Research on the Impact of the Midwestern Higher Education Revitalization Plan on Improving the Urban Innovation Level

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Abstract: The panel data of 254 prefecture-level cities in China from 2008 to 2019 and the Double Difference Method method(DID) was used in this paper to examine the relationship between the revitalization of higher education and urban innovation level. The study finds that the Midwestern Higher Education Revitalization Plan has significantly promoted urban innovation level, and has stronger policy effects on the northeast region, the central region and the cities ranked second and third. Therefore, the government should continue to improve the depth and breadth of the implementation of the Midwestern Higher Education Revitalization Plan in a planned way, continuously enhance the fit between the policy and the current situation of local development, enhance the application of university-based scientific research findings to the practice of urban production, and expedite the integration of industry, academia, and research.

Keywords: Revitalization of Higher Education; Urban Innovation Level; Double Difference Method

1. Introduction

China's economy is currently transitioning from a high-speed growth stage to a high-quality development stage, with innovation driving economic development becoming the dominant trend. Colleges and universities, as one of the key institutions in the regional innovation system, play a significant role in nurturing exceptional talent, executing knowledge innovation, and advancing the results of scientific and technical innovation accomplishments. Promoting the overall enhancement and balanced growth of regional innovation capacity is extremely important

from a practical standpoint. In July 2010, "the outline of the national medium and long-term education reform and development plan (2010-2020)" was released, pointing out that "colleges and universities should fully play an important role in the national innovation system, contributing to knowledge innovation, technological innovation, national defense science and technology innovation and regional innovation", and firstly proposed to implement the Midwestern Higher Education Revitalization Plan(MHERP). In 2012, the plan was formally implemented, which was regarded as a significant step in China's efforts to improve its higher education system.

Therefore, this paper attempts to test and answer whether the implementation of the Midwestern Higher Education Revitalization Plan has promoted urban innovation level efficiently? Is there heterogeneity in policy effects of various regions and cities at the individual level? This paper hopes to provide suggestions and basis for accelerating the construction of innovative cities through the study of the above problems.

2. Literature Review

At present, scholars mainly study the impact of higher education on regional innovation from two aspects: the innovation of scientific research knowledge in colleges and universities and the cultivation of high-level talents.

Buesa et al. used the knowledge production function to find that university scientific research into the impact on the regional innovation function compared with other institutions more prominent[1]. Aamoucke et al. found that the improvement of regional higher education level has a positive effect on the formation and progress of innovative industries[2]. Pogodaeva et al. concluded that

institutions of higher learning are the main factors for innovation to promote regional economic development, and its role path is that universities apply scientific research and innovation achievements to enterprise production practice, thus helping regional innovation[3]. Lv Yan et al. believe that colleges and universities positively influence regional innovation through cultivating high-level talents and participating in regional innovation activities[4]. Moreover, some scholars have also put forward targeted suggestions. Li Heng believes that the fit between higher education and regional scientific and technological innovation needs to be enhanced[5]. Zong Xiaohua et al. found that higher education resources obviously promote the urban technological innovation ability through the study of 41 cities in the Yangtze River basin[6].

At present, domestic scholars have little research on the Midwestern Higher Education Revitalization Plan, mainly studying its effect on economic growth[7] and the allocation of higher education resources[8].No scholars have combined the policy with the level of regional innovation.

In summary, according to the existing literature study, this paper analyze the policy of regional innovation capability from the microscopic view, observes whether it has a positive effect, and further explores regional heterogeneity.

3. Research Hypothesis

At present, with the support of the mass innovation policy, domestic higher education pays more attention to cultivate students' independent innovation spirit, which lays an important value guidance for technological innovation and provides higher quality human capital for the city to a certain extent. In addition, innovative achievements such as papers and patents generated by university research institutes are applied to production practice in the transformation mode of "industry-university-research-application", so as to provide an innovation-driven engine for the high-quality development of regional economies[9].Local governments will also increase investment in scientific research and innovation, promote school-enterprise cooperation, and continue to expand the advantages of "industry-university-research-

application".

