards regional central cities and key towns. With the relaxation of the household registration system and the implementation of regional economic balanced

[2]Data source: China's third and seventh National censuses

[3]The term "public space" comes from Habermas's book "*The Structural Transformation of the Public Sphere*". It refers to the shared space of urban residents' life, communication, and activities, which is closely related to citizens' public life.

development strategies, the regional development gap in China is gradually narrowing in the long term. This provides a more practical foundation and technical support for localized urbanization.

To effectively solve the problem of urbanization, the Central Civilization Committee first proposed the campaign of civilized city in 1999. The national civilized city campaign process mainly includes five steps: first, voluntary application; second, recommendation by various provinces to the Central Civilization Committee; third, the relevant departments to review the various aspects of urban work; fourth, investigation based on the "National Civilized City Evaluation System"; fifth, comprehensive scoring of the urban performance over three years, followed by approval by the Central Civilization Committee.

The basic content of the civilized city evaluation involves the establishment of a civilized city evaluation system by the state. At a designated time, on-site inspections of the corresponding cities are conducted, and cities are scored according to a specific evaluation system. Cities that meet certain standards are included in the list of civilized cities. It is noteworthy that the evaluation system for civilized cities is continuously updated, usually following the announcement of evaluation results, with an update cycle of generally 3 to 4 years. The structure of the evaluation system includes two main parts: basic indicators and characteristic indicators. Basic indicators cover fundamental aspects of civilized city construction, such as governance environment, market environment, ecological environment, and living environment. Characteristic indicators reflect the creation of spiritual civilization in the city, such as whether the experiences of building a civilized city have been promoted nationwide and whether the city has received honorary titles. The evaluation methods comprise three approaches: 1) Online application, which involves submitting picture materials, official documents, explanatory reports, and data tables; 2) On-site inspections, conducted through unannounced visits based on the principles of uniform location types, uniform inspection subjects, and uniform inspection methods; 3) Questionnaire surveys, conducted through household surveys based on community household distribution maps and selected according to random interval principles. This demonstrates the rationality and rigor of the evaluation methods, which assess both the macro level (such as the per capita GDP level submitted online) and micro perspectives (such as the questionnaire surveys). Additionally, according to the latest evaluation system for civilized cities, the Central Civilization Office conducts annual evaluations of all national civilized cities, effectively preventing "formalistic projects" and "last-minute efforts" in the construction of civilized cities. The evaluation cycle for civilized cities is generally three years, with evaluation results each year. The total score is determined by the weighted scores of three years, with weights of 15%, 25%, and 60% respectively. This setup significantly incentivizes governments at all levels to normalize and institutionalize the construction of civilized cities.

Existing data shows that the campaign of civilized city will help to enhance their innovative capabilities. For example, in 2008, Hangzhou's patent applica-

tions[4] were 14,772, but after being recognized as a civilized city, the number of patents reached 55,379 in 2018, nearly three times higher than in 2008. Five years after being selected as a civilized city, Changsha's patent applications were about 3.2 times higher than in the previous year.

2.2. Theoretical Hypotheses

As shown in Figure 1, the campaign of civilized city improves urban innovation through the direct mechanism of attracting high-skilled labor and increasing public R&D expenditure, while the campaign of civilized city improves urban innovation through the indirect mechanism of enhancing the agglomeration effect of population, industry and finance.

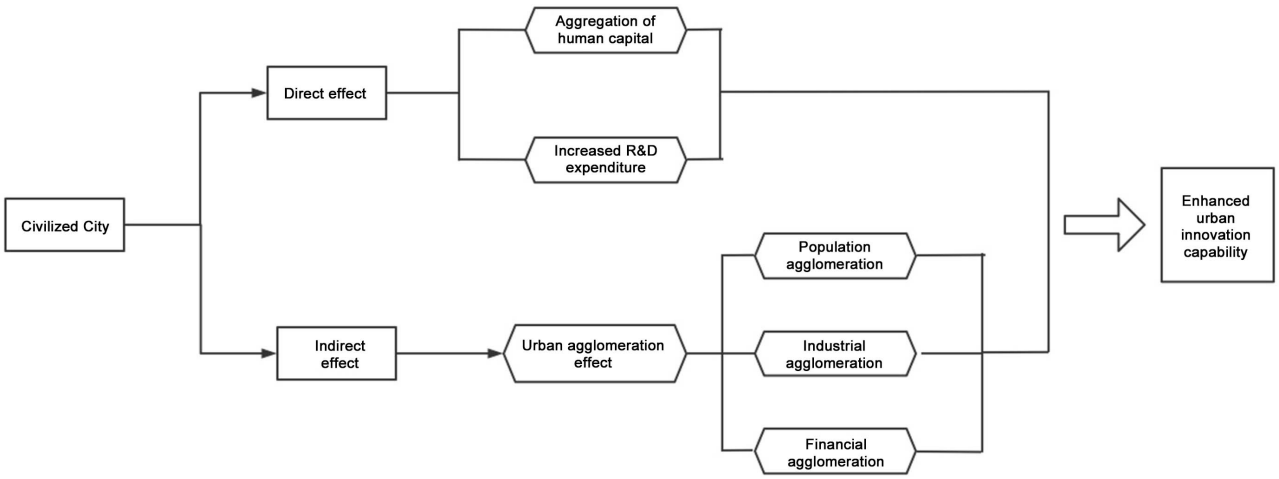

Figure 1. Main mechanisms.

Firstly, the campaign of civilized city aims to enhance the city's image and improve the urban environment to attract the aggregation of high-skilled labor, who in turn directly elevates innovation through knowledge spillovers and technological advancements. Livable cities should satisfy some conditions such as safe and comfortable living environment, positive social culture, and complete infrastructure. Interestingly, based on the characteristics of livable cities and civilized cities, we found that these two types of cities share many commonalities in their construction requirements. In addition, according to the evaluation criteria for livable cities (Nie et al., 2012), some cities with relatively good livability, such as Beijing, Shanghai, Guangzhou, Hefei, Nanjing, Hangzhou, have all been rated as civilized cities, indicating that most civilized cities are very suitable for people to live in. If a city has good livability and high civilization degree, it will have strong attraction to laborers. However, moving to a new city is a challenge for most people, because leaving their original place of residence means leaving their "comfort zone", and it also comes with psychological burdens such as the feeling of unfamiliarity with the new environment and incomplete information

[4]City-level patent data comes from the China Urban Yearbook and the China Research Data Platform.

