Can the Establishment of University Science and Technology Parks Promote Urban Innovation? Evidence from China

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Abstract: China’s university science and technology parks (USTPs) were established with the aim of closely combining the scientific and educational intellectual resources of universities with the advantageous innovation resources of the market to form a fusion of industry and education. This paper uses the establishment of national university science and technology parks (NUSTPs) as a “quasi-natural experiment.” We used the panel data of 293 cities from 1999 to 2017 as a sample to analyze the impact of NUSTP establishment on urban innovation, using the difference-in-difference method. The research found the following: (1) The establishment of NUSTPs significantly improves the level of urban innovation, and the conclusion is still valid after a series of robustness tests. The urban innovation effect of the establishment of NUSTPs is dynamic, non-lagging, and continuous. (2) The innovation effect differs significantly, depending on the city region, the city scale, and the university level. Specifically, the innovation effect of the establishment of NUSTPs is significant for cities in middle and western cities, large-scale cities, and cities with double first-class and local universities setting up USTPs, while the effect is not significant for cities in eastern cities, small- and medium-scale cities, and non-double first-class and ministry-affiliated institutions. (3) The impact mechanism test shows that NUSTPs contribute to urban innovation by increasing the city’s human capital, enhancing the degree of industrial agglomeration, and creating an innovation space effect.

Keywords: national university science and technology parks; urban innovation; DID; quasi-natural experiments

1. Introduction

1.1. Background

Innovation as China’s development strategy is the subject of various government work reports, and innovation plays a vital role in the transformation of China’s economic development. However, with the deterioration of the international trade situation and the successful implementation of the domestic “double-cycle,” a lack of innovation capacity in the quality of economic development constraints has gradually emerged. China’s economic development has changed from high-speed development to a high-quality development stage. High-quality economic development needs the support of innovation, and the role of innovation in this development is becoming increasingly obvious [1]. However, compared with foreign countries, the international competitiveness of China’s independent innovation is still slightly weak, and there are problems, such as the insufficient power of independent research and development, and a strong dependence on foreign technology [2]. The research and development expenditures of Chinese central enterprises (Chinese central enterprises are referred to as “centrally managed enterprises”, which are wholly state-owned or state-controlled enterprises that are managed by the Central People’s Government (State Council) or entrusted by the State-Owned Assets Supervision and Administration Organization (SASAC) or other central ministries (associations). According to the division of China’s state-owned assets management authority, state-owned
enterprises are divided into central enterprises (state-owned enterprises that are supervised and managed by the central government) and local enterprises (state-owned enterprises that are supervised and managed by local governments) are growing at an average annual rate of over 25%, but R&D investment is still low [2]. Utilizing the resource advantages of the innovation subjects and thus generating innovation synergies determines whether China’s economy can be successfully transformed into a high-quality development track.

To fully implement the strategy of independent innovation, China promulgated the document entitled “Decision of the State Council of the CPC Central Committee on Strengthening Technological Innovation, Developing High Technology and Realizing Industrialization” in 1999, which encouraged university teachers and researchers to enter high-tech industrial development zones to engage in the transformation of scientific and technological achievements, and supported the development of USTPs. To implement the above decision, the Ministry of Science and Technology and the Ministry of Education jointly launched the construction of a National University Science and Technology Park (NUSTP), which elevated their establishment to the national level and made it an important strategic decision. NUSTPs incubate high-tech industries to drive industrial upgrading, which in turn promotes regional economic development, and talent is an indispensable key resource element for innovation [3]. With USTPs as a platform linking the government, industry, and academia, superior resources and talents are injected into the high-tech enterprises incubated in science and technology parks to accelerate the transformation of scientific and technological achievements, form a complete industrial chain, improve the efficiency of innovation, and drive the innovation of the whole region. The NUSTP has become an important base for incubating high-tech enterprises, transforming high-tech achievements, and cultivating strategic emerging industries, and is an important part of the national innovation system and higher education system with Chinese characteristics.

With the promotion of NUSTPs, the USTP platform is conducive to the concentration of senior and technical talents in the region where it is located, and it enhances the regional innovation strength. The synergistic innovation effect of an NUSTP gradually radiates to the region where it is located, driving the innovation development of the region. For example, since its establishment, the Hefei National Science and Technology Park (Hefei National University Science and Technology Park is one of the 15 pilot units approved by the Ministry of Science and Technology and the Ministry of Education of China in December 1999 for the construction of an NUSTP. The Hefei NUSTP is located in the west of Hefei city, situated in the Hefei High-Tech Industrial Development Zone, one of the five state-level high-tech industrial development zones open to APEC, which is planned to cover an area of 3000 mu and is linked to more than 10 universities, including University of Science and Technology of China, Hefei University of Technology, Anhui University, and PLA Electronic Engineering College) has been built into a model base for innovation in Hefei, with a total of 540 enterprises incubated, 124 graduated, 181 high-tech enterprises cultivated, and 2187 intellectual property rights accumulated by enterprises, including 367 invention patents, which has greatly enhanced the overall innovation level of Hefei. The Shanghai National University Science and Technology Park (The development of Shanghai University Science and Technology Park also began in 1991. After nearly 30 years of development, the city has 14 NUSTPs, accounting for 10% of China’s total, mainly including the Shanghai Jiao Tong University National University Science and Technology Park, the Fudan University National Science and Technology Park, and so on) in 2017 housed more than 1400 enterprises, graduated nearly 1200 enterprises, and incubated enterprises applying for more than 950 patents, including 300 invention patents, and these innovations have made remarkable achievements in serving local regional economic development. At the same time, the NUSTPs with double-class universities are having great innovative effects. For example, 29 new high-tech enterprises were added to the National University Science and Technology Park of Southeast University in 2018, which continuously injects new vitality into the regional economic development and the construction of Nanjing’s famous innovation city. Thus, the establishment of NUSTPs is conducive to improving
the transformation of scientific and technological achievements between universities and enterprises, promoting regional innovation, and playing a leading and exemplary role.

The NUSTP is an important platform for higher education institutions to combine production, education, and research, serve society, cultivate innovative and entrepreneurial talents, and promote the main source of innovation for the technological progress of regional industries. An NUSTP builds a platform for the integration of industry and education. The accumulated scientific and technological achievements of higher education lack the support of industrialization. Industrial sectors with commercialization need new scientific and technological achievements to enhance competitiveness. The two are highly coupled in the transformation of scientific and technological achievements [4]. The initial purpose of an NUSTP is to break the barriers between universities and industry, and promote the industrialization of the scientific and technological achievements of universities. The industry should deploy the innovation chain around the industrial chain, and guide universities to build industry–education integration technology parks to promote the timely transformation of scientific and technological achievements [5]. The integration of industry and education plays an important role in transforming scientific and technological achievements and promoting regional innovation [6].

