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Effects of Government Innovation Support on the Innovation Ability of Universities: Evidence from the Quasi-Natural Experiment of China's Innovation and Entrepreneurship Pilot Demonstration Policy

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Abstract: Although there have been many studies on the factors influencing university innovation, few studies have focused on the causal relationship between government innovative support and the innovation ability of universities (IAU). To fill this research gap, based on the quasi-natural experiment perspective of the pilot policy of innovation and entrepreneurship demonstration-bases (IEDB), this study uses the difference-in-differences spatial-autocorrelation model and the mediating-effect model to study the influence mechanism of the government innovation support on IAU, based on Project 211's panel data consisting of 104 universities and provinces and ministries in China, from 2009 to 2018. The results showed that: (1) the pilot policy of IEDB has a significantly positive effect on IAU, and its robustness is verified; (2) the university–industry cooperation (UIC) intensity has a partial mediating effect on the relationship between the pilot policy of IEDB and IAU; and (3) the pilot policy of IEDB shows a more significant positive impact on the IAU of research-oriented than on non-research-oriented universities.

Keywords: innovation and entrepreneurship pilot demonstration; innovation ability of universities; university–industry cooperation; spatial-difference-in-differences model

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1. Introduction

To accelerate innovation and entrepreneurship policies, the Chinese Government identified different batches of innovation and entrepreneurship demonstration-bases (IEDB) in 2016 and 2017 [1]. The construction of the IEDB provides a good institutional environment for the development of innovation and entrepreneurship in China. It can also play an innovative diffusion role for other regions and industry–university research subjects through government support in the key areas of innovation and entrepreneurship [2]. In this context, many studies have focused on the IEDB in academia. However, through a literature review, we found that most scholars focus on the construction paths, motivation mechanisms, and status evaluation of the IEDB [1,3]. There is a lack of studies focusing on its policy effects by comparing the differences between pilots and non-pilots. Even among the few studies focusing on the effects of the pilot policy of the IEDB, scholars tend to concentrate on the macro-level exploration and analysis [4], while neglecting the micro-level effects, such as the impact on universities. Therefore, this study examines the effects of the pilot policy of the IEDB on the innovation ability of universities (IAU) from the perspective of universities.

In the process of implementing China's innovation-and-entrepreneurship pilot policy, the construction of the IEDB is a typical policy exploration showing government innovation [5]. Universities, which are important organizational units for innovation and

entrepreneurship in education, play an important role in promoting China's pilot policy of the IEDB. Therefore, governments attach great importance to the construction of the IEDB in universities [6]. Specifically, there were four universities in the first batch of the IEDB piloted in 2016, and 26 universities in the second batch released in 2017 [1]. Therefore, as pioneers of the pilot policy of the IEDB, we investigate the effects of its implementation on the IAU and its effective transmission paths. There is a gap in the literature for these topics.

In recent years, many studies have gradually started to adopt the paradigm of treating policy implementation as a quasi-natural experiment using difference-in-differences models to analyze policy effects. For example, a multi-period difference-in-differences model using prefecture-level city data was conducted, to study the effects and mechanisms of the innovative cities' pilot policy on the efficiency of urban-university–industry research-knowledge flow [7]. The effects of an innovative cities' pilot policy of innovative cities on urban-green sustainable-development were analyzed, using a spatial difference-in-differences model [8]. Similarly, there is also literature that treats the pilot policy of the IEDB as a quasi-natural experiment, and conducts a policy-effect analysis. Innovation and entrepreneurship demonstration-cities are treated as research objects, and the policy effects on the urban innovation and entrepreneurship index is explored using the difference-in-differences model [9]. Adopting propensity score matching and the difference-in-differences model, the pilot policy of the IEDB shows a significant effect on the innovation capacity of corresponding cities. The above studies typically used traditional difference-in-differences models and their variants, such as the regression method, establishing a causal inference of policy effects. However, emerging studies ignore the existence of policy spillover, which may lead to errors in the estimation results, and thus miscalculate the coefficient of policy effects.

Based on the above considerations, this study attempts to build on the existing research, based on the following aspects. First, the study enriches the research on the effects of the pilot policy of the IEDB; specifically, we conduct an empirical analysis to explore the influence of the pilot policy of the IEDB on IAU in the context of the universities, using the data from 104 universities in 2009–2018. Second, the study reveals the relationship between the pilot policy of the IEDB and IAU in the context of university–industry cooperation (UIC). Specifically, we investigate the mediating effect of UIC intensity on the relationship between the pilot policy of the IEDB and IAU. Finally, the study incorporates the spatial-spillover effects of the pilot policy of the IEDB on IAU, depending on the university type (UTY). We adopt the difference-in-differences spatial autocorrelation model to reduce estimation errors.