(Zhang, 2018). However, these challenges are less costly for high-skilled labor, for the following reasons: first, high-skilled labor possesses a large amount of knowledge and strong adaptability; second, most cities adopt talent introduction policies, and high-skilled labors are highly preferred. Talents will acquire various preferential policies, and their sense of identity with the city is high (Qi et al., 2020). In summary, good livability and talent preferential policies promote the influx of high-skilled labor, thereby accelerating the agglomeration of high-skilled labor. Compared with ordinary labor, high-skilled labor has a high degree of specialization and makes significant contributions in high-tech, advanced manufacturing, and other industries. The agglomeration of talents will promote the process of knowledge spillover and technological progress, which will enhance urban innovation capability.

Secondly, the campaign of civilized city can directly enhance a city's innovation capability by increasing its R&D investment. One of the conditions for successfully being selected as a civilized city is that the per capita GDP in the past two years before application must be continuously higher than the national average, which indicates that the campaign for civilized city also emphasizes economic development. On the other hand, being successfully selected as a civilized city also has a positive impact on the promotion of local officials (Zhang & Wang, 2020), thus providing sufficient incentive for cities to participate in the campaign. In the context of the new economy, increasing R&D investment in research institutions and universities is crucial for economic development. For political promotion and economic development, local governments will increase R&D expenditure to improve the city's innovation capability in the long run.

Thirdly, the campaign of civilized city indirectly enhances a city's innovation capability by strengthening the population agglomeration effect. Although the talent policies of civilized cities target high-skilled individuals, individuals are part of a family, and they may move into a civilized city as a family unit. Besides, the evaluation criteria for civilized cities require standardized government behavior and promote "streamlining administration and delegating power" to reduce administrative approval procedures and improve government efficiency. On the other hand, the living environment is an important evaluation criterion[5]. This indicates that the campaign of civilized city will enhance local social governance capability, optimize the living environment, and thus have a suction effect on the population in neighboring areas. Overall, the number of people attracted to civilized city is several times higher than that of high-skilled individuals, resulting in a stronger population agglomeration effect. Furthermore, the stronger population agglomeration effect leads to increase innovation capability through the city effect. The city effect refers to the population diversity that creates a relaxed and diverse atmosphere, which is conducive to the exchange of new ideas.

[5]The 2018 evaluation system stated that each participating city's built-up area should have a green coverage rate of at least 35%, with a per capita public park and green space of more than 12 square meters and comprehensive community service facilities achieving full coverage.

Fourthly, the campaign of civilized city indirectly enhances a city's innovation capability by strengthening the industrial agglomeration effect. According to the Core-Periphery Model, as the population of a civilized city grows and the market size expands, more companies are attracted, and the local market effect and price index effect increase. Industrial agglomeration promotes the division of labor between different enterprises and increases the breadth of services of enterprises. Additionally, industrial agglomeration facilitates the exchange and sharing of information and knowledge among different industries and reduces the phenomenon of mismatched urban resources, prompting local enterprises to increase R&D investment, improve technology, and enhance productivity (Zhang & Yang, 2015). More significantly, utilizing the brand effect of civilized city can optimize the business environment, facilitate the introduction of advanced technology and capital, which improve the city's innovation capability.

Fifthly, the campaign of civilized city indirectly enhances a city's innovation capability by strengthening the financial agglomeration effect. The population and industrial agglomeration effects form a virtuous cycle that promotes urban innovation. However, companies entering a new city need the support of financial institutions in financing and other transactions. Financial institutions choose to be located in areas with concentrated populations to reduce information search costs and form a financial agglomeration effect. The strengthening of the financial agglomeration effect will first reduce the phenomenon of mismatched funds, channel credit funds into high-innovation-capability enterprises, and reduce the risk of investment in innovative projects, ensuring the stability of the supply of funds for innovative projects. Besides, financial agglomeration promotes the development of industries such as data mining, and digital finance, increasing the supply of skilled personnel. The purchasing power of the consumers represented by skilled workers is strong, and factors such as diverse consumer demands and fierce competition among companies force enterprises to increase R&D investment and improve their utilization of technology to secure a foothold in the turbulent market.

Therefore, this paper arrives at the following hypotheses to be tested:

Hypothesis 1: The campaign of civilized city can enhance a city's innovation capability.

Hypothesis 2: The campaign of civilized city directly enhances a city's innovation capability by attracting high-skilled labor and increasing public R&D expenditure.

Hypothesis 3: The campaign of civilized city indirectly enhances a city's innovation capability by strengthening the population, industrial and financial agglomeration effects.

3. Research Design

3.1. Model Specification

Firstly, being recognized as national civilized city is the most influential urban

honor in China, and its strict and authoritative campaign by the National Committee of Civilizations minimizes potential human intervention factors. Secondly, the fact that the national civilized city campaign process occurs every three years and requires a step-by-step approval process, which provides good quasi-natural experimental characteristics for the evaluation of the impact of this honor on urban innovation. Therefore, this study regards the national civilized city campaign as a quasi-natural experiment and constructs a multi-period double difference model as follows.

$$Y_{it} = \alpha + \beta D_{it} + \theta X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

where i represents the city, t represents the year, Y_{it} represents the outcome variable, which is the innovation capacity of city i in year t, D_{it} represents the core explanatory variable, which takes a value of 1 if city i is selected as a civilized city in year t, and 0 otherwise. X_{it} represents the control variables, μ_i and δ_t represent city and time fixed effects, respectively, α represents a constant term, and ε_{it} is a random disturbance term. The coefficient β represents the innovation effect of the national civilized city campaign process. If $\beta > 0$, it indicates that this honor enhances urban innovation capacity, otherwise it hinders it.