Therefore, the following hypothesis is proposed:

The Midwestern Higher Education Revitalization Plan can significantly improve urban innovation level.   (H1)

The promotion on urban innovation level of the MHERD has been widely recognized, but its effect is still different among different regions and urban levels. On the one hand, the eastern region is the most economically developed region, and its innovation level and industrial structure reform are better than other regions. However, because the Midwestern Higher Education Revitalization Plan is a compensatory policy for the balanced development of higher education regions, its policy dividend also points to the central and western regions. On the other hand, the attraction of different cities for talents and the financial investment in scientific research and education are different. Cities above the third-tier level are more able to attract high-quality college graduates and innovative enterprises due to the advantages of developed economy and perfect urban infrastructure. The effect of talent agglomeration is obvious and the industrial structure is more reasonable. Additionally, most of the selected universities in the Midwestern Higher Education Revitalization Plan are concentrated in second- and third-tier cities, so the policy effect of second-and third-tier cities is more significant.

Therefore, the following hypothesis is proposed:

There exists regional heterogeneity in the consequence of the plan on urban innovation level, which is more prominent in the non-eastern regions.   (H2)

The promotion effect of the plan on urban innovation level has urban grade heterogeneity, and the policy dividend is more released in the second and third tier cities.   (H3)

4. Research Design

4.1 Data Sources

To ensure the authority, sufficiency and timeliness of the sample data, the urban data this article uses originates from "China City Statistical Yearbook" and "China Education Statistical Yearbook", selecting 2008-2019 as the time span. Some missing values are filled by manually querying the statistical yearbooks

and bulletins of each city, and the unpublished data are supplemented by linear interpolation. The samples are also processed as follows: Firstly, only considering the policy impact in 2012, the cities in which the universities were selected in 2016 were deleted; secondly, delete the cities with extremely serious data loss in the variables. Finally, this paper selects 254 prefecture-level city samples as the research object.

4.2 Variable Declaration
This article selects the proportion of Research Expenditure of each prefecture-level city in the total expenditure from 2008 to 2019 to describe urban innovation level(UIL). In this text, the following control variables are selected: (1) Open Degree(OD): measured by the logarithm of the actual use of foreign investment; (2) Urbanization Level(UL): using the urban population accounts for the percentage of urban population to measure; (3)Human Capital Level(HCL): evaluate by the number of college students per 10,000 students; (4) Economic Development Level(EDL): select the actual GDP per capitain in 2008 as the base period to describe; (5) Urban Innovation Atmosphere(UIA): the proportion of the number of invention patents authorized per year in the total number of patents authorized in the adopted cities; (6)

Industrial Structure Level(ISL): ratio of added value of secondary and tertiary industries to GDP.The descriptive statistics of variables are shown in Table 1.

4.3 Model Construction
This article takes the policy of the revitalization plan of higher education in the Midwestern Higher Education Revitalization Plan as a quasi-natural experiment, and evaluates the impact of the promotion of regional innovation ability in the program by using the double difference method.Therefore, this paper takes the cities of the universities in the Midwestern Higher Education Revitalization Plan as the experimental group, the rest cities are the control group:

$$UIL_{it} = \alpha + \beta policy_{it} + \gamma X_{it} + \mu_i + \sigma_t + \varepsilon_{it} \ (1)$$

Of which, i and t respectively delegate the city and year,UIL_{it} is the innovation ability level of city i in period t;$policy_{it}$ is the policy variable of MHERP. If the city i includes the universities covered by the plan in the administrative division of period t, the value is 1, otherwise it is 0, its coefficient βreflects the policy net effect of the revitalization of higher education on the development of urban innovation level; X_{it} is the set of all control variables;μ_i and σ_t are the individual and time-fixed effects in each city respectively; ε_{it} is a random perturbation term.