2. Background and Theoretical Hypotheses

2.1. Policy Background

In 1999, China's Ministry of Education issued the "Action Plan for Revitalizing Education in the 21st Century", which mentioned cultivating a group of talents with innovation ability for the first time, marking the beginning of China's innovation and entrepreneurship policy [10]. In 2002, it proposed conducting the IEDB in nine universities, setting an important starting point for universities to conduct innovation and entrepreneurship in education [1]. In 2010, it issued the "Opinions on Vigorously Promoting Innovation and Entrepreneurship Education in Higher Education Institutions and Independent Entrepreneurship Work of College Students", which provided more detailed and specific guidance on innovation and entrepreneurship in education. The Chinese Government then issued a call for "mass entrepreneurship and innovation" for the first time, in 2014 [5].

In 2016, China's State Council proposed the implementation of the IEDB. It laid out a plan for constructing 120 demonstration bases in two batches, including 62 regional bases, 30 university bases, and 28 enterprise bases, while specifying the objectives and priorities of each base type [9]. In the construction process, university bases have the basic task of cultivating innovative talents, because they generally have advantages in terms of scientific- and technological-innovation resources [11]. Four universities in the first batch were piloted

in 2016, and 26 universities in the second batch were released in 2017, showing the role of the Chinese Government in the IEDB in universities. One of the priorities in universities was to encourage innovation and entrepreneurship among R&D personnel, to open up all types of innovation and entrepreneurship resources, and accelerate the transformation of innovative achievements [12].

Compared with China, innovation and entrepreneurship in education in foreign universities started earlier. The United States was the earliest country to implement research and practice in innovation and entrepreneurship in education. Subsequently, some developed countries started innovation and entrepreneurship in education in universities one after another [12]. The objectives of innovation and entrepreneurship in education in universities in these countries are clear, and mainly focus on cultivating students' innovation consciousness and ability. For example, Stanford University combines scientific research, knowledge innovation, and social development and builds "field dependence" between enterprises, universities, and research institutes [11]. Most innovation and entrepreneurship education in Chinese universities is focused on achieving innovation and entrepreneurship goals, building innovation and entrepreneurship platforms, and cultivating an innovation and entrepreneurship faculty. For example, Shanghai Jiao Tong University attempted to build an innovation and entrepreneurship ecosystem that combines innovation and entrepreneurship practices with business incubation and practical systems [1].

By comparing the innovation and entrepreneurship policies of universities in China and other countries in the world, we find that they all prioritize the cultivation of students' ability in innovation and entrepreneurship, which mainly start with industry–university research-cooperation [10,11]. However, China's innovation and entrepreneurship policies in universities are focused on constructing and improving the institutional environment for innovation and entrepreneurship. Specifically, the government will provide sufficient R&D funds for innovation activities in universities to construct an innovative institutional environment for innovation activities; it will also provide a series of practical measures to stimulate entrepreneurship and further improve the institutional environment for entrepreneurship [1]. For example, in the implementation of China's innovation and entrepreneurship policies in universities, support is mainly reflected in the creation of a positive university innovation atmosphere [12].

As the largest developing country, China's policy practices in the areas of innovation and entrepreneurship can guide other developing countries worldwide. At the same time, China is also the most typical emerging economy, and its policy measures in the field of innovation and entrepreneurship have received attention from many developed countries around the world. Despite some differences, China's innovation and entrepreneurship policies in universities still share commonalities with similar policies in some major countries. Developed countries may take advantage of these commonalities as they explore China's innovation and entrepreneurship policies in universities. Therefore, although the subject of this study is China, its findings can be generalized to other countries.

2.2. Theoretical Analysis and Hypotheses Development

2.2.1. The Policy Effect of the IEDB on IAU

The construction of the IEDB is a typical policy showing government support, and much research has been conducted on the influence of government support on IAU, based on the triple-helix theoretical framework [13,14]. Since 2016, two versions of the Chinese Government's "Implementation Opinions on Building Mass Entrepreneurship and Innovation Demonstration Bases" have been proposed, to support the construction of the IEDB in areas with a good foundation for innovation and entrepreneurship, such as universities and research institutes. There has been rich research on the impact of government support on IAU. Some studies have focused on theoretical analysis, and core achievements are reflected in the proposal and development of the triple-helix theory. The triple-helix model was originally proposed by Etzkowitz and Leydesdorff [13], emphasizing that in the innovation process, the three main bodies, namely, the university, government, and industry form

a collaborative model of innovation through mutual collaboration, thereby promoting a spiral progress of the innovation process. Among these entities, universities play the role of realizing innovation through knowledge and talent production, while the government maintains social order and supports innovation by establishing reasonable contractual relationships and policies [15–17]. With the continuous evolution of the social environment, the quadruple-helix theory, which includes the role of the citizens, and the five-helix theory, which includes the role of the natural environment (based on the triple-helix theory), have been proposed, successively. These proposals aim to evaluate the impact of various elements on innovation and development from a more systematic perspective [18–20].

