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The Economic Effect of Urban Innovation Capacity on Employment in China

Wang Runchen[1,†] and Yang Jinglin[2,*,†]

[1]Shandong Experimental High School, China
[2]Guangdong Country Garden School, China
* Corresponding author: guanghua.ren@gecacademy.cn
[†]These authors contributed equally:

ABSTRACT
The level of urban employment is one of the important evaluating factors for urban economic development, investigating the influencing factors of urban employment level is of great policy value. Contemporarily, economic development has entered a new stage, which has gradually changed from factor-driven development to innovation-driven development. In order to verify the growth effect of urban innovation level on employment, an econometric model is established. Specifically, we collect and organize the innovation capability indexes and employment population data of 200 cities in China. Then an ordinary least squares regression model is constructed to obtain the following results. First, the improvement of urban innovation capability can indeed lead to the improvement of urban employment level. In addition, the impact of innovation on employment growth does not have significant heterogeneity. Besides, there is no significant difference between the effect on urban employment level and private employment level. Subsequently, the mechanism of innovation level effects is demonstrated through economic logic explaining. Finally, we propose corresponding policy suggestions on urban innovation level improvement.

Keywords: *Urban Innovation Capacity, Employment.*

1. INTRODUCTION

China is increasingly becoming a considerable innovation force driving global innovation in plenty of sectors, e.g., artificial intelligence (AI), smart manufacturing, fintech etc. Strong entrepreneurship and market size, combined with government support and guidance, explain China's advance in innovation across a broad range of areas.

The World Intellectual Property Organization released the "2020 Global Innovation Index Report"(2020)[10], indicating that China's innovation ability ranking remains 14th place in 2020 as shown in Table 1. China ranks 1 among the 37 upper middle-income group economies. China ranks 4 among the 17 economies in South East Asia, East Asia, and Oceania.

Table1. Rankings of China (2018-2020).[1]

	GII	Innovation inputs	Innovation outputs
2020	14	26	6
2019	14	26	5
2018	17	27	10

According to the Table 1, China's ranking has risen rapidly in recent years, rising to 14th in 2019. In this year's report, China remained at the same level as last year and remained at No. 14 on the Global Innovation Index. It is worth noting that China hosts 17 of the top science and technology clusters worldwide, where Shenzhen–Hong Kong–Guangzhou and Beijing taking the 2nd and 4th spots, respectively. China produces more innovation outputs relative to its level of innovation investments.

From Figure 1 and 2[10], we can find that China has high scores in all seven GII pillars, which are above average for the upper middle-income group. China performs best in Knowledge & technology outputs and its weakest performance is in Institutions.

Besides, it should be noted that china is a world leader in Artificial Intelligence. Chinese businesses filed 473 of the 608 Artificial Intelligence patents lodged with the World Intellectual Property Organization last year and a third of all block chain patents. The Chinese government is reportedly investing

billions (Yuan) to support AI developers, including creating a $2 billion AI development park in Beijing.