1.2. Purpose of This Research

NUSTPs, which took shape in 1999, have been around for a long time, so the innovation effect of the “industry–education convergence” created by these NUSTPs needs to be reasonably and accurately evaluated. This requires an assessment not only of the conversion rate of the USTPs themselves, but also of the innovation opportunities and development of the regions where they are located. An NUSTP with Chinese characteristics is obviously a macro-level policy factor in China. Regarding the effect of an NUSTP on urban innovation and whether the original purpose of an NUSTP is achieved, the existing research is lacking, and quantitative research related to the establishment of NUSTPs is even scarcer. A review of the literature reveals that some studies have analyzed the impact of NUSTPs only [7]. Previous studies have focused on exploring them from a city perspective, while the impact of NUSTPs, which have been implemented in cities for more than two decades, on regional innovation has not been effectively studied. In China, it has been 20 years since the establishment of NUSTPs, but there is a lack of quantitative analysis of the impact of NUSTP establishment on urban innovation. The literature [8] shows that studies related to UK and US parks are mainly due to the availability of data; in China and Spain, the emphasis is mainly on case studies. Therefore, using data to quantitatively assess the impact of NUSTPs with Chinese characteristics on urban innovation can provide policy development ideas for the Chinese government. Based on this, we evaluate the effectiveness of the implementation of NUSTPs established in 2002. The establishment of NUSTPs has been steadily promoted in batches and over many years, which provides a good “quasi-natural experiment.” To this end, we use the difference-in-differences method to explore the impact of NUSTP establishment on urban innovation, and empirically analyze its impact mechanism, using 293 cities from 1999 to 2017. The possible contributions of this paper are as follows: (1) In terms of research objects, from the perspective of industry–education integration resulting from USTPs, the impact on urban innovation is comprehensively analyzed with or without the establishment of NUSTPs, which enriches and expands the micro-empirical evidence of the impact of NUSTPs on regional innovation by combining industry–university research, and at the same time, more systematically explores the impact mechanism of the role of NUSTPs on regional innovation, broadening the research perspective of innovation theory. In contrast, previous studies mainly started from the fact that NUSTPs were established [9,10] and did not systematically explore the impact on the region. (2) This paper provides a more comprehensive assessment of the urban innovation effects brought about by the establishment of NUSTPs. Although the establishment of NUSTPs draws on the experiences of European and American countries, China is still lacking in experience and has distinct Chinese characteristics. At the same time, exploring
the mechanism of the role of the establishment of NUSTPs on urban innovation can provide insights into the channels through which the NUSTPs in China influence urban innovation and provide directions for the future improvement of USTP establishment.

1.3. Structure

The remainder of the paper is organized as follows: Section 2 describes the methodology and how the double difference model is constructed, Section 3 presents the data, Section 4 presents the results and a discussion, Section 5 provides an analysis of heterogeneity and impact mechanisms, Section 6 contains the conclusion and policy recommendations, and Section 7 expresses the limitations of the paper and recommendations for future research.

2. Methodology

In order to analyze the impact of the establishment of NUSTPs on urban innovation, we refer to Beck et al. (2010) [11] and define the following difference-in-difference (DID) model:

$$ y_{i,t} = \alpha + \theta (treat_i \times post_{i,t}) + \beta X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t} $$

where $y_{i,t}$ is the dependent variable, $i$ ($i = 1, 2, \ldots, N$) is the individual, $t$ ($t = 1, 2, \ldots, T$) is the time, $\mu_i$ is the individual fixed effect, $\lambda_t$ is the time fixed effect, $X$ is the control variable that changes with time and the individual, $\hat{\beta}$ is the coefficient of the control variable, and $\epsilon_{i,t}$ is the model error term. The variable $treat$ is the dummy variable of the treated group. If individual $i$ belongs to the “treated group”, i.e., is impacted by the policy, then $treat = 1$; if the individual $i$ belongs to the “control group”, i.e., is not impacted by the policy, then $treat = 0$ [2]. The variable $post$ is the dummy variable in the processing period, and the individual in the processing group will not be impacted by the policy until the processing period. If individual $i$ enters the processing period, then $post = 1$; otherwise, $post = 0$.

The cross-multiplication term $treat_i \times post_{i,t}$ in the above model is equivalent to the dummy variable ($did_{i,t}$), representing that individual $i$ is processed in the $t$ period. Therefore, the DID model can also be set as follows [2]:

$$ y_{i,t} = \alpha + \theta did_{i,t} + \beta X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t} $$

Based on the above analysis, we constructed a DID model to evaluate the policy effects of the establishment of NUSTPs on the level of urban innovation. Since NUSTPs are implemented in different regions and at different times, we built a time-varying DID model for the analysis. The model is established as follows:

$$ innovation_{i,t} = \beta_0 + \beta_1 did_{i,t} + \beta_2 X_{i,t} + \mu_i + \lambda_t + \epsilon_{i,t} $$

where $i$ is the city individual, $t$ is the time, $innovation$ is the urban innovation, and $X$ is the control variable. The variable $did$ is the constructed difference-in-difference item, i.e., the year when the city first established the NUSTP and subsequent years are defined as $did = 1$; otherwise, $did = 0$. The estimated coefficient $\beta_1$ is the impact of the establishment of NUSTPs on urban innovation.

3. Data

(1) Explained variable

The explained variable in this paper is urban innovation ($innovation$). In this paper, we use the number of city invention patents granted to indicate the urban innovation [2,12]. The number of city patents is processed by adding 1 and taking the natural logarithm ($\ln\text{patent}$), and the number of patents granted per capita in millions ($\text{patent}$) is used to measure the innovation potential of cities. The number of patents granted for inventions is used, because first, patent data are open, objective, and rarely manipulated [13]; second, patents for inventions are expensive to develop, have more complex technologies, and better reflect the substantive level of regional innovation.
(2) Explanatory variable

The variable $did$ is the main explanatory variable. Some cities have NUSTPs established in different years. For this reason, this paper constructs a difference-in-difference term with the earliest establishment time.