Other studies have discussed the role of the government in promoting innovation in universities by looking at actual innovation policies in various regions. For example, Mowery explored the impact of the Bayh–Dole Act in the United States, and found that its passage allowed federal agencies to grant patents to small businesses and universities, resulting in a significant increase in the number of university patents [21]. Bloom et al. analyzed the U.S. government's promotion of university innovation by improving the education system and focusing on promoting students' development in the fields of science, technology, engineering, and mathematics. This support comes in the form of student funding and financial support [22] and the establishment of the Advanced Research Projects Agency for Education to strengthen innovation and research in breakthrough technologies [14]. Fleming et al. [23] found that government funding increased innovation. Taking the United States as an example, nearly one-third of patents at this stage directly rely on federal-funding support. Universities and enterprises, being two of the most important entities in terms of innovation output, are also highly reliant on federal funding.

China's university innovation is also affected by government support policies, and, compared with other countries, it has a higher proportion of public universities which are highly dependent on government financial support [24,25]. Specifically, in emerging papers, scholars have found that the impact of the Chinese Government support on IAU is mainly reflected in their financial investment. For example, it has been found that the allocation of innovation resources such as R&D investment by governments can positively affect universities' university–industry-collaboration innovation [2]. The government needs to create a good external-innovation environment by increasing financial investment in universities, to improve their innovation ability [26]. Some studies also analyze the effect of policy support on IAU in the context of macro regulation. For instance, the researchers find that the implementation of "Project 211" policy can further improve the innovative system of universities and optimize the allocation of innovation resources to enhance scientific and technological innovation-efficiency [27]. In other words, the government can play the role of financial supporters and policy designers, to help universities implement scientific and technological innovation-activities and improve their innovation abilities [28].

Therefore, the government's implementation of the pilot policy of the IEDB can be used as the basis for the planning and the macro regulation of the innovation-ability enhancement of universities. Moreover, it can help universities obtain more R&D funding for science and technology innovation-activities, stimulating innovation vitality, alleviating innovation risk, and promoting their innovation ability [2,29].

Therefore, based on the above theoretical analysis, we propose the first hypothesis:

H1: *The pilot policy of the IEDB is significantly correlated with the innovation ability of universities.*

2.2.2. The Mediating Effect of the Intensity of University–Industry Cooperation

In this section, we (1) analyze how the pilot policy of the IEDB affects UIC, and (2) review the literature on the impact of UIC intensity on IAU. UIC refers to the cooperation between universities, scientific research institutions, and enterprises. It is an effective organizational form commonly used by countries to realize the complementary advantages of R&D resources of enterprises and universities, and to enhance the economic and social benefits of enterprises, regions, or countries. Initiating university–industry collaboration often requires government support [30,31]. The pilot policy of the IEDB may lead to further

decentralization and simplification of the government, greatly enhancing the enthusiasm of subjects involved in the innovation and entrepreneurship initiatives in the regional demonstration zones [5]. Specifically, the corresponding government usually provides enterprises with special financial support for innovation development. It can help to enhance the overall innovation and entrepreneurship level of the region, eliminate the negative externality of financing constraints on enterprise innovation, and promote the innovation activities of enterprises [32]. In this context, universities, as the main actors of scientific and technological innovation-achievements, are important partners of enterprises in innovation [33]. Therefore, along with the pilot policy of the IEDB, UIC has become key for enterprises to implement innovative activities [34,35]. In addition, once universities become the pilot location for IEDB, the transformation of their scientific and technological innovation and achievement will receive significant attention and support from local governments, attracting enterprises to seek innovation cooperation [32,36]. In other words, the construction of IEDB may have a positive impact on the UIC intensity.

It is important to evaluate the influence of UIC on IAU. However, the relationship between the two is currently debated. Most scholars believe that UIC promotes IAU because it may provide universities with financial and innovative environmental support [33]. UIC intensity is a driving force for resource integration between the two partners, further enhancing IAU [34]. It may provide financial support for universities and encourage participation of university researchers [35]. Lee found that UIC helps scholars gain new insights into their own research by observing the practical application of their theories. In addition, UIC is beneficial for the universities' internal cultivation of talent [37]. It may also promote knowledge-flow in universities [38].