To prevent non-exogenous interference from the civilized city campaign process, this study adopts PSM-DID for robustness analysis. Year-by-year matching can provide a more accurate matching of each sample period. Thus, this study adopts year-by-year matching and the specific steps are as follows: This study selects urban economic development level, industrial structure, government support, and market environment as covariates, constructs a logit model to calculate the propensity score, and uses 1:2 nearest neighbor matching to select the control group cities (Gong et al., 2018). Therefore, the PSM-DID model is constructed as follows, with other symbol meanings the same as Equation (1).

$$Y_{it}^{PSM} = \alpha_2 + \beta_2 D_{it} + \theta_2 X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

3.2. Variable Definition

1) Outcome variable: city innovation capacity. Firstly, previous studies demonstrate that the number of patents comprehensively reflects social innovation activities and inputs, making it one of the most appropriate indicators for evaluating regional innovation capacity (Bo, 2019). Additionally, patent data can be divided into the number of patent applications and the number of patent authorizations, with the latter indicating higher recognition. Secondly, the city innovation index considers multiple factors related to innovation, such as patent value and micro-enterprise innovation data, making it more comprehensive. Therefore, this study uses the number of patent authorizations (*PAT*) at the city level and the city innovation index (*LnPINDX*) to measure city innovation capacity.

2) Core explanatory variable: dummy variable for civilized city (*D*). It takes a value of 1 if a city is recognized as a civilized city in the year of campaign or

subsequent years and 0 otherwise. Furthermore, since construction of relevant projects already begins before the results of the civilized city campaign are announced, i.e., the policies have already taken effect, this study adjusts the time for the dummy variable by three years prior to the campaign year, according to relevant literature (Wu & Huang, 2022; Gong et al., 2018). Based on this, the experimental group consists of 149 cities and the control group consists of 136 cities.

3) Control variables: In order to accurately identify the innovation effect of civilized cities, this paper includes the following control variables: 1)regional economic development level (*PGDP*): measured by per capita GDP in ten thousand yuan; 2)industrial structure level (*IND*): measured by the percentage of the tertiary industry's output value to the local gross domestic product.; 3)government support level (*GOV*): measured by the percentage of expenditures on science and education as a proportion of total government expenditures.; 4)human capital situation (*HUM*): measured by the percentage of scientific research personnel employed to total employment.; 5)regional infrastructure condition (*INF*): measured by the percentage of the sum of posts and telecommunications services to local gross domestic product.; 6)regional openness level (*FDI*): measured by the actual6 use of foreign capital, in ten thousand US dollar; 7)urban scale (*URB*): measured by the population of the urban area, in millions of people; 8)market environment level (*MAR*): measured by the number of state-owned and non-state-owned enterprises, in units of hundreds. Table 1 presents the descriptive statistics of the variables.

Table 1. Descriptive statistics of variables.

Variables	Name	Mean	STD	MIN	MAX	Sample size
PAT	Patent Authorization	0.2805	0.8458	0.0001	14.0202	5395
LnPINDX	City Innovation Index	0.5449	1.9403	5.2719	6.9673	4546
D	Dummy Variable Civilized City	0.1747	0.3797	0	1	5415
PGDP	Regional Economic Development Level	3.5119	9.4911	0.1660	21.5488	5076
IND	Industrial Structure Level	37.9099	9.3582	8.5	85.34	5348
GOV	Government Support Level	19.0927	5.1824	0	49.7399	5354
HUM	Human Capital Situation	6.862	24.1290	0	49.1071	5357
INF	Regional Infrastructure Condition	3.113	2.3785	0	50.4135	5062

Continued

FDI	Regional Openness Level	6.3850	16.6638	0	308.2563	5133
URB	Urban Scale	1.4554	2.4627	0.0178	52.9025	5077
MAR	Market Environment Level	10.9927	15.8211	0.19	187.92	5343

Note: This article logarithmically transforms the city innovation index to reduce the impact of heteroscedasticity on model estimation.

3.3. Data Sources

The original data sets used in this paper are as follows: 1) ordinary city macroeconomic data set, with most of the data sourced from the annual China Regional Economic Statistical Yearbook, China City Statistical Yearbook, and City Construction Statistical Yearbook, and a small number of missing values manually collected from each city's statistical bulletin; 2) Civilized City Pilot City List Data Set, obtained by collating the six-year list of civilized cities published by the National Civilized Commission. Due to the high amount of missing data for cities in the Tibet Autonomous Region and the Xinjiang Uygur Autonomous Region, as well as the fact that cities in Hong Kong, Macau, and Taiwan Province do not participate in the campaign of civilized city, these cities have been excluded.

4. Analysis of Econometric Results

4.1. Baseline Results

To test hypothesis 1, this study utilizes a multi-period difference-in-differences (DID) model to examine the innovative effects of the campaign for the civilized city award. The model (1) is applied to a bidirectional fixed-effect regression, and both the dependent variables of patent numbers and city innovation index are analyzed. Columns (1) and (2) of Table 2 present the regression results for patent numbers, while columns (3) and (4) present the regression results for city innovation index. Columns (1) and (3) present the regression results without any control variables, while columns (2) and (4) include control variables. As shown in Table 2, the core explanatory variable coefficients are 0.48 and 0.45 in columns (1) and (3) respectively. After incorporating the control variables, the coefficients of the innovative effect of the civilized city campaign in columns (2) and (4) are 0.217 and 0.268 respectively, indicating that the patent growth rate of civilized cities will increase by approximately 21.7% compared to non-civilized cities. Furthermore, the results show that the average city innovation index of civilized cities is higher than that of non-civilized cities by 26.8%. The regression results of the control variable in columns (2) and (4) also suggest that the level of industrial structure, government support, and regional openness all significantly promote urban innovation. This is due to the continual optimization of the industrial structure, the increasing emphasis on education and technology by Chinese government, and the increasing efficiency of utilizing foreign invest-

ment, which enhance the city's innovation capability. The effects of infrastructure, human capital, and market environment on innovation capability are not significant.

Table 2. Benchmark regression results.