(3) Control variables

Based on the approach of the available literature, the control variables affecting urban innovation are measured as follows. The level of urban economic development ($lnpgd$) is measured using the logarithm of GDP per capita [2]. Industrial structure upgrading ($advance$) is based on the measure of industrial structure advancement. (The specific expression is $advance = \sum_{i=1}^{3} w_i y_i$, where $w_i$ is the weight and $y_i$ is the proportion of each industry, and the weight is obtained using the entropy weight method.) The level of foreign openness ($fdi$) is measured by the proportion of foreign real investment to GDP, which is calculated using the annual average exchange rate of RMB to USD. The higher the level of economic development of a city, the better the environment is for attracting high-level talent for employment and entrepreneurship, and the more favorable the local government’s financial spending is on urban innovation activities in general. The level of financial development ($fin$) is measured using the city’s year-end financial institution deposit balance-to-GDP ratio. Population size ($lnpop$) is measured using the logarithm of the city’s year-end total population. The science development level ($science$) is measured via the ratio of the city’s year-end expenditure on science to GDP.

The data in this paper were obtained from the China Research Data Service Platform (CNRDS) and the China City Statistical Yearbook 2000–2018. The sample period of 1999–2017 was selected, in order to retain as much information as possible from the city statistical yearbook. Cities with serious omissions of variables were removed, and the missing values of some variables were completed using the method of the average annual growth rate of cities. Finally, non-parallel panel data of 293 cities with a total of 5469 observations from 1999 to 2017 were obtained, including 52 cities with USTPs in the treated group and 241 cities without USTPs in the control group. The statistics of the variables are shown in Table 1.

Table 1. Statistical description of variables.

| Variable | Mean  | SD    | Min  | Max   | Obs. |
|----------|-------|-------|------|-------|------|
| lnpatent | 3.293 | 1.998 | 0.000 | 10.736| 5469 |
| patent   | 4.331 | 12.906| 0.001 | 215.644| 5469 |
| did      | 0.105 | 0.307 | 0.000 | 1.000 | 5469 |
| lnpgdp   | 9.809 | 0.977 | 6.638 | 13.156| 5469 |
| advance  | 0.271 | 0.043 | 0.105 | 0.407 | 5469 |
| fdi      | 0.033 | 0.140 | 0.000 | 7.495 | 5469 |
| fin      | 1.100 | 0.780 | 0.132 | 16.743| 5469 |
| lnpop    | 15.044| 0.709 | 11.888| 18.525| 5469 |
| science  | 0.028 | 0.041 | 0.000 | 1.042 | 5469 |

4. Results and Discussion

4.1. DID Results Analysis

4.1.1. Basic Results Analysis

Table 2 shows the fixed effects regression results of the DID method. Column (1) and (2) are the regression results without control variables, and Column (3) and (4) are the regression results with control variables. It is clear that the estimated coefficient of $did$ is significantly positive at the 1% level with or without the inclusion of control variables, which indicates that the establishment of NUSTPs is conducive to the improvement of the city’s innovation level. Specifically, in Column (3), after controlling for time and industry effects and adding control variables, the regression coefficient of $did$ is 0.400, indicating
that the establishment of NUSTPs increases patents by 40% in cities with USTPs, and the
results in Column (4) further indicate that the establishment of NUSTPs increases patents
by 10.470 per million people in cities. Therefore, the establishment of NUSTPs is conducive
to improving the level of innovation in the city. On the one hand, the establishment
of NUSTPs can give full play to the advantages of university research institutions and
implement the transformation of scientific research results, which in turn promotes the
overall innovation of the city. On the other hand, the establishment of NUSTPs can incubate
high-tech enterprises, and the gathering of high-tech industries tends to increase the inflow
of labor factors, talent factors, and R&D factors, providing various favorable resources for
urban innovation and thus facilitating urban innovation.

Table 2. Results of DID analysis.

| Variable     | (1)       | (2)       | (3)       | (4)       |
|--------------|-----------|-----------|-----------|-----------|
|              | lnpatent  | patent    | lnpatent  | patent    |
| did          | 0.437 *** | 11.075 ***| 0.400 *** | 10.470 ***|
|              | (9.50)    | (16.84)   | (8.84)    | (15.92)   |
| lnpgdp       | −0.074 *  | 2.130 *** | −7.528 ***| 54.092 ***|
|              | (−1.86)   | (3.71)    | (−14.86)  | (7.36)    |
| advance      | −0.039    | −0.743    | −0.66     | −0.87     |
|              | (−0.66)   | (−0.87)   | (−0.66)   | (−0.87)   |
| fdi          | 0.030     | −0.023    | 0.157 **  | 1.061     |
|              | (1.49)    | (−0.08)   | (2.51)    | (1.17)    |
| lnpop        | −2.821 ***| −31.539 ***| −2.821 ***| −31.539 ***|
|              | (−7.27)   | (−5.60)   | (−7.27)   | (−5.60)   |
| _cons        | 1.095 *** | 0.513     | 1.805     | −51.185 ***|
|              | (31.99)   | (1.05)    | (1.47)    | (−2.86)   |
| Time dummies | Yes       | Yes       | Yes       | Yes       |
| N Obs.       | 5469      | 5469      | 5469      | 5469      |
| R²           | 0.921     | 0.611     | 0.925     | 0.622     |

Note: t statistics in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01.

4.1.2. Discussion of Results

China’s USTPs have gradually evolved from providing mainly entrepreneurial origins
to innovation platforms for high-tech incubation, the transformation of scientific and
technological achievements, and policy consultation. The high-tech enterprises incubated
in USTPs are essentially a kind of business incubator [14], and the incubated enterprises
are prone to forming high-tech industrial clusters. To achieve the incubation and industrial
clustering effect, the environment and conditions for the growth of USTPs need to be given.
Under the same conditions, USTPs can accelerate the exchange of new knowledge and
bring into play the synergistic effect between innovation agents [15]. A university science
and technology park can make universities, enterprises, and the government cooperate
with each other, break the barriers between resources, effectively integrate the innovation
elements needed by innovation subjects, and form a collaborative innovation network with
complementary resource advantages for each party.

The main reasons an NUSTP enhances urban innovation are threefold. (1) For regional
innovation, the establishment of NUSTPs can promote effective knowledge spillover and
diffusion in the region, and the concentration of their advantageous resources facilitates
the construction of a network platform for innovation clustering, which in turn promotes
the dynamic opening and continuous evolution of regional innovation, and ultimately
enhances the independent innovation capability of the region. (2) For cities, NUSTPs lead
to high-level human capital, and incubated enterprises gradually form high-tech industrial
clusters, which constitute the rich knowledge reserve of the region and provide the most
basic guarantee for regional innovation. The innovation network formed by the agglomeration effect can promote flow among various elements and form a spatial innovation network of regional knowledge sharing, which can promote the overall innovation level of the region. (3) In 2018, China’s Ministry of Finance and the General Administration of Taxation introduced tax exemptions for enterprises incubated in NUSTPs, and these tax exemptions promoted the outsourcing of service projects and the level of investment in the main business of incubated enterprises, boosting the investment demand of incubated enterprises and the substitution of capital for labor \cite{16,17}, which in turn enhanced the R&D intensity of the incubated enterprises, promoted the innovation of the incubated enterprises, facilitated the incubation of the results of the NUSTP, and thus improved the regional innovation level.