Table 1. Variable Descriptive Statistics

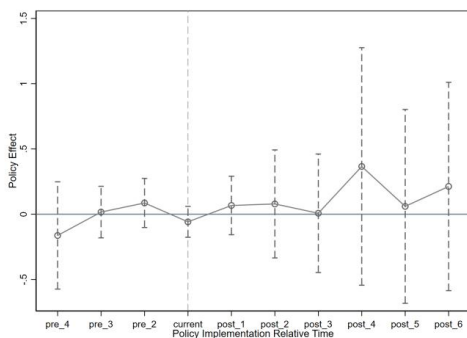| Variable	Mean	Standard Deviation	Minimum	Maximum	Sample
UIL	1.839	1.767	0.000	20.907	3048
MHERP	0.100	0.300	0.000	1.000	3048
OD	9.996	1.822	1.099	15.820	3048
UL	52.740	15.026	18.791	100.000	3048
HCL	189.690	220.332	2.000	1294.000	3048
EDL	46705.850	32083.180	99.000	467749.000	3048
UIA	0.620	4.545	0.000	201.000	3048
ISL	87.628	7.605	53.600	99.970	3048

Figure 1. Parallel Trend Test of Difference-in-Difference Model

5. Empirical Study

5.1 Parallel Trend Test
Ensure that the urban innovation level of the experimental and control group meets the parallel trend hypothesis test before the plan is a material premise of using the DID method. This paper uses the event analysis method to verify. Figure 1 is the final result. It represented that the regression coefficient is not statistically conspicuous before the policy,

indicating that before the conduct of the policy, the experimental group and the control group of the urban innovation level to enhance the trend is basically the same, there is no distinctive difference, parallel trend test has passed

5.2 Baseline Regression Results

All variables were tested for collinearity, and found no strong collinearity. OLS regression is used to investigate the association between the Midwestern Higher Education Revitalization Plan and the improvement of urban innovation level by gradually adding fixed effects and control variables. The results are presented in Table 2.The results display that whether the fixed effect or control variable is added, the policy effect of the Midwestern Higher Education Revitalization Plan on the improvement of urban innovation level is

conspicuous at the level of 1%.Column (4) shows that with the addition of control variables and fixed effects, the urban innovation level, that is, the urban financial expenditure on scientific research, has increased by 0.57%. Therefore, the hypothesis H1 has been verified. At the same time, all the control variables positively affect on the urban innovation level, among which open degree and urbanization level have the most significant effect, but the impact of human capital level and urban innovation atmosphere is relatively not significant. This displays that with the continuous improvement of the city's economic level, urbanization level and the gradual deepening of opening to the outside world, it could attract more innovative talents and enterprises, and further promote the promotion of urban innovation level through industrial structural reform.

Table 2. Impact of the MHERP on Urban Innovation Level

Variable	(1)	(2)	(3)	(4)
	UIL	UIL	UIL	UIL
MHERP	1.2067*** (0.1047)	0.8330*** (0.1202)	0.6051*** (0.0997)	0.5693*** (0.0971)
OD			0.3679*** (0.0163)	0.2827*** (0.0173)
UL			0.0316*** (0.0022)	0.01448*** (0.0025)
HCL			0.0005*** (0.0002)	0.0002 (0.0001)
EDL				0.00001*** (1.25e-06)
UIA				0.0067 (0.0056)
ISL				0.0088* (0.0048)
City Fixed Effect	×	√	√	√
Year Fixed Effect	×	√	√	√
Constant Term	1.7190*** (0.0331)	1.4772*** (0.0560)	-3.5793*** (0.1620)	-3.1644*** (0.3750)
R^2	0.0415	0.0535	0.3533	0.3894

Note: ***,**,* are respectively conspicuous at the level of 1 %, 5 % and 10 %,; ( ) is standard error, the same below.

In addition, although the Midwestern Higher Education Revitalization Plan has helped attract more high-quality students in the regions and improve the regional human capital level, the positive influence of human capital level is relatively insignificant in the short term due to the long student training cycle and the policy implementation cycle is relatively short.