Variable/Model	(1)	(2)	(3)	(4)	(5)	(6)
	PAT	PAT	LnPINDX	LnPINDX	PAT^{psm}	$LnPINDX^{psm}$
D	0.480***	0.217***	0.450***	0.268***	0.073**	0.105**
	(0.070)	(0.064)	(0.061)	(0.056)	(0.032)	(0.046)
PGDP	——	0.001	——	0.025*	0.007	−0.017
	——	(0.001)	——	(0.013)	(0.010)	(0.016)
IND	——	0.015***	——	0.016***	0.005*	0.006
	——	(0.004)	——	(0.005)	(0.003)	(0.005)
GOV	——	0.005***	——	0.004***	0.011***	0.020***
	——	(0.001)	——	(0.001)	(0.004)	(0.005)
HUM	——	0.000	——	0.001*	−0.000	−0.017
	——	(0.000)	——	(0.000)	(0.001)	(0.031)
INF	——	−0.010**	——	0.004	0.005	0.012
	——	(0.004)	——	(0.006)	(0.006)	(0.010)
FDI	——	0.026***	——	0.002	0.004*	−0.001
	——	(0.006)	——	(0.001)	(0.002)	(0.003)
URB	——	0.061*	——	0.011	0.018*	0.008
	——	(0.032)	——	(0.007)	(0.010)	(0.012)
MAR	——	0.008	——	0.018***	0.005***	0.011***
	——	(0.008)	——	(0.003)	(0.002)	(0.002)
Fixed effects for year	√	√	√	√	√	√
Fixed effects for city	√	√	√	√	√	√
Constant term	0.025	−0.722***	−2.272***	−3.020***	−0.520***	−1.922***
	(0.030)	(0.184)	(0.032)	(0.181)	(0.118)	(0.197)
Sample size	5395	4526	4546	4262	825	694
R^2	0.210	0.490	0.900	0.911	0.385	0.925
F	7.799	16.524	298.487	260.869	15.281	258.687

Note: The standard errors are reported in parentheses; the symbols ***, **, and * indicate significance at the 1%, 5%, and 10% level respectively. The remaining tables are similar to Table 2.

The most important premise for implementing the DID method is that the trend of change for the experimental group and the control group is the same before policy implementation. Therefore, we test whether the parallel trend as-

sumption is satisfied. By constructing a year dummy variable and an interactive term of the core explanatory variable D, and replacing the core explanatory variable, the model is included in the baseline regression. Figure 2 and Figure 3 indicate that the fluctuation of patent numbers and city innovation index is relatively small in the years prior to the policy implementation and is distributed around zero. This suggests that the city development trends of the treatment and control groups are highly similar before policy implementation and that there is no evidence to indicate that The Central Civilization Committee deliberately designated cities that were originally economically and technologically advanced and favored by the policy as civilized city, thus satisfying the "parallel trends" assumption.

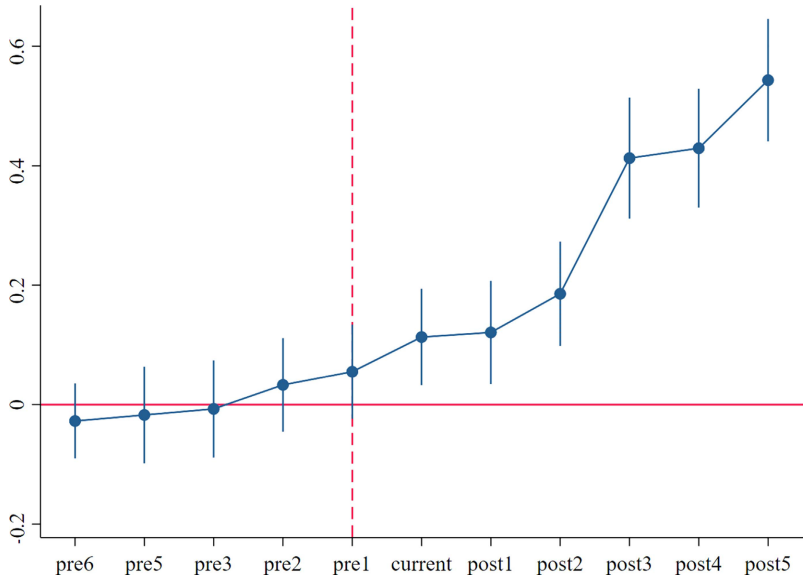

Figure 2. Parallel trend test for patent numbers.

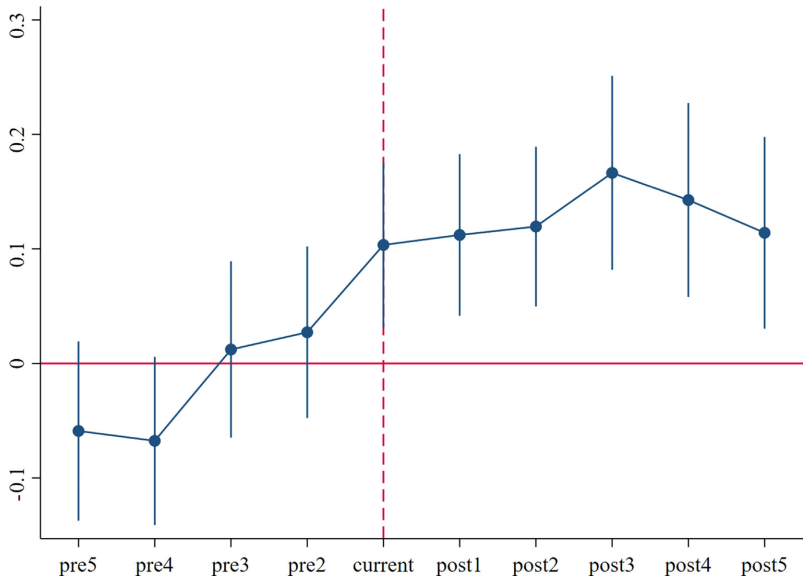

Figure 3. Parallel trend test for city innovation index.