Our results differ from the literature \cite{18}, which states that the more involved a university is in the management of an engaged campus, the slower the firm brings innovation to market. An analysis of Spanish science and technology parks in the literature \cite{19} found that university participation in science and technology parks had a negative impact on tenants’ innovation sales, but a positive impact on the number of patent applications. The reason for the different results is that Chinese USTPs are mainly government-led and require innovative outputs, while foreign science and technology parks are mainly determined by the universities themselves, and the outputs may not be announced or made public to the government. Therefore, foreign scholars lack data for empirical analysis, and the lack of data is similar to the literature \cite{8}.

4.2. Parallel Trend Test and Dynamic Effects

The DID method requires that no significant differences exist between the treated and control groups prior to the establishment of NUSTPs, or, if differences do exist, they do not change sharply over time. For this reason, a parallel trend test is required to ensure that the DID method used in this paper satisfies the parallel trend. At the same time, although the previous analysis showed that the establishment of NUSTPs has a significant contribution to urban innovation, the above estimates only average the treatment effect and do not distinguish whether there is a time lag and or persistence of the effect of NUSTP on urban innovation. To this end, we refer to Bertrand and Mullainathan’s (2003) model setting approach and add further dummy variables around the time of establishment of the NUSTP to test for parallel trends and to analyze dynamic effects. Thus, the following model is constructed for this purpose \cite{2,20}:

\[
\text{innovation}_{i,t} = \beta_0 + \beta_1 \text{before3}_{i,t} + \beta_2 \text{before2}_{i,t} + \beta_3 \text{before1}_{i,t} + \beta_4 \text{current}_{i,t} + \\
+ \beta_5 \text{after1}_{i,t} + \beta_6 \text{after2}_{i,t} + \beta_7 \text{after3}_{i,t} + \sum_{j=8}^{13} \alpha_j X_{i,t} + \mu_i + \varphi_t + \epsilon_{it}
\] (4)

where \text{before3}, \text{before2}, \text{before1}, \text{current}, \text{after1}, \text{after2}, and \text{after3} are dummy variables, which are observations from 3 years before, 2 years before, 1 year before, the current year, 1 year after, 2 years after, and 3 years after the city establishes an NUSTP, respectively. That is, the difference-in-difference term constructed in the previous section is intersected with these established year dummy variables. If the estimated coefficients of \text{before} are mostly insignificant or less significant, then there is no significant difference between the treated and control groups before the establishment of NUSTPs, which indicates that the parallel trend hypothesis is satisfied, and the parallel trend test is passed.

Table 3 shows the estimation results of the parallel trend test. It can be seen that none of the estimated coefficients of the \text{before} variables are significant, indicating that there is no significant difference between the experimental group and the control group before the establishment of NUSTPs, satisfying the parallel trend hypothesis. Meanwhile, the estimated coefficients of the \text{current} variable are significantly positive at least at the 5% level, indicating the establishment of NUSTPs worked in the current year, and there is no time lag on the impact on urban innovation. The estimated coefficients of the \text{after} variables are all significant, indicating that the impact of the establishment of NUSTPs on urban
innovation is persistent. However, when the number of city patents (lnpatent) is used as the explanatory variable, the estimated coefficient is the largest in the year of establishment (current), then decreases in the following two years, and then increases in the following three years; when the number of patents per million (patent) is used as the explanatory variable, it is largest in the year of establishment and then decreases gradually.

Table 3. Results of the parallel trend test and dynamic effects.

| Variable | (1) | (2) |
|----------|-----|-----|
|          | lnpatent | patent |
| before3  | −0.209 (−1.54) | 7.610 (1.33) |
| before2  | 0.249 (1.03) | 7.241 (1.03) |
| before1  | 0.195 (1.37) | 7.360 (1.13) |
| current  | 0.191 ** (2.32) | 6.563 *** (5.46) |
| after1   | 0.100 ** (2.21) | 4.681 *** (3.89) |
| after2   | 0.035 *** (3.42) | 3.508 *** (2.92) |
| after3   | 0.065 *** (2.79) | 2.163 * (1.80) |
| Control variables | Yes | Yes |
| Time dummies | Yes | Yes |
| N Obs.    | 5469 | 5469 |
| R²        | 0.924 | 0.612 |

Note: * indicates p < 0.1, ** p < 0.05, *** p < 0.01.

This phenomenon may be explained by the fact that, when establishing a USTP in China, it is necessary to assess the level of scientific and technological innovation, and the ability to transform the results of the university. Therefore, before the establishment of the park, the university has already “worked hard” on the results of innovation, and the preliminary effect is significant. In conclusion, the establishment of NUSTPs has a dynamic effect on urban innovation without a lagging effect, and it has a sustained effect in the short term.

4.3. Robustness Test

4.3.1. PSM-DID

The establishment of NUSTPs is not completely random. For example, the latest pilot NUSTPs are in the cities of Beijing, Shanghai, Tianjin, and other economically developed, university-rich mega-cities. These cities’ innovation environments and the ability to transform the scientific and technological achievements of universities are significantly greater than those of other cities, so it is possible to distort the urban innovation effect of the establishment of NUSTPs if the reasons for why they were established are not taken into account. At the same time, although the impact of NUSTPs on urban innovation can be obtained using the DID method, the development of cities also exhibits greater heterogeneity over time, and the characteristics of cities change over time. Therefore, it is difficult to ensure that the basic characteristics of the treated and control groups are as similar as possible. To address these issues, and to further confirm the causal effect of NUSTPs on urban innovation, we used the propensity score matching model (PSM) developed by Heckman (1979) [21] and Rosenbaum and Rubin (1983) [22] to find a close control group of cities for the establishment of NUSTPs. Although the PSM can correct for any sample selection bias, it only relies on observable variables to calculate propensity scores and pair cities based on propensity score values, thus ignoring the effects of co-shocks of unobserved factors on urban innovation, which in turn leads to endogeneity problems due to omitted variables.
The DID, on the other hand, cannot solve the sample selection bias problem well, but it can better avoid the endogeneity problem and obtain the effect of the establishment of NUSTPs. Therefore, applying the DID method based on the PSM to estimate the impact of the establishment of NUSTPs on urban innovation can well overcome the above problems.