However, some scholars believe that UIC has a negative effect on IAU. First, it reduces the time for academic research activities [39]. Second, corporate commercial interests may limit journal publications. In fact, Toole and Czarnitzki found evidence of scenarios where publications were delayed or prohibited, in [40]. Finally, it affects the choice of research topics and methods. Trajtenberg et al. pointed out that university research usually focuses on basic scientific issues, while industrial research aims to solve commercial problems to meet market needs. These objectives do not align at all times [41]. In addition, other scholars present both negative and positive effects. For example, Aguiar et al. posit that UIC is beneficial to scientific production to a certain extent, and when the critical point is reached, patent output and academic output will substitute each other [42]. Through empirical research, Gao et al. found a significant inverted U-shaped relationship between the strength of university–industry connections and the efficiency of innovation in universities [43]. Under the premise of not exceeding a certain threshold, the strength of university–industry connections can enhance the efficiency of scientific and technological innovation in universities.

Although research on the influence of UIC on IAU has not yet reached a unanimous conclusion, the mainstream view is that UIC can effectively promote IAU. Therefore, synthesized with the theoretical analysis that the construction of the IEDB may have a positive impact on the UIC intensity, we propose the second hypothesis:

H2: *The intensity of university–industry cooperation plays a mediating role in the relationship between the pilot policy of IEDB and IAU.*

Based on the above theoretical analysis, the research framework of this paper is shown in Figure 1.

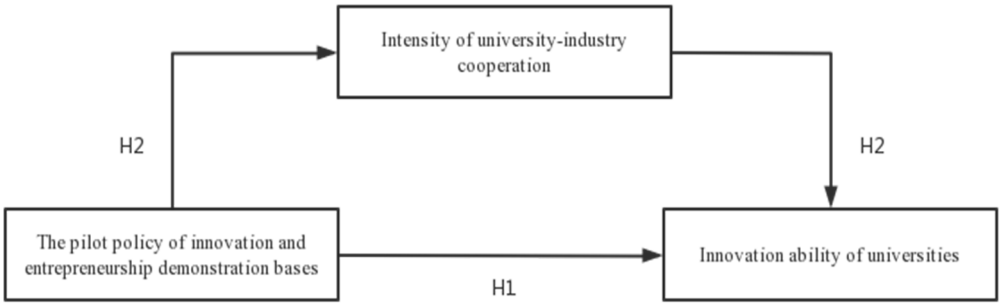

Figure 1. Research-framework diagram.

3. Empirical Research Design

3.1. Spatial Autocorrelation Test

To accurately observe the degree of spatial clustering of the factors in a given geographical location, previous studies have usually adopted the Global Moran's Index for spatial autocorrelation tests [44]. We also used this index to test the spatial autocorrelation characteristics of IAU, which are calculated as follows:

$$\text{Moran's I} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(y_i - \overline{y})\left(y_j - \overline{y}\right)}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \quad (1)$$

In Equation (1), Moran's I is the Global Moran's Index, and its value is contained in the interval $[-1, 1]$. If it is greater than 0, there is a positive spatial correlation; if it is less than 0, there is a negative spatial correlation; if the value is 0, there is no significant correlation. $S^2 = \left[\sum_{i=1}^{n}(y_i - \overline{y})^2\right]/n$ represents sample variance: y_i denotes the observed value of region i, $\overline{y}$ denotes the average y_i of all observations, and W_{ij} indicates the spatial-weight matrix. Considering that universities are geographically dispersed, and that the most obvious differences between universities mainly occur within the province, we constructed a special geographic-adjacency matrix, based on the principle of geographic proximity and of whether each university was in the same province. Specifically, the matrix element was 1 if different universities were within the same provincial domain, and 0 otherwise.

3.2. Spatial-Difference-In-Differences Model

Because the difference-in-differences model has unique advantages in the field of policy-effect research [9], we used it to analyze the policy effect of the IEDB on IAU. Moreover, from the perspective of spatial econometrics, the policy effect generated by the construction of the IEDB may have spillover effects among universities in the same province or among other universities with similar behaviors [45]. In other words, if the traditional difference-in-differences model is used, the potential spatial-spillover effect in the model may be overlooked. Therefore, we conducted a spatial difference-in-differences model for empirical analysis. In particular, we used a differences-in-differences spatial autocorrelation model, which can show both spatial autocorrelations and autoregressive coefficients to study the effects of the pilot policy of the IEDB on IAU. The model can be expressed as follows:

$$IAU_{i,t} = \rho W(IAU_{j,t}) + \beta_0 + \sum_{k=1}^{K} X_{i,t,k}\beta_k + IEDB_{i,t}\beta_{k+1} + u_{i,t} + v_{i,t} + \varepsilon_{i,t} \qquad \varepsilon_{it} = \lambda W\left(\varepsilon_{j,t}\right) + \varphi_{i,t} \quad (2)$$

In Equation (2), $IAU_{i,t}$ denotes the independent variable, namely, the innovation ability of universities. Furthermore, i = 1, 2, . . . , N, where N = 104, representing the 104 universities; t = 1, 2, . . . , T, where T = 10, representing the last sampled year; $x_{i,t,k}$ denote the control variables, and k = 1, 2, . . . , k.