4.2. PSM-DID Method

Due to the systematic differences in the trends of change between the control group and the experimental group, PSM-DID is employed to more accurately measure policy effects and reduce endogenous problems caused by sample selection bias. The precondition for PSM matching is that the matched sample should satisfy the stationary test. This study adopts a year-by-year matching method and conducts a stationary test, matching 15 years for the patent numbers and 14 years for the city innovation index. After matching, the differences between the treatment and control groups are significantly reduced each year, thus satisfying the stationary hypothesis[6]. Based on the PSM method, the core explanatory variable coefficients for columns (5) and (6) in Table 2 are 0.073 and 0.105 respectively, both significant at the 5% confidence level. Compared to the coefficients in columns (2) and (4), the coefficients of the core explanatory variable after PSM matching are lower. The above process indicates that the baseline OLS regression may overestimate the policy effects, but it still proves that the campaign of civilized city can enhance the urban innovation.

4.3. Robustness Test

To ensure the reliability and robustness of the baseline results, this paper conducted the following robustness tests. Firstly, we lagged the control variables in the baseline model by one period. In the baseline regression, the control variables were all current values. Due to the potential endogeneity problem of these variables, we included the lagged control variables in the model, and the estimated results are shown in columns (1) and (2) of Table 3. The coefficient of the core explanatory variable in column (1) of Table 3 is 0.154, significant at the 5% level, and the coefficient in column (2) of Table 3 is 0.260, significant at the 1% level. The size of the core explanatory variable coefficient is similar to that in columns (2) and (4) of Table 2, indicating the robustness of the results.

Secondly, we lagged the core explanatory variable (dummy variable of civilized city policy) by three years. As mentioned earlier, in order to successfully be selected as a civilized city, each city had started relevant construction (such as environmental improvement and propaganda) before the list was released (usually three years prior to the list publication) in order to win the campaign. However, even though it is reasonable to advance the policy by three years, the improvement of a city's innovation capacity during this period may have been affected by other policy interventions. Therefore, we lagged the dummy variable of civilized city policy by three years to test whether the policy treatment effect is robust. Based on this, the regression results of the lagged core explanatory variable for three years are shown in columns (3) and (4) of Table 3, and the coefficients of the core explanatory variable in columns (3) and (4) are 0.520 and 0.191, significant at the 1% level, indicating that the effect of civilized city campaign on the number of patents and urban innovation index remains signifi-

[6]On stationary test, a lot of detailed information available on request.

cantly positive, and the results are robust.

Thirdly, we excluded municipalities and provincial capitals. Generally, these cities have developed economies, well-established infrastructure and strong scientific and technological strength, and their innovation ability may be affected by other policies or may be stronger due to their good initial endowment, which does not benefit to identify the policy effect of civilized city campaign. Therefore, we excluded these two types of cities from our sample and conducted the regression again. Columns (5) and (6) of Table 3 show the regression results for the sample excluding these two types of cities, and the promotion effect of civilized city campaign on city innovation capability remains significantly positive. Moreover, the coefficient of the core explanatory variable in column (6) of Table 3 is 0.320, which is higher than the coefficient of 0.268 in column (4) of Table 2, indicating that the innovation capability of ordinary cities is more effectively improved by civilized city campaign.

Table 3. Robustness test.

Variable/Model	(1)	(2)	(3)	(4)	(5)	(6)
	PAT	LnPINDX	PAT	LnPINDX	PAT	LnPINDX
D	0.154**	0.260***	0.520***	0.191***	0.203***	0.320***
	(0.073)	(0.054)	(0.102)	(0.059)	(0.075)	(0.069)
Control variable	√	√	√	√	√	√
Fixed effects for year	√	√	√	√	√	√
Fixed effects for city	√	√	√	√	√	√
Constant term	−0.752***	−2.894***	−0.578***	−2.571***	−0.585***	−3.246***
	(0.187)	(0.190)	(0.193)	(0.188)	(0.167)	(0.188)
Sample size	4512	4002	3999	3737	4029	3793
R^2	0.486	0.909	0.480	0.903	0.370	0.905
F	19.586	237.683	12.953	274.527	26.922	211.597

Fourthly, when we use the DID method for causal inference, if the non-spillover assumption is satisfied, the innovation effect of civilized city campaign will be more convincing. If the innovation capability of adjacent cities to a civilized city is strong, the improvement of this city's innovation capability may be due to the positive spillover effect from adjacent cities rather than the policy effect of civilized city campaign. To test whether the non-spillover hypothesis is valid or not, we used Bo (2019)'s method to estimate the spillover effects and constructed the model as follows:

$$Y_{it} = \alpha + \beta D_{it} + \lambda \text{Adjacent}_{t_{it}} + \theta X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

The variable Adjacent_{it} is a dummy variable that indicates whether city *i* is adjacent to a civilized city. If it is adjacent, the value is 1, otherwise it is 0. λ

represents the spillover effect of the adjacent city on the civilized city. In addition, the other parameters and variable meanings in Equation (3) are the same as in Equation (1). Table 4 (1) and (2) show the spillover effects of adjacent cities on the patents and innovation index of civilized cities. Table 4 (1) shows that the coefficient of the effect of adjacent cities on the number of patents in civilized cities is 0.042 and not significant, indicating that there is no spillover effect of adjacent cities on the number of patents in civilized cities. Moreover, Table 4 (2) shows that the coefficient of the effect of adjacent cities on the innovation index of civilized cities is −0.907, which is significantly negative, indicating that adjacent cities hinder the improvement of the innovation capability of civilized cities, possibly due to talent competition between cities. However, the core explanatory variable, the civilized city campaign (D) in columns (1) and (2) still has a significant effect on the innovation capability of the city, which highlights the effectiveness of the policy. Therefore, the non-spillover assumption is satisfied.

Table 4. Non-spillover test and interference exclusion policy.