In summary, the PSM-DID method was used to analyze the impact of the establishment of NUSTPs on urban innovation, which can effectively avoid the problem that “quasi-natural experiments” are not completely randomized, and reduce systematic differences. The PSM-DID method is based on (1) adding the variables that cities need to match, (2) regressing the dummy variables between the experimental and control groups using the Logit method, so that the matching variables are reduced to a single value, and (3) using the value as the propensity score to match the cities in the control group that are closest to the experimental group, and finally conducting DID regression with the matched data.

We used the $k$-nearest neighbor matching method ($k = 4$, $R = 0.05$) to analyze the matching effect. The premise of matching using the PSM model is to satisfy the parallel assumption and the common support assumption. The parallel assumption requires that the basic characteristics of the covariates (matched variables) of the treated and control groups do not differ significantly after matching. That is, the covariates of the treated and control groups are balanced. The matching effect is shown in Figure 1. As can be seen in Figure 1, the points representing the variables before matching are far from the vertical line with a standard error of 0, indicating a large difference between the covariates, and most of the points after matching are near the vertical line, indicating that there is no significant difference between the covariates. The common support assumption can be judged by the receiver operating characteristic (ROC) curve, and the principle of satisfying the common support assumption is that the AUC (area under the curve) result after matching is close to 0.5. The closer it is to 0.5, the better the matching effect is. It can be seen in Figure 2 that the area under the ROC line is 0.5144, which is relatively close to 0.5, indicating that it passes the common support hypothesis test. Therefore, the PSM-DID model used in this paper can better solve the problem of non-complete randomness and endogeneity.

![Figure 1. Standardized % bias across covariates. Note: The covariates here are also control variables.](image-url)
model used in this paper can better solve the problem of non-complete randomness and endogeneity.

Figure 1. Standardized % bias across covariates. Note: The covariates here are also control variables.

Figure 2. ROC curve.

After matching is completed, observations that do not satisfy the common region assumption are removed. In order to ensure the robustness of the results obtained from the DID analysis of the matched data, the kernel matching method is also used in this paper for the analysis of the results. As can be seen in Table 4, the estimated coefficients of did are significantly positive at the 1% level, regardless of whether the k-nearest neighbor matching and or kernel matching methods are used, indicating that the establishment of an NUSTP has a significant promotion effect on urban innovation.

Table 4. Results of PSM-DID.

| Variable            | k-Nearest Neighbor Matching | Kernel Matching |
|---------------------|-----------------------------|-----------------|
|                     | Inpatent | patent | Inpatent | patent |
| did                 | 0.294*** | 7.809*** | 0.397*** | 10.269*** |
|                     | (6.50)   | (12.42) | (8.76)   | (16.04)  |
| Control variables   | Yes      | Yes    | Yes      | Yes     |
| Time dummies        | Yes      | Yes    | Yes      | Yes     |
| N Obs.              | 5093     | 5093   | 5460     | 5460    |
| R²                  | 0.923    | 0.611  | 0.924    | 0.616   |

*** p < 0.01.

4.3.2. Substitute Variable Test

Considering that patents have a long period during R&D from application to final grant, in order to further ensure the robustness of the previous estimation results, the measures of urban technology innovation (Inpatent, patent) are lagged by one and two periods, respectively, for regression. Meanwhile, the robustness test is performed using the city innovation index (index) from the report of Kou and Liu (2017), which is based on city patents and calculated using the patent update model to obtain city-level innovation with objectivity [23]. If the estimated coefficient of did remains significantly positive, then the estimation results of this paper are robust and reliable. The results in Table 5 show that, after lagging the number of city patents (Inpatent) and the number of patents per million (patent) by one and two periods, respectively, the estimated coefficients of did are still both significantly positive at the 1% level, indicating that the estimation results in this paper are still reliable, even after considering the time lag of city patents. Column (5) uses the
city innovation index (index) to measure the overall level of innovation in cities, and the estimated coefficient of did remains significantly positive at the 1% level, indicating that the previous estimation results are robust and reliable.

Table 5. Substitute variable test results.

| Variable                  | (1)       | (2)       | (3)       | (4)       | (5)       |
|---------------------------|-----------|-----------|-----------|-----------|-----------|
| L.lnpatent                | 0.413 *** | 0.398 *** | 8.700 *** | 7.391 *** | 14.787 ***|
| L2.lnpatent               |           |           | (13.70)   | (11.42)   | (5.99)    |
| L.Patent * L2.Patent * Index |          |           |           |           |           |
| did                       | (8.56)    | (7.66)    | (13.70)   | (11.42)   | (5.99)    |
| Control variables         | Yes       | Yes       | Yes       | Yes       | Yes       |
| Time dummies              | Yes       | Yes       | Yes       | Yes       | Yes       |
| N Obs.                    | 5175      | 4881      | 5175      | 4881      | 4593      |
| R²                        | 0.922     | 0.918     | 0.628     | 0.616     | 0.534     |

* L. indicates a lag of one period and L2. indicates a lag of two periods. *** p < 0.01.

4.3.3. Uniqueness Test of Policy Effect

The level of urban innovation may not only be influenced by the establishment of NUSTPs, but other urban policies may also affect urban innovation, possibly causing overestimations in the results. To address this, we searched for major urban policies in China and found that China implemented the innovative city pilot policy in 2008 and the pilot policy of smart city construction in 2012, both of which occurred after the establishment of NUSTPs in 2002, but jointly influenced urban innovation to some extent in the later period, leading to an overestimation of the innovation effect of the establishment of NUSTPs in this paper. To address this, we further added difference-in-difference terms of the innovation city pilot policy (did1) and the smart city pilot policy (did2) to the model, and performed estimations using the DID method.

Column (1) and (2) in Table 6 report the results of the policy uniqueness test estimates. The estimated coefficients of did remain significantly positive at the 1% level, and the positive and negative signs and the significance of the estimated coefficients do not fundamentally change compared to the baseline regression coefficients in Table 2, with a small overall decrease in the coefficient estimates, mainly because the estimated coefficients of did1 and did2 are significant, and the innovative city pilot policies and smart city pilot policies conducted by the country at a later stage had some impact on urban innovation. However, the impact of the establishment of NUSTPs on urban innovation does not change significantly due to the establishment of other pilot policies, and the establishment of NUSTPs is still shown to have a significant impact on urban innovation, further indicating the good robustness of the estimation results in this paper.