$IEDB_{i,t}$ denotes the effect of the pilot policy of IEDB. If the university is a pilot IEDB, it is assigned a value of one; otherwise, it is zero. Moreover, W_{ij} is the spatial-weight matrix; ρ denotes the spatial autocorrelation coefficient; (if ρ is positive, there is a spatial-spillover effect of IAU among neighboring universities); and λ represents the spatial autoregression coefficient of the spatial autocorrelation model; (if λ is positive, the pilot policy of the IEDB has a spillover effect on the IAU of neighboring universities); β denotes the regression coefficient of the model, and β_0 is the constant; $u_{i,t}$ reflects the individual fixed effect; $v_{i,t}$ denotes the time fixed effect; and $\varepsilon_{i,t}$ and $\varphi_{i,t}$ represent random-error terms.

3.3. Variable Selection

3.3.1. Dependent Variables

The dependent variable in this study is IAU. We measured it using the number of published papers and patent applications [27,36,45]. We also conducted a robustness check by using the number of patent applications from universities to redefine their innovation ability.

3.3.2. Independent Variables

The core independent variable in this study is the pilot policy of the IEDB. When selecting other independent variables, we referred to the previous papers, specifically to their findings on the influencing factors of university science and technology innovation [7,28,46]. We selected control variables based on provincial and university data. Specifically, the control variables at the provincial level were innovation-agglomeration level (IAL) and human-capital level (HCL); the control variables at the university level were R&D personnel (RDP) and government funding investment (GFI). The proportion of R&D personnel in regional universities with respect to the total national R&D personnel in universities was used to measure IAL; the proportion of the number of students enrolled in regional universities with respect to the total population was used to measure HCL; the logarithm of the full-time equivalent of R&D personnel in universities was used to measure RDP; the logarithm of the total government funding for science and technology received by universities was used to measure GFI.

3.3.3. Mediating Variable

The mediating variable in this study is the UIC intensity. Drawing on the relevant literature on UIC [28,38], this study used the proportion of entrusted cooperation funds received by universities from enterprises within the total research funds of universities, to measure the intensity of UIC.

The results of the descriptive analysis of each variable and the correlation analysis with IAU are presented in Table 1. The correlation analysis results show that the correlation coefficient between the pilot policy of the IEDB and IAU is significantly positive, which initially indicates that the pilot policy of the IEDB can promote IAU, to a certain extent. Of course, the correlation analysis cannot reflect the causal relationship between the pilot policy of the IEDB and IAU; thus, the application of the spatial difference-in-differences model for causal inference is necessary.

Table 1. Results of descriptive analysis and correlation analysis.

Variables	Symbol	Average Value	Standard Deviation	Correlation Coefficient
Innovation ability of universities	IAU	6.702	1.831	1
The pilot policy of innovation and entrepreneurship demonstration-bases	IEDB	0.035	0.012	0.146 ***
Intensity of university–industry cooperation	UIC	0.273	0.185	0.194 ***
Innovation-agglomeration level	IAL	0.108	0.315	0.082 **
Human-capital level	HCL	0.139	0.104	0.066 **
R&D personnel	RDP	6.016	2.328	0.524 ***
Government Funding Investment	GFI	11.841	4.093	0.232 ***

Note: *, **, and *** indicate significant at the 10%, 5%, and 1% statistical levels, respectively. Same as below.

3.4. Data Sources

The data used in this study were mainly from the Compendium of Science and Technology Statistics of Higher Education Institutions and the China Statistical Yearbook, corresponding to the years 2009–2018. The sample was selected from 104 "Project 211" universities in China, resulting in 1040 observations. The geographic distribution of the sample was spread over 30 provincial administrative units except for the Tibet Autonomous Region, Hong Kong and Macao in China. In addition, all variables with economic implications were adjusted for constant values, using the 2009 price index, and the missing values were supplemented using linear-interpolation and mean-interpolation methods.

4. Results

4.1. Spatial-Autocorrelation-Test Results

To effectively identify the spatial-spillover effect of the pilot policy of the IEDB on IAU, we adopted the Global Moran's Index for the spatial-autocorrelation test. From Table 2, we can see that there is a significant positive-spatial-correlation of IAU during 2009–2018, which indicates that there is a positive spatial-spillover effect among universities, in terms of IAU. This also shows that the empirical analysis using the spatial-econometric model in this study is rational.

Table 2. Results of spatial-autocorrelation-test of IAU.

Year	Moran' I	Z-Value
2009	0.115 **	1.72
2010	0.136 ***	2.14
2011	0.097 **	1.61
2012	0.103 **	1.65
2013	0.242 ***	3.62
2014	0.149 ***	2.28
2015	0.121 ***	1.83
2016	0.210 ***	3.27
2017	0.158 ***	2.93
2018	0.238 ***	3.34

Note: *, **, and *** indicate significant at the 10%, 5%, and 1% statistical levels, respectively.