5.3 Heterogeneity Analysis of Urban Location

In this paper, the samples are divided into four sub-samples according to the region of the city, and regression is conduct respectively. The regression results are shown in Table 3. It is presented that the policy effect in northeast region is the most conspicuous, followed by

the central region, while the western region is the weakest. Most of the universities selected are concentrated in the northeast and central regions, so the policy dividend is more obvious for the region. It can be seen from Column (4) that the positive effects of HCL and ISL are significant at the level of 5 % in the western region, while those in other regions are not significant. This shows that compared with other regions, in recent years, the dilemma of serious brain drain and low level of industrial structure upgrading in the western region has been alleviated, the attraction of cities to high-quality talents in colleges and universities has gradually increased, the reform of industrial structure has been deepened, and the concept of innovation-driven development has been continuously and deeply implemented. In summary, H2 is verified.

5.4 Heterogeneity Analysis of City Grade
According to the 2023 "City Business Charm Ranking List", this paper classifies the prefecture-level cities contained in the sample and regresses them in groups. The results are displayed in Table 4. It is found that the policy effect is positively significant at the level of 1 % in cities of all grades. However,

the policy effect of the second and third tier cities is the highest, followed by the first and new first tier cities, and the fourth and lower tier cities are the lowest. It is worthy to notice that the HCL of the fourth-tier and below cities has a negative effect, which further proves that the phenomenon of high-quality brain drain in underdeveloped cities is serious, and more valuable talent introduction policies need to be introduced to solve it. In conclusion, hypothesis H3 was verified.

5.5 Robustness Test
This paper uses the experimental group to carry out OLS regression on the Midwestern Higher Education Revitalization Plan, and finds a significant differenc eat the level of 1 %.Next, this paper randomly samples the experimental group and repeats 500 times. The results show that all the sampling estimation results are smaller than the previous OLS regression coefficients, most samples estimates are concentrated around 0, as shown in Figure 2.Therefore, the influence of other unobservable factors on the empirical results is excluded.

Table 3. Heterogeneity of the Impact of the MHERP on Different Urban Locations

Variable	(1) Eastern	(2) Northeast	(3) Central	(4) Western
MHERP	0.5609*** (0.0961)	0.5887*** (0.0961)	0.5727*** (0.0969)	0.5573*** (0.0926)
OD	0.2472*** (0.0177)	0.2803*** (0.0171)	0.2675*** (0.0178)	0.2286*** (0.0195)
UL	0.0111*** (0.0025)	0.0151*** (0.0025)	0.0149*** (0.0025)	0.0122*** (0.0025)
HCL	0.0003 (0.0002)	0.0001 (0.0002)	0.0003 (0.0002)	0.0003** (0.0002)
EDL	0.00001*** (1.24e-06)	0.00001*** (1.24e-06)	0.00002*** (1.29e-06)	0.00002*** (1.26e-06)
UIA	0.0066 (0.0055)	0.0058 (0.0055)	0.0068 (0.0056)	0.0075 (0.0055)
ISL	0.0071 (0.0047)	0.0009 (0.0048)	0.0072 (0.0048)	0.0093** (0.0047)
City Fixed Effect	√	√	√	√
Year Fixed Effect	√	√	√	√
Constant Term	-2.6814*** (0.3757)	-2.4367*** (0.3815)	-2.9958*** (0.3772)	-2.5326*** (0.3881)
R^2	0.4023	0.4024	0.3918	0.3961

Table 4. Heterogeneity of the Impact of the MHERP on Different City Grade

Variable	(1) the First and New First Tier Cities	(2) the Second and Third Tier Cities	(3) the Fourth-tier and Below Cities
MHERP	0.5542*** (0.0972)	0.5713*** (0.0962)	0.5444*** (0.0955)