Table 6. Results of policy uniqueness estimation.

| Variable                  | (1)      | (2)      |
|---------------------------|----------|----------|
|                           | lnpatent | Patent   |
| did                       | 0.360 *** | 8.382 ***|
|                           | (8.79)   | (14.00)  |
| did1                      | 0.396 *** | 1.923 *  |
|                           | (5.75)   | (1.91)   |
| did2                      | 3.612 *** | 15.733 ***|
|                           | (43.69)  | (13.00)  |
| Control variables         | Yes      | Yes      |
| Time dummies              | Yes      | Yes      |
| N Obs.                    | 5469     | 5469     |
| R²                        | 0.926    | 0.618    |

*p < 0.1, *** p < 0.01.
4.3.4. Counterfactual Test

The above tests suggest that NUSTPs have a significant impact on urban innovation, but further tests using counterfactual methods are still needed. A year from 1999 to 2017 was randomly selected as the time of the establishment of NUSTPs among 52 cities with NUSTPs, to construct a counterfactual difference-in-difference term. In this paper, 500 random samples were taken, and the empirical p-value was calculated for each time and plotted on a scatter plot. If the empirical p-values obtained from 500 random draws are mostly greater than 0.1 and the estimated results are significantly different from the estimated coefficients of did in Table 2, then the counterfactual test passes, and the estimation results of this paper are robust. As can be seen in Figure 3, most of the p-values obtained from the counterfactual tests are greater than 0.1 and deviate from the estimates of did in Table 2 by 0.400 and 10.470, indicating that the estimation results of this paper remain robust.

![Figure 3. Estimated results of 500 samplings using the bootstrap method.](image)

5. Analysis of Heterogeneity and Influence Mechanism

5.1. Analysis of Regional Heterogeneity

Due to the uneven distribution of Chinese universities, there are many universities in eastern cities with USTPs, while there are fewer universities in mid-western regions with such parks. However, with better economic development and a strong innovation atmosphere in the eastern region, the impact of establishing a USTP on urban innovation may be overshadowed by other policies or resources, and the role of the NUSTPs in regional innovation is unknown. For example, the eastern region has a large concentration of innovative resources and talents, and the innovation effect is significant in a good atmosphere, while the establishment of NUSTPs can only be considered to be the “icing on the cake.” However, in the mid-western region, due to the lack of innovative environment and competitive talent resources, the establishment of NUSTPs can rapidly transform scientific and technological achievements and enhance the local innovation level. However, due to the geographical location and the level of economic development of the mid-western regions, it is worth exploring how large the impact of an NUSTP is, and whether the “innovation effect” from the establishment of NUSTPs is greater than the economic and geographical “limitation effect.”
At the same time, the size of the city also affects the impact of the establishment of USTPs on regional innovation. When NUSTPs are established in large cities, innovation resources are more concentrated, while in small and medium-sized cities, there are fewer innovation factors, the number of NUSTPs established is limited, and the effect on regional innovation may not yet be apparent. Due to the large differences among universities, double-class universities and universities under the ministry have a higher position and more abundant development resources available, and these universities have more innovative resources to establish science and technology parks. The impact of the scientific and technological achievements on regional innovation may not be evident, due to a lack of sufficient innovative elements and the late establishment of NUSTPs of non-dual top universities. In addition, the NUSTPs of the ministry’s universities are more inclined toward cross-regional cooperation, and the transformation of their scientific and technological achievements do not remain in the local city, while most of the USTPs of local universities are concentrated in prefecture-level cities, with limited access to resources. When USTPs are established, they can obtain policy preferences, and the transformation of their scientific and technological achievements can all remain in their cities. There are differences in these two kinds of innovation results of transformation. How exactly do these two types of USTPs contribute to urban innovation? Therefore, this paper analyzes the heterogeneity in four aspects: urban region heterogeneity, city-size heterogeneity, whether the city has double-class universities, and ministerial and local university heterogeneity. Table 7 reports the heterogeneity test results. (The heterogeneity and mechanism of action analysis only presents the results for the number of patents granted in cities (lnpatent) as an explanatory variable. The regression results for the number of patents granted per million (patent) as the solved variable are consistent with the results for lnpatent as the explained variable.)

Table 7. Results of heterogeneity estimation.

| Variable                      | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|-------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
|                               | Eastern Cities | Mid-Western Cities | Small and Medium-Sized Cities | Large Cities | Cities with Double-Class Universities | Cities without Double-Class Universities | Local University City | Ministerial University City |
| did                           | 0.175 | 0.310*** | 0.179 | 0.404*** | 0.257 | 0.246** | 0.283** | 0.150 |
| (1.27)                        | (2.88) | (1.02) | (4.07) | (1.46) | (2.23) | (2.13) | (1.04) | |
| Control variables             | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time dummies                  | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N Obs.                        | 2256 | 3213 | 3693 | 1776 | 4709 | 760 | 5051 | 418 |
| R²                            | 0.934 | 0.924 | 0.893 | 0.957 | 0.893 | 0.965 | 0.902 | 0.973 |

**p < 0.05, ***p < 0.01.

5.1.1. Urban Regional Heterogeneity

Considering that there are large regional differences in China, cities with good economic development and a high level of science and education may be the first to have an NUSTP, so regional heterogeneity is explored by eastern cities and mid-western cities. Column (1) and (2) of Table 7 report the regression results for the split eastern and mid-western samples. (Eastern and mid-western cities are divided mainly based on the degree of economic development. Eastern cities mainly include cities in the following provinces: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; mid-western cities mainly include cities in the following provinces: Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Sichuan, Chongqing, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, and Guangxi. It is important to note that four Chinese municipalities have the same status as provinces. Hong Kong, Macau, and Taiwan are not included in the sample.) The results show that the estimated coefficients of the difference-in-difference term DID in eastern cities are not significant, while the estimated coefficients of the difference-in-difference term DID in mid-western cities are significant at the 1% level, indicating that the establishment of
NUSTPs positively affects innovation in mid-western cities but does not significantly affect innovation in eastern cities. This may be because human resources are less developed in mid-western cities, and the establishment of NUSTPs can drive the inflow of talent, incubate high-tech enterprises, and increase the willingness to innovate, thus promoting urban innovation. In contrast, the eastern cities have a large number of universities, a high conversion power of scientific and technological achievements, sufficient human capital, and a high concentration of high-tech enterprises, which provide good resource allocation for urban innovation. The urban innovation effect of the establishment of NUSTPs is "masked", and thus does not significantly promote urban innovation, and the innovation effect is not revealed.