Variable/Model	(1)	(2)	(3)	(4)
	PAT	LnPINDX	PAT	LnPINDX
D	0.202***	0.266***	——	——
	(0.056)	(0.056)	——	——
Adjacent	0.042	−0.907***	——	——
	(0.033)	(0.130)	——	——
D_T	——	——	0.048**	0.228***
	——	——	(0.024)	(0.054)
Control variable	√	√	√	√
Fixed effects for year	√	√	√	√
Fixed effects for city	√	√	√	√
Constant term	−0.583***	−2.840***	−0.764***	−3.039***
	(0.118)	(0.187)	(0.063)	(0.183)
Sample size	4526	4262	4526	4262
R^2	——	——	0.482	0.911
F	——	——	156.830	262.225

Fifthly, to exclude interference policy. China's Ministry of Science and Technology identified the first list of innovation-oriented industrial cluster pilot projects in 2013. By the end of 2020, there were 47 training points and 61 pilot projects. The innovation-oriented industrial cluster pilot policy will promote innovation through innovative enterprise incubation, talents gathering, and other

means. Will the innovation-oriented industrial cluster pilot policy interfere with the estimation of the innovation effect of the civilized city campaign? This article adds the dummy variable of the innovation-oriented industrial cluster pilot policy (T_{it}) to the baseline regression model, we make T_{it} interact with D_{it}, that is D_T. The regression results of columns (3) and (4) in **Table 4** show that D_T is the core explanatory variable coefficient after excluding the impact of the innovation-oriented industrial cluster pilot policy. It can be seen that after controlling for the impact of the innovation-oriented industrial cluster pilot policy, the coefficients of the patent number and innovation index are still significant. This indicates that the innovation-oriented industrial cluster pilot policy did not interfere with the policy effect of the civilized city campaign.

5. Mechanism and Heterogeneity Analysis

5.1. Direct Mechanism Test

As mentioned earlier, the campaign of civilized city promotes the agglomeration of high-skilled labor and increases public R&D expenditures. In 2015, the National Bureau of Statistics (NBS) formulated a new classification standard for occupations. Liu et al. (2019) categorized personnel from national government agencies and party organizations as managerial personnel, and professional technical personnel as technical personnel, with the total number of these two categories being the number of high-skilled labor. Meanwhile, Florida (2002) believed that the creative class (referring to people who engage in creative professions without a high education degree), such as self-employed entrepreneurs and private business owners, also belong to the category of high-skilled labor. Therefore, this paper measures high-skilled labor as the sum of the number of managerial personnel, technical personnel, and creative class personnel, expressed in units of person and logarithmically transformed. High-skilled labor is used as the dependent variable, while the campaign of civilized city is the core independent variable. **Table 6** (1) and (2) respectively present the regression results of high-skilled labor with and without control variables. The results show that the effect coefficient of the campaign of civilized city on high-skilled labor is positively significant at the 1% level. As previously argued, the campaign of civilized city increases public R&D expenditures. Due to expenditures on science and technology reflects local government's attention on R&D, this paper selects local expenditure on science and technology to measure public R&D expenditures. The unit is 10,000 yuan. The regression results of public R&D expenditures are shown in columns (3) and (4) of **Table 5**. Column (3) of **Table 5** shows that the campaign of civilized city significantly increased urban R&D expenditures at 1% level without control variables, while with control variables, the campaign of civilized city significantly increased urban R&D expenditures at 5% level. This indicates that the campaign of civilized city increased R&D expenditures. The hypothesis 2 is fully verified.

Table 5. Direct mechanism.

Variable/Model	(1)	(2)	(3)	(4)
	LnHSH	LnHSH	LnRD	LnRD
D	0.204***	0.190***	0.182***	0.146**
	(0.032)	(0.032)	(0.067)	(0.062)
Control variable	——	Control	——	Control
Fixed effects for year	√	√	√	√
Fixed effects for city	√	√	√	√
Constant term	12.148***	12.738***	5.857***	−5.904***
	(0.023)	(0.416)	(0.063)	(1.495)
Sample size	5349	5302	5348	4918
R^2	0.572	0.582	0.894	0.899
F	90.580	77.447	391.947	344.808

5.2. Indirect Mechanism Test

As previously mentioned, the campaign of civilized city indirectly promotes urban innovation by reducing labor and capital mismatches, improving resource allocation efficiency, and enhancing the agglomeration effects of population, industry, and finance. To verify the indirect mechanism, we adopt the mediating effect model, extending the model based on Equation (1) to Equations (4) and (5):

$$M_{it} = \alpha + \beta_1 D_{it} + \theta X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (4)$$

$$Y_{it} = \alpha + \beta_2 D_{it} + \beta_3 M_{it} + \theta X_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (5)$$

In Equation (4), M_{it} is the mediating variable, and the other variables are the same as those in Equation (1). As mentioned earlier, the agglomeration effect of the population is enhanced by the campaign of civilized city, and population diversity is an important driving force for innovation. Therefore, we select urban population diversity as the mediator variable. We use the number of temporary residents and urban population[7] (*POP*) to measure urban population diversity. Temporary residents refer to people who temporarily live in the city for more than three days, for purposes such as tourism or study, etc. The urban area, as the gathering area for a city's economic and technological activities, reflects the human capital potential of the local population. Therefore, urban population diversity is positively correlated to innovation.

Table 6 shows the mediating effect test results for urban population diversity, with *POP* as the mediator variable. Columns (1) and (2) respectively show the regression of the campaign of civilized city on patents and innovation indices, while column (3) shows the regression of the campaign of civilized city on urban population diversity, and columns (4) and (5) respectively show the regression

[7]Data source: China Urban Statistical Yearbook and China Urban Construction Statistical Yearbook.

of urban population diversity on patents and innovation indices. According to the conditions of the mediation effect, Table 6 (4) shows that urban population diversity significantly increases urban patents at 10% level, indicating that the mediating effect exists. In addition, column (5) of Table 6 indicates that the impact of urban population diversity on the innovation index is not significant, possibly because the innovation index contains a wide range of content, while population diversity only affects some components of the innovation index. In summary, urban population diversity promotes urban innovation capability.

Table 6. Mechanism of urban population diversity.