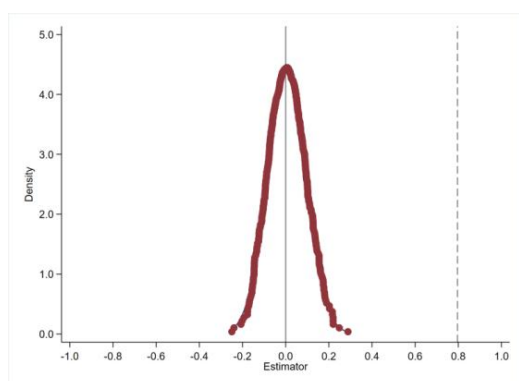| OD	0.2703*** (0.0179)	0.2483*** (0.0177)	0.2080*** (0.0185)
UL	0.0138*** (0.0025)	0.0131*** (0.0025)	0.0111*** (0.0025)
HCL	0.0001 (0.0002)	0.0002 (0.0002)	-0.00002 (0.0002)
EDL	0.00001*** (1.26e-06)	0.00002*** (1.25e-06)	0.00002*** (1.23e-06)
UIA	0.0063 (0.0056)	0.0070 (0.0055)	0.0065 (0.0055)
ISL	0.0100** (0.0048)	0.0083* (0.0047)	0.0103** (0.0047)
City Fixed Effect	√	√	√
Year Fixed Effect	√	√	√
Constant Term	-3.1000*** (0.3753)	-2.8956*** (0.3731)	-2.0083*** (0.3855)
R^2	0.3908	0.4009	0.4098

Figure 2. Placebo Test Plot

This paper further narrowed the sample time range to 2008-2016, to exclude the effect of the construction policy of "Double first-class" universities in 2017. After considering the control variables and fixed effects, the regression results show that the policy effect is still significantly positive, at the 1% confidence level. In addition, the level of urban innovation increased by 0.49%, which once again verified the reliability of the conclusions of this study.

6. Conclusion and Foresight

This paper takes 254 cities in China as research samples, employs the DID method to examine the influence of higher education revitalization on urban innovation level, and conducts robustness test and heterogeneity analysis. The main conclusions are as follows:

First, the Midwestern Higher Education Revitalization Plan positively affect on the promotion of urban innovation level. This shows that the plan plays an important role in helping cities to attract high-quality talents, promote industrial restructuring reform and the innovative development of total factors of production.

Second, the positive incentive effect on urban innovation level has regional heterogeneity and urban grade heterogeneity. Due to the bias of covering the selection of colleges and universities, the policy effects of the northeast region, the central region and the second and third tier cities are more significant, and they can better enjoy the policy dividend. In addition, the current situation of brain drain in fourth-tier and below cities should be paid attention to and solved.

Based on the analysis of the theoretical and empirical research results, this text makes the following policy recommendations:

First, continue to systematically improve the depth and breadth of the Midwestern Higher Education Revitalization Plan. On the basis of fully summarizing the advanced experience of the policy, the government should continue to increase policy support for higher education in the central and western regions, give certain policy preferences in terms of financial allocations and teacher-student training, and further enhance the implementation depth of the plan. Conditional colleges and universities will be included in the follow-up plan, and the breadth of the plan will be continuously expanded to contribute to improving the innovation level of the central and western cities.

Second, enhance the fit between the Midwestern Higher Education Revitalization Plan and the current situation of local development. In the process of policy

implementation, it is necessary to fully combine the local characteristics and development status of the city where the university is located, fully consider the heterogeneity of universities and regions, and avoid the "one-size-fits-all" policy. Universities should identify their own discipline characteristics and advantages, focus on supporting the development of emerging majors and first-class majors, accelerate the integration of production, education and research, combine discipline innovation with industrial innovation, promote the application of scientific research achievements in colleges and universities to urban production practice, and provide the power source of sustainable development for the improvement of urban innovation level. Underdeveloped cities must be fully aware of the seriousness of the problem of brain drain, formulate more attractive talent attraction policies, and cultivate a good employment environment to enhance the attraction of high-quality college graduates.

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