5.1.2. City Size Heterogeneity

According to the Notice on Adjusting the Standard of City Size Classification, issued by the State Council, cities are divided into small and medium-sized cities and large cities. (The criteria for classifying city size take the resident population of urban areas as the statistical caliber. In this paper, cities with more than 1 million people are classified as large cities, while the rest are small and medium-sized cities.) Columns (3) and (4) of Table 7 report the regression results for the different city size samples. The results show that, for small and medium-sized cities, the estimated coefficient of the difference-in-difference term is insignificant, indicating that the establishment of NUSTPs was not effective in promoting urban innovation. The estimated coefficient of the difference-in-difference term for the sample of large cities is significantly positive at the 1% level, indicating that the establishment of NUSTPs significantly promotes large-scale urban innovation.

The main reason for this may be that when NUSTPs are established in large cities, human capital is more concentrated, incubated high-tech enterprises are more clustered, innovation resources are more concentrated, and the agglomeration effect is more significant, which makes it easier to form innovation space networks that are more conducive to urban innovation. The establishment of NUSTPs in large cities is more likely to accumulate resources, while the resource effect in small and medium-sized cities is relatively weak, which also verifies that NUSTPs were first implemented in large cities, and then in small- and medium-sized cities, resulting in the industry–education integration in small and medium-sized cities not being fully effective in the short term.

5.1.3. Heterogeneity of Cities with or without Double-Class Universities

Columns (5) and (6) of Table 7 report the regression results for the sample of cities with or without dual-class universities. The results show that the estimated coefficients of the difference-in-difference term for cities with double top universities are significantly positive at the 1% level, indicating that the establishment of NUSTPs promotes the innovation level of cities with double-class universities. The estimated coefficients of the difference-in-difference term for cities without double top universities are not significant, indicating that the NUSTP does not promote innovation in cities without double-class universities.

The reason for this result may be that cities with double-class universities can effectively transform their research results by using their research platform. Double-class universities have good human resources, which can help promote innovation in cities, and they set up NUSTPs earlier to incubate high-tech industries and cooperate with local enterprises, thus promoting innovation in their cities. Cities without double-class universities, on the other hand, generally set up NUSTPs later, do not have more senior human capital, and have not formed high-tech enterprise clusters, and their impact on urban innovation has not appeared. Therefore, the establishment of NUSTPs is beneficial for the improvement of innovation level in cities with double-class universities.

5.1.4. Ministerial and Local Heterogeneity

Columns (7) and (8) of Table 7 report the regression results for ministerial and local universities. Cities with only local universities and the establishment of an NUSTP can
effectively improve the level of innovation in the city. In contrast, cities with ministerial universities and the establishment of NUSTPs do not significantly increase the level of innovation in the city. The possible reasons for this are that most of the universities under the ministry are in the developed eastern regions, the universities themselves have a strong innovation capacity, the cities have good human capital and have formed high-tech enterprise clusters, and the innovation effect of the establishment of USTPs on the cities cannot be significantly revealed. Furthermore, local universities generally set up NUSTPs in non-capital prefecture-level cities, which have weaker human capital and a low concentration of high-tech enterprises, but the establishment of NUSTPs can improve the environment of urban innovation. After receiving national support, it can improve the level of urban innovation faster. Another reason may be that colleges and universities under the ministry may be more willing to cooperate across regions, and their scientific and technological achievements are transformed such that they can remain in other cities, while local colleges and universities can only incubate their achievements locally, due to the conditions that favor innovation in their cities.

5.2. Influence Mechanism Analysis

In what ways does the establishment of an NUSTP affect urban innovation? The construction document of the NUSTP emphasizes that the NUSTP relies on the advantages of the university’s knowledge, talent density, and innovative environment, combined with the society’s capital, management, and market demand, as an important national science and technology innovation base, a high-tech enterprise incubation base, an innovation and entrepreneurship talent gathering and training base, and a demonstration base of industry–university research, driving the development of the regional economy. It can be seen that NUSTPs can promote the gathering of innovation resources to cities with USTPs, facilitate the transformation of scientific and technological achievements, and to a certain extent, can enhance the level of urban innovation. Therefore, we analyze the impact of the establishment of NUSTPs on urban innovation from the perspective of the innovation resource elements endowed to the city by the establishment of NUSTPs in the following three aspects.

(1) Human Capital Effect

Human capital is particularly important in technological innovation [24], and the accumulation of specialized human capital directly affects the level of technological innovation [25]. University science and technology parks can cultivate specialized talents, and the construction and introduction of high-level education and research institutions can allow for the concentration of specialized talents. At the same time, talents, as one of the innovation factors, are clustered by science and technology incubation in NUSTPs. The gathering of a large number of specialized talents provides a platform for mutual learning and exchange for human capital accumulation, while the knowledge and technology overflow resulting from the flow of talents is conducive to the burst of innovative ideas and good human capital accumulation in cities. It can be seen that the establishment of NUSTPs promotes the inflow of talent elements, which in turn improves the allocation efficiency of urban human resources and contributes to the accumulation of specialized human capital in the city, ultimately promoting urban innovation.

(2) Industrial Agglomeration Effect

The NUSTP has become an important base for transforming high-tech achievements, incubating high-tech enterprises, and cultivating strategic emerging industries and the entrepreneurship of university teachers and students. The good humanistic and innovative environment of USTPs can develop high-tech industries and modern service industries, promote the development of industrial innovation clusters, accelerate the process of the high-tech transformation of traditional industries, and optimize the industrial structure. Under the model by which NUSTPs drive city development, NUSTPs can promote cities to introduce target industries for city innovation development and their associated industries,
such that strategic emerging industries such as new energy, new materials, and biomedicine cultivated by cities can form industrial clusters and produce an agglomeration effect. On the one hand, the industrial agglomeration effect can result in a specialized division of labor in cities, as well as the inflow and concentration of foreign labor, thus providing favorable resources for urban technological innovation. On the other hand, industrial agglomeration is conducive to information exchange and communication among innovation subjects, which is conducive to the generation of innovative knowledge and new technologies. The spillover effect of knowledge and technology due to industrial agglomeration provides a knowledge supply for innovation subjects, thus facilitating urban innovation.

(3) Innovative Cyberspace Effects

The construction of a regional innovation network is the key to implementing regional innovation. Innovation networks allow basic elements such as information, technology, and knowledge to flow in the network to all corners of the city, thus forming an innovation network space and promoting regional innovation. The establishment of an NUSTP will enable a USTP to achieve effective communication between science and technology incubation, the industrialization of enterprises’ scientific and technological achievements, and allow a level of financial innovation service, government management, and industry–academia research to form an innovation network space. The formation of regional innovation cyberspace can mutually stimulate innovation enthusiasm among innovation subjects, and allow for the flow of technology and knowledge of innovation to form an innovation cyberspace effect between regions, thus promoting urban innovation.