4.2. Baseline Regression

We used the difference-in-differences spatial-autocorrelation model to study the effect of the pilot policy of the IEDB on IAU. The regression results of the model are shown in Table 3. The estimates corresponding to the pilot policy of the IEDB, control variables, and time and individual fixed-effects are seen in Columns (1), (2), and (3), respectively.

Table 3. The results of baseline regression.

Variables	(1)	(2)	(3)
IEDB	0.185 ***	0.147 **	0.126 ***
	(0.021)	(0.065)	(0.036)
IAL		0.835 ***	1.071 **
		(0.230)	(0.428)
HCL		0.559 *	0.379
		(0.295)	(0.338)
RDP		0.252 **	0.193 **
		(0.113)	(0.088)
GFI		0.438 ***	0.713 ***
		(0.107)	(0.185)
_cons	0.626 ***	0.292 ***	0.216 **
	(0.128)	(0.083)	(0.106)
Time fixed-effects	NO	NO	YES
Individual fixed-effects	NO	NO	YES
ρ	0.083 **	0.121 ***	0.068 **
	(0.035)	(0.039)	(0.031)
λ	0.318 ***	0.269 ***	0.224 **
	(0.057)	(0.064)	(0.105)
N	1040	1040	1040
R^2	0.182	0.304	0.251

Note: Values in parentheses are standard errors; YES indicates control. IEDB is the pilot policy of innovation and entrepreneurship demonstration-bases; IAL represents innovation-agglomeration level; HCL is human-capital level; RDP represents R&D personnel input; GFI is government funding investment.

Columns (1) to (3) in Table 3 show that the pilot policy of the IEDB is significantly positively correlated with IAU, indicating that the IEDB pilot policy has a positive effect on IAU, verifying H1. Moreover, the spatial effect coefficients of the model were positive and significant (see Table 3). For example, in columns(3), the ρ = 0.068 indicates a positive and significant spatial-spillover effect on the IAU of universities in the same province; the λ = 0.224 indicates the positive and significant effect the pilot policy of IEDB can have, with a spillover effect on the IAU of other non-pilot universities in the same province.

4.3. Robustness Checks

4.3.1. Parallel-Trend Test

The difference-in-differences model is used because the treatment and control groups of the sample are assumed to have parallel trends before the policy shock, and such trends are not assumed to change significantly over time without any shock to the system [5]. To test whether IAU passes the parallel-trend hypothesis, we estimate the policy effects of the years before and after the pilot policy of the IEDB, using the event study method. It should be noted that the first period of the sample-time window is chosen as the base period.

The results of the parallel-trend test are shown in Table 4, where the *Pre* series represents the regression results of the interaction terms of the time dummy-variables and the treatment-group dummy-variables corresponding to the period before the policy. The *Current* series represents the regression results of the interaction terms of the time dummy-variables and treatment-group dummy-variables corresponding to the period during the policy's implementation. The *Post* series represents the regression results of the interaction terms of the time dummy-variables and treatment-group dummy-variables corresponding to the period after the policy. From the table, we can see that the estimation results of Pre_6 to Pre_1 are not significant, indicating that there is no significant difference in the trend of IAU in the treatment groups and the control groups before the implementation of the pilot policy of the IEDB. Therefore, the hypothesis of a parallel trend using the difference-in-differences spatial-autocorrelation model in this study is valid.

Table 4. Results of spatial-autocorrelation-test of IAU.

Variables	Parameter Estimation	t-Value
Pre_6	0.080	(0.45)
Pre_5	0.107	(0.62)
Pre_4	0.112	(0.76)
Pre_3	0.103	(0.58)
Pre_2	0.149	(1.38)
Pre_1	0.124	(1.12)
Current	0.161	(1.47)
Post_1	0.215	(2.14)
Post_2	0.227	(2.20)

4.3.2. Dependent-Variable Replacements

The dependent variable, in the baseline regression, was IAU, measured as the total number of papers. In the robustness check, we measured it using the number of patent applications. We then developed a difference-in-differences spatial-autocorrelation-model analysis.

As shown in Table 5, the estimates associated with the IEDB, control variables, and time and individual fixed-effects are found in Columns (1), (2), and (3), respectively. It can be seen in columns (1) to (3) that the pilot policy of the IEDB has a significant positive impact on IAU, verifying the robustness of the baseline regression.

Table 5. Test results of the robustness-check for replacing the dependent variable.