Variable/Model	(1)	(2)	(3)	(4)	(5)
	PAT	LnPINDX	POP	PAT	LnPINDX
D	0.406***	0.375***	0.494***	0.374***	0.348***
	(0.066)	(0.056)	(0.129)	(0.063)	(0.058)
POP	——	——	——	0.068*	0.003
	——	——	——	(0.037)	(0.006)
Control variable	√	√	√	√	√
Fixed effects for year	√	√	√	√	√
Fixed effects for city	√	√	√	√	√
Constant term	4.056***	−2.262**	−1.696	3.125***	−2.553**
	(1.497)	(1.149)	(2.014)	(1.159)	(1.234)
Sample size	4506	4242	4154	4152	3891
R^2	0.278	0.910	0.199	0.309	0.908
F	6.707	253.110	13.207	9.372	217.983

The campaign of civilized city promotes the externalities of industrial agglomeration, which helps enterprises to share information, and promotes the reasonable flow of information, capital, and talent, thereby enhancing urban innovation capability. This article selects employment density (*ED*) and the urban business environment index (*MINDX*) to measure the externalities of industrial agglomeration[8]. The reason for selecting these two indicators is that industrial agglomeration can facilitate enterprise sharing infrastructure and information, thereby improving enterprise productivity, increasing profits, labor demand, and employment density. At the same time, industrial agglomeration can also attract talent, forcing the government to optimize the business environment, pushing enterprises inflowing to public service areas where are more comprehensive and convenient. Cities with higher employment density have better matches between

[8]Employment density is calculated as the sum of employment in the secondary and tertiary industries divided by the administrative area land area, in units of people/square kilometer. The urban business environment index comes from the "2019 China urban business environment index Evaluation Report," and both indicators are logarithmically transformed.

enterprise demand and labor supply, stronger externality of industrial agglomeration, less mismatching of labor, which is conducive to promoting innovation. The higher the urban business environment index, the better the hardware environment (infrastructure) and software environment (entrepreneurial atmosphere), the more it can attract enterprises. Enterprise agglomeration can help accelerate the rate of knowledge progress by facilitating information exchange, thereby promoting innovation.

Table 7 (1)-(3) examine the relationship between employment density and the campaign of civilized city. *LnED* is the mediating variable. Column (1) is the regression of the campaign of civilized city on employment density, while columns (2) and (3) respectively regress the campaign of civilized city and employment density on patent and innovation indices. In columns (2) and (3) of Table 7, *D* is significantly positively related to *LnED*, indicating that the mediating effect exists. Table 7 (2) shows that employment density significantly increased the number of urban patents at 1% confidence level. Table 7 (3) shows that employment density significantly improved the innovation index at 1% confidence level.

Table 7. Indirect mechanism of employment density and urban business environment index.

Variable/Model	(1)	(2)	(3)	(4)	(5)	(6)
	LnED	PAT	LnPINDX	lnPAT	LnMINDX	lnPAT
D	0.156***	0.335***	0.315***	0.332**	0.191***	0.111
	(0.027)	(0.062)	(0.055)	(0.138)	(0.053)	(0.125)
LnED	——	0.449***	0.367***	——	——	——
	——	(0.078)	(0.067)	——	——	——
LnMINDX	——	——	——	——	——	1.155***
	——	——	——	——	——	(0.261)
Control variable	√	√	√	√	√	√
Fixed effects for year	√	√	√	√	√	√
Fixed effects for city	√	√	√	√	√	√
Constant term	0.633	3.768**	−2.296**	5.143***	2.331***	2.450***
	(0.588)	(1.466)	(1.080)	(0.491)	(0.213)	(0.788)
Sample size	4506	4504	4240	96	96	96
R^2	0.584	0.316	0.915	0.807	0.730	0.849
F	52.135	6.949	256.388	47.520	32.768	67.696

Due to the limited availability of data on the urban business environment index, this study uses 2018 data for cross-sectional regression analysis. Table 7 (4) - (6) present the relationship between the urban business environments index

and the number of urban patents, with *LnMINDX* used as a mediator variable. Based on the results of stepwise regression, the mediating effects exist. In particular, Table 7 (6) reveals that the policy virtual variable (*D*) for the campaign of civilized city is not significant, indicating that the urban business environment index has a complete mediating effect, while Table 7 (6) shows a significant increase in the number of urban patents due to the urban business environment index. Based on above, we prove that the externality of industrial agglomeration indirectly enhances urban innovation capability.

Furthermore, the campaign of civilized city enhances urban innovation capability through the indirect mechanism of strengthening financial agglomeration. This paper uses the financial institution deposit and loan density (*Fin*) to measure the degree of financial agglomeration[9], because this index captures the relationship between financial resources and spatial dimensions more effectively. Table 8 presents the mediating effect test for financial agglomeration density, with *LnFin* used as a mediator variable. Table 8 (1) manifests the regression of the campaign of civilized city on financial agglomeration density, while columns (2) and (3) respectively preset at the regressions of the campaign of civilized city and financial agglomeration density on the number of patents and the urban innovation index. Table 8 (2) and (3) reveal that the coefficient of the impact of financial agglomeration on the number of urban patents and the coefficient of the impact of financial agglomeration on the urban innovation index are both significant at 1% confidence level. These results indicate that mediating effects exist, demonstrating that financial agglomeration enhances urban innovation capability. In conclusion, hypothesis 3 is fully verified.

Table 8. Test for the mediating effect of financial agglomeration.

Variable/Model	(1)	(2)	(3)
	LnFIN	PAT	LnPINDX
D	0.079***	0.383***	0.348***
	(0.018)	(0.067)	(0.056)
LnFIN	——	0.289***	0.295***
	——	(0.098)	(0.088)
Control variable	√	√	√
Fixed effects for year	√	√	√
Fixed effects for city	√	√	√
Constant term	2.576***	3.369**	−2.685**
	(0.628)	(1.507)	(1.150)
Sample size	4503	4501	4237
R^2	0.948	0.288	0.912
F	1077.051	7.265	240.102

[9] $\text{Fin}_{it} = \frac{\text{Dept}_{it} + \text{Loan}_{it}}{\text{Area}_{it}}$, Fin_{it} represents the financial agglomeration density, with Dept_{it} and Loan_{it} representing the number of financial institution depositcs and loans at the end of each year, and Area_{it} representing the administrative area. The unit for deposits and loans is RMB 10,000, while the unit for the area is square kilometers. The unit of financial agglomeration density is RMB 10,000 per square kilometer and is logarithmically transformed.