Does the establishment of NUSTPs really affect urban innovation through human capital, industrial agglomeration, and innovation network spatial effects? To answer this, we need to further verify whether NUSTP establishment affects urban innovation, through advanced human capital, industrial agglomeration, and innovation network spatial effects. To determine the influence mechanism, human capital (human), industrial agglomeration (aggl), and innovation space effect (space) were selected as measures for the influence mechanism test; that is, human capital (human), industrial agglomeration (aggl), and innovation space effect (space) were analyzed as the mediating variables for whether the establishment of NUSTPs influences urban innovation.

Human capital (human) is measured by the number of students enrolled in urban higher education institutions, industrial agglomeration (aggl) is measured by the number of high-tech enterprises, and the innovation space effect (space) is calculated based on the literature [26]. Thus, the following model is constructed to test the mediation effect [2,27]:

\[
\text{Med}_{i,t} = \varphi_0 + \varphi_1 \text{did}_{i,t} + \varphi_2 X_{i,t} + \mu_1 + \lambda_1 + \epsilon_{i,t} \tag{5}
\]

\[
\text{innovation}_{i,t} = \gamma_0 + \gamma_1 \text{did}_{i,t} + \gamma_2 \text{Med}_{i,t} + \varphi_3 X_{i,t} + \mu_1 + \lambda_1 + \epsilon_{i,t} \tag{6}
\]

where Med_{i,t} is an intermediate variable, including human, aggl, and space.

The results of the impact mechanism test are shown in Table 8. From the estimation results, the estimated coefficients of did from Column (1) to (3) are all significantly positive at the 1% level, indicating that the establishment of NUSTPs has a significant contribution to high-level human capital (human), industrial agglomeration (aggl), and the spatial effect of innovation networks (space). Column (4)–(6) show the regression results of Equation (6), where Column (4) is estimated by adding human capital (human), Column (5) is estimated by adding industrial agglomeration (aggl), and Column (6) is estimated by adding the innovation space effect (space). The results show that the estimated coefficients of the difference-in-difference term did decreased from 0.400 in Table 2 to 0.179, 0.304, and 0.182, respectively, and all of them are significant at the 1% level, which indicates the existence of a strong mediating effect, suggesting that the variables human, aggl, and space are mediating variables for the establishment of NUSTPs to promote urban innovation.
Table 8. Results of the influence mechanism.

| Variable | (1)       | (2)       | (3)       | (4)       | (5)       | (6)       |
|----------|-----------|-----------|-----------|-----------|-----------|-----------|
|          | human     | aggl      | space     | Inpatent  | Inpatent  | Inpatent  |
| did      | 10.497 ***| 4.567 *** | 6.979 *** | 0.179 *** | 0.304 *** | 0.182 *** |
|          | (32.25)   | (7.16)    | (13.47)   | (4.04)    | (7.63)    | (4.68)    |
| human    |           |           |           |           |           | 0.016 *** |
|          |           |           |           |           |           | (0.016)   |
| aggl     |           |           |           |           |           | 0.028 *** |
|          |           |           |           |           |           | (0.028)   |
| space    |           |           |           |           |           |           |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| N Obs.   | 5469      | 5469      | 5469      | 5469      | 5469      | 5469      |
| R²       | 0.887     | 0.927     | 0.719     | 0.930     | 0.611     | 0.934     |

Note: Another measure of urban innovation, the number of patents granted per million (patent), has also reached the same conclusion. *** p < 0.01.

6. Conclusions and Policy Implications

We empirically analyzed the impact of the establishment of NUSTPs on urban innovation, using the difference-in-difference method based on panel data from 293 cities from 1999 to 2017. The main conclusions are as follows: (1) The establishment of NUSTPs significantly enhances innovation in cities, while the conclusions obtained still hold after robustness analyses, such as replacing city innovation measures, time sensitivity tests, policy uniqueness tests, and counterfactual tests. (2) The establishment of NUSTPs has a certain dynamic effect on urban innovation, with no lagging effect and a continuous promotion effect, but there are significant differences in urban regional heterogeneity, urban scale heterogeneity, double-class heterogeneity, and ministerial and local heterogeneity. Specifically, the establishment of NUSTPs has a significant effect on urban innovation in central and western cities, large-scale cities, and cities with double-class and local universities establishing USTPs, while the effect is not significant for eastern cities, small and medium-sized cities, and cities with non-double-class and ministerial universities. (3) In terms of influence mechanism, the establishment of NUSTPs can improve the level of human capital and industrial agglomeration in cities where science and technology parks are located, and can form the city’s innovation space effect to influence urban innovation.

Based on the main conclusions above, the following policy recommendations are proposed: (1) Confidence in the establishment of NUSTPs should be firmly established, and pilot NUSTPs should continue to be promoted. NUSTPs should be appropriately established in small and medium-sized cities as well as local universities, so as to give full play to the role of the NUSTP in the construction of an innovative country. (2) NUSTPs should continue to focus on large-scale cities and double-class universities, and should continue to bring the innovation effect of USTPs into play. At the same time, corresponding measures should be taken to ensure that universities in eastern cities and universities under the ministry can give greater play to the due innovation effect, focusing on the scientific and technological conversion results of these universities. (3) Cities should continuously improve their talent policies and human capital levels, increase the agglomeration levels of target industries and related industries, and form innovation space effects, thus enhancing the innovation competitiveness of cities, especially small and medium-sized ones.

7. Limitations and Future Research

Although the impact of NUSTPs on urban innovation can be assessed using the difference-in-difference approach, this result is also only an average effect. There are differences in the support for NUSTPs in China, with different policy strengths for different universities, and the construction of difference-in-difference dummy variables may not be perfect either. Furthermore, the impact of NUSTPs on urban innovation changes
significantly over time, and the use of fixed effects estimation may also be biased [28]. Future policy evaluations can use a method recommended in [28] to determine whether a two-way fixed effects DD estimator (TWFEDD) can provide meaningful causal estimates. The method provided in the literature [29] can also be used to compare the results of fixed effects.

**Author Contributions:** Study design, S.L.; data processing, Y.X. and S.L.; statistical analysis, Y.X. and S.L.; writing—review and editing, Y.X. and S.L. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the National Natural Science Foundation of China, grant number 71761015.

**Institutional Review Board Statement:** Not applicable.

**Data Availability Statement:** Data for this work are available through the corresponding author.

**Acknowledgments:** This work was supported by the National Natural Science Foundation of China under grant 71761015. The authors are grateful to the four anonymous reviewers for their valuable comments, and the authors are grateful to the editors for their hard work.

**Conflicts of Interest:** The authors declare that there are no conflict of interest.

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