Variables	(1)	(2)	(3)
IEDB	0.152 ** (0.071)	0.126 ** (0.063)	0.168 *** (0.045)
Control variables	NO	YES	YES
Time fixed-effects	NO	NO	YES
Individual fixed-effects	NO	NO	YES
ρ	0.117 *** (0.039)	0.075 ** (0.037)	0.154 *** (0.048)
λ	0.264 *** (0.051)	0.192 *** (0.043)	0.163 * (0.091)
N	1040	1040	1040
R^2	0.250	0.207	0.326

Note: Values in parentheses are standard errors; YES indicates control. IEDB is the pilot policy of innovation and entrepreneurship demonstration-bases.

4.3.3. Counterfactual Test

This study also verifies the regression results of the difference-in-differences spatial-autocorrelation model, using a counterfactual test. Specifically, three regression models were conducted, based on the timing of the IEDB implementation (one, two, and three years ahead of policy time). If IEDB in the model was not significant at this time, the robustness of the baseline regression results was verified; otherwise, it indicated the existence of systematic errors.

Columns (1), (2), and (3) of Table 6 show the regression result one, two, and three years ahead of policy time, respectively. Columns (1) to (3) show that none of the policy effects of the IEDB on IAU are significant. In other words, the robustness of the baseline regression results is verified once again.

Table 6. The results of the counterfactual test.

Variables	(1)	(2)	(3)
IEDB	0.058	0.113	0.086
	(0.229)	(0.195)	(0.074)
Control variables	YES	YES	YES
Time fixed-effects	YES	YES	YES
Individual fixed-effects	YES	YES	YES
ρ	0.077 **	0.096 **	0.133 **
	(0.035)	(0.047)	(0.057)
λ	0.169 *	0.221 **	0.185 **
	(0.088)	(0.094)	(0.079)
N	5360	5360	5360
R^2	0.093	0.156	0.130

Note: Values in parentheses are standard errors; YES indicates control. IEDB is the pilot policy of innovation and entrepreneurship demonstration-bases.

5. Further Discussion

5.1. Mechanism Analysis

We also used the mediating-effect model to test the influence of the pilot policy of the IEDB on IAU. The results are shown in Table 7. Columns (1) and (3) show the estimates associated with both IAUs, while column (2) shows the estimates associated with the intensity of UIC.

Table 7. The results of mediating-mechanism analysis.

Variables	(1)	(2)	(3)
IEDB	0.126 ***	0.235 **	0.093 **
	(0.036)	(0.107)	(0.045)
UIC			0.130 *
			(0.071)
Control variables	YES	YES	YES
Time fixed-effects	YES	YES	YES
Individual fixed-effects	YES	YES	YES
ρ	0.068 **	0.218 *	0.119 ***
	(0.031)	(0.125)	(0.036)
λ	0.224 **	0.291 **	0.320 ***
	(0.105)	(0.134)	(0.108)
N	1040	1040	1040
R^2	0.251	0.079	0.296

Note: Values in parentheses are standard errors; YES indicates control. IEDB is the pilot policy of innovation and entrepreneurship demonstration-bases, and UIC represents the intensity of university–industry cooperation.

Columns (1) and (2) highlight that IEDB has a significant effect on IAU and UIC, and this result satisfies the basic conditions for the establishment of the mediating-effect model. In column (3), both IEDB and UIC have a significantly positive relationship with IAU, and IEDB is significantly positively correlated with IAU (see Table 3). The regression coefficient of IEDB in column (3) ($\beta = 0.093$) is smaller than that in column (1) ($\beta = 0.126$). Therefore, we find that the intensity of UIC has a partial mediating effect on the influence of IEDB on IAU, verifying H2. This means that the pilot policy of the IEDB can not only directly promote IAU, but also indirectly enhance IAU by improving the intensity of UIC.

5.2. Heterogeneity Analysis

The above analysis is based on a full sample but without consideration of the heterogeneity of universities and the potential heterogeneity of the policy effect of the IEDB on IAU. Therefore, this paper refers to the classification of university types in emerging papers [28,45] and divides the 104 universities into research-oriented universities and non-research-oriented universities, according to whether or not they are selected for the "Project 985". The results of the heterogeneity analysis are shown in Table 8; the estimates associated with IEDB, the dummy-variable of university-type (UTY), and the interaction term IEDB×UTY are found in columns (1), (2), and (3), respectively.

Table 8. The results of the heterogeneity analysis.

Variables	(1)	(2)	(3)
IEDB	0.126 ***	0.108 **	0.152 ***
	(0.036)	(0.049)	(0.041)
UTY		0.238 **	0.296 *
		(0.104)	(0.160)
IEDB*UTY			0.184 *
			(0.102)
Relevant control variables	YES	YES	YES
Time fixed-effects	YES	YES	YES
Individual fixed-effects	YES	YES	YES
ρ	0.068 **	0.051 *	0.116 **
	(0.031)	(0.028)	(0.047)
λ	0.224 **	0.185 **	0.273 **
	(0.105)	(0.092)	(0.128)
N	1040	1040	1040
R^2	0.251	0.277	0.308

Note: Values in parentheses are standard errors; YES indicates control. IEDB is the pilot policy of innovation and entrepreneurship demonstration-bases, and UTY denotes the university type.