5.3. Heterogeneity Analysis

As mentioned earlier, the campaign of civilized city aims to enhance a city's innovation capacity by strengthening mechanisms related to industrial, population, and financial agglomeration. However, does the innovative effect of this policy vary across cities with different levels of economic vitality and agglomeration? In this paper, we use the nighttime light data of cities (Yang & Hu, 2021) to classify our sample into economically vibrant and economically lagging cities. We construct the dummy variable of a city's economic activity level (*econo*) by using the nighttime light data, with a value of 1 assigned to cities with nighttime light greater than the national average and 0 otherwise. We then introduce the interaction term between *econo* and the civilized city policy (*econo*×*D*) to the baseline model. Regression results are shown in columns (1) and (2) of **Table 9**. The interaction term coefficient is significant at 1% confidence level, indicating that the civilized city policy has a better innovative effect in economically active areas. This is because economically vibrant areas have better infrastructure and stronger talent attraction, and the civilization city policy can better fortify the agglomeration effects of these areas to enhance innovation.

China has entered a new stage of high-quality development, in which innovation-driven growth and technological progress play a more critical role to economic growth. The green total factor productivity considers comprehensively the relationship between economic development and environmental protection, and reflects the level of economic development with green contribution (Yu, 2019). Does the varying level of city green development affect the effectiveness of the civilized city policy? In this study, we use urban green total factor productivity data[10] to classify our sample into cities with high and low levels of green development. We construct the dummy variable of a city's green development level (*gtfp*) with a value of 1 assigned to cities with *gtfp* greater than 1 and 0 otherwise. We then introduce the interaction term between *gtfp* and the civilized city policy (*gtfp*×*D*) to the baseline model. As shown in column (3) of **Table 9**, the interaction term coefficient is significant at 5% confidence level, indicating that the civilized city policy has a better effect on promoting urban patents in cities with higher levels of green development. High green development suggests a strong technological capability and high resource utilization efficiency in cities. The policy encourages these cities to form a positive reinforcement mechanism by increasing R&D expenditures and encouraging talent agglomeration, resulting in a virtuous cycle of innovation activities and incentive policy implementation. The interaction term coefficient in column (4) is not significant. This may be due to the broad content of the city innovation index and the fact that the heterogeneity of city green development only affects some of its components. In summary, the civilized city policy has a better innovative promotion effect in regions with higher green development and relatively developed economy.

[10]This paper utilizes the ideology put forth by Luenberger (1992) to construct a directional distance function for SBM. Based on data related to the inputs of labor, capital, energy, and expected and unexpected outputs, the green total factor productivity (TFP) of urban areas is calculated.

Table 9. Heterogeneity analysis.

Variable/Model	(1)	(2)	(3)	(4)
	PAT	LnPINDX	PAT	LnPINDX
D	0.120**	0.762***	0.526***	1.230***
	(0.050)	(0.083)	(0.076)	(0.080)
econo×*D*	0.717***	0.682***	——	——
	(0.113)	(0.116)	——	——
econo	−0.138**	0.313***	——	——
	(0.056)	(0.086)	——	——
gtfp×*D*	——	——	0.180**	0.058
	——	——	(0.089)	(0.078)
gtfp	——	——	−0.024*	−0.057*
	——	——	(0.012)	(0.030)
Control variable	√	√	√	√
Fixed effects for year	√	√	√	√
Fixed effects for city	√	√	√	√
Constant term	−0.831***	−11.117***	−0.848**	−11.364***
	(0.313)	(0.444)	(0.328)	(0.453)
Sample size	4501	4237	4501	4237
R^2	0.230	0.679	0.199	0.672
F	15.668	297.084	14.546	257.316

6. Conclusions and Policy Implications

Urbanization in China has greatly improved people's well-being and alleviate global poverty. However, issues such as environmental pollution and unequal public services should not be ignored. To improve the quality of urban development, Chinese government has launched a competition for civilized city. In the new stage of high-quality development, this paper uses panel data from 285 prefecture-level cities between 2000 and 2018 and introduces a difference-in-differences (DID) model to investigate the impact of civilized city campaign on urban innovation.

The study found that the campaign of civilized city significantly improved urban innovation capability. Mechanism analysis shows that the campaign of civilized city effectively attracts high-skilled labor force aggregation and increases public R&D expenditure. In addition, the campaign of civilized city enhances urban industrial, population, and financial agglomeration effects, and these factors directly and indirectly improve urban innovation levels. Heterogeneity analysis shows that the promotion effect of civilized city campaign on urban innovation is better for economically active and high-level green development cities.

Based on these findings, this paper proposes the following policy implications:

1) Local governments should focus on building a city brand. As the campaign of civilized city will bring positive effects such as improving urban innovation and enhancing the agglomeration economy, local governments should continue to promote relevant construction of civilized city, improve the strength of urban hardware and software, and prevent the title from being "stripped". Local governments can increase the influence of city brands by strengthening propaganda, such as disseminating city feature images, local customs, and cuisines.

2) Guide cities towards becoming livable cities. There are many overlaps between civilized city and livable city. To increase urban development momentum, local governments need to vigorously implement talent introduction policies, optimize urban infrastructure construction, increase public domain expenditure on education, research, and medical care, and provide more preferential policy support for innovative enterprises.

3) Build a more inclusive city. Deepening the reform of the household registration system is an effective measure to release economic momentum and also the best choice to promote China's urbanization and enhance the agglomeration economy of cities. To further deepen the reform of the household registration system, breakthroughs can be made in the following two directions: First, accelerate the reduction of the development gap between urban and rural areas, using sustainable development as the main means to resolve the various contradictions caused by the current household registration system; Second, enhance the enthusiasm of local governments to promote reforms and reasonably balance the interests among the stakeholders related to the household registration system.

Data Availability Statement

This paper includes different data source, main of them are at https://data.cnki.net. If there is any problem, please contact liweitao2016@126.com.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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