Columns (1) to (3) show that IEDB has a significant positive impact on IAU, regardless of UTY and IEDB×UTY. Meanwhile, column (3) shows that the coefficient of IEDB×UTY is positive and significant, indicating that the policy effect of the IEDB on the innovation-ability enhancement of research-oriented universities is significantly stronger than that of non-research-oriented universities. This may be because research-oriented universities have more advantages than non-research-oriented universities, due to their accumulated science and technology innovation-resources and government funding. In this case, the pilot policy of the IEDB may bring more policy support for innovation and entrepreneurship in research-oriented universities, which in turn has a greater promotional effect on the improvement of their innovation ability.

6. Conclusions and Discussion

6.1. Conclusions

To further reveal the effect of the pilot policy of the IEDB on IAU, we use the difference-in-differences spatial-autocorrelation model. The main conclusions are as follows:

First, the pilot policy of the IEDB is positively correlated with IAU; this result is verified by a series of robustness checks, indicating that the IEDB pilot policy has a significant promotional effect on IAU. Moreover, the difference-in-differences spatial-autocorrelation model reveals that the pilot policy of the IEDB can not only improve the innovation ability of pilot universities but can also have a positive spatial-spillover effect on the innovation ability of non-pilot universities in the same province. Second, the pilot policy of the IEDB has a positive effect on the intensity of UIC; thus, the intensity of UIC plays a partial

mediating role in the relationship between the pilot policy of the IEDB and IAU. This finding suggests that the implementation of the IEDB can not only directly enhance IAU, but also indirectly promote universities' innovation ability by increasing the UIC intensity. Finally, UTY has a mediating effect on the relationship between the pilot policy of the IEDB and IAU; that is, the effect of the pilot policy of the IEDB on IAU of research-oriented universities is stronger than that of non-research-oriented universities. This result shows that, compared with non-research-oriented universities, research-oriented universities take more advantage of the pilot policy of the IEDB because of their superior innovation resources.

6.2. Discussion

There is a rich literature on the impact of government innovation-support policies on IAU, and some scholars have found that such policies positively influence IAU [2,27,30]. The results of this study confirm the findings of the aforementioned studies. Moreover, we contribute to the enrichment of the literature in two aspects: (1) the study of the effect of government innovation-support policies on IAU from the perspective of the pilot policy of the IEDB, which is an example of broad-application policy practice in China; and (2) the study of the mediating effect of UIC intensity in the relationship between the pilot policy of the IEDB and IAU.

Our study has three other practical implications. First, based on the difference-in-differences spatial-autocorrelation model, we find that the pilot policy of the IEDB promotes IAU and has a positive spatial-spillover effect on the IAU of non-pilot universities in the same provincial area. This implies that the government should advance the construction process of IEDB by further expanding the scope of pilot universities [5,12,47] and offering more assistance to pilot and non-pilot universities. Second, we find that UIC intensity plays a partial mediating role in the relationship between the pilot policy of the IEDB and IAU. This indicates that, in the process of the construction of the IEDB, the government can further improve the effectiveness of the pilot policy of the IEDB in enhancing IAU by strengthening the UIC intensity of universities [38,39,48]. Finally, we also find that the effect of the pilot policy of the IEDB on the IAU of research-oriented universities is stronger than on that of non-research-oriented universities, rendering a more in-depth finding than in previous studies. This shows that the government should also pay attention to the heterogeneous influence of the innovation effect of the pilot policy of the IEDB in different types of universities; in particular, it is especially important to further increase support for non-research-oriented universities [24,28,45]. Local governments are supposed to allocate reasonably the innovation resources given by the central government to research-oriented and non-research-oriented universities, to avoid the differences in innovation ability of different types of universities.

There are also several research limitations in this paper. First, the study mainly analyzed the macro policy effects of the IEDB on IAU. In addition, we will further investigate the heterogeneous effects of different types of support policies on IAU, by differentiating innovation and entrepreneurship initiatives in the future. Second, the study only explored the mediating role of the intensity of industry–university cooperation in the relationship between the pilot policy of the IEDB and IAU. Therefore, we will delve into the research of other variables that may act as transmission channels in the future. For example, the pilot policy of the IEDB may stimulate universities to increase R&D funding and enhance the quality of R&D talent, both of which are potential paths for universities to improve their innovation abilities. In other words, the R&D funding and the quality of R&D talent may play the role of mediators in the relationship between the pilot policy of the IEDB and IAU.

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