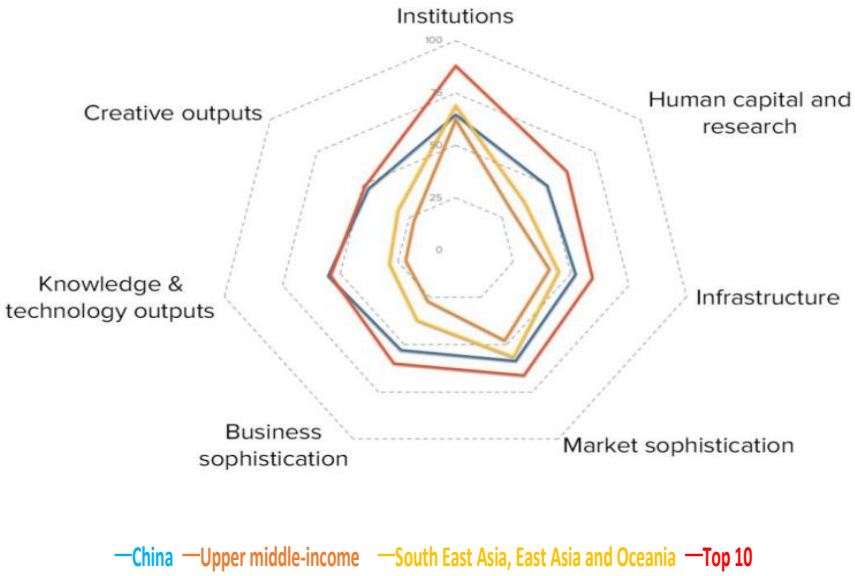

Figure1. China's scores in the seven GII pillars

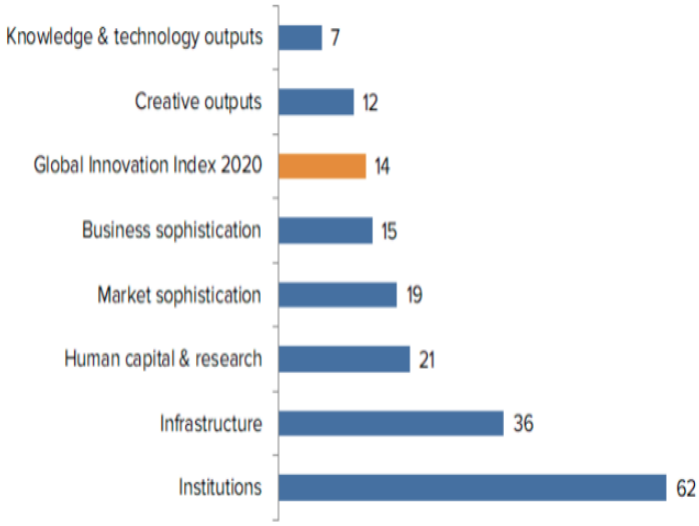

Figure2. Overview of china rankings in the seven GII areas

There are three reasons accounted for the fast development of innovation. First, over the past three decades, China has grown through massive capital, infrastructure investments and labor market with an export-oriented economy. The economic boom has lifted a large portion of the population out of poverty, but at the cost of environmental degradation, rising inequality, and growing demographic challenges. As a result, China needs to innovate to address some of its national challenges, which could also have significant global implications if left behind.

Second, the Chinese government expects to convert the China's innovation capacity to be knowledge-based. China has achieved impressive success in terms of research investment, R&D manpower, number of publications, and patents. This has translated into higher productivity and a higher capacity for technology-driven innovation.

Third, China has a huge domestic market and domestic industries that are protected to some extent from external competitors. This has allowed for the emergence of nationally competitive industries.

In other aspects of innovation, China is making progress, but still lags behind developed economies. Improved levels of primary and secondary education and increased funding for entrepreneurship have helped to foster innovation in China, but problems remain in higher education, the business environment etc.

In fact, there are many factors contributing to the availability and conditions for innovation, e.g., the climate differences, coastal differences, educational level, and payment of research. According to the

regional distribution, the innovative capabilities vary significantly. As provided the integrate innovation ability ratings of each city, coastal cities are more likely to have higher capability of innovation, which the ratings are higher, e.g. Shenzhen, Hangzhou, and Guangzhou. Development of innovation abilities seems to be significantly affected by other factors as well. On the one hand, trade can be easily conducted near coastal because of the developed transportation network. On the other hand, education resources are one of the attributes as well, where higher education level tends to be more innovative. Moreover, it is more capable to make significant innovation development with larger scientific budget.

2. LITERATURE REVIEW

There are many existing literatures that have analyzed the capabilities and effects of innovation development. Zhou et al. (2019)[2] assess the future innovative development conditions of 4 large and advanced metropolitans (Beijing, Shanghai, Shenzhen, and Hangzhou) from 3 different perspectives. They also emphasize the significance and point out the flaws of the population development and education level in the innovation process by comparing the data. Hong and Hu (2015)[3], indicate the impact of urbanization on innovative activities based on empirical analysis. Specifically, eastern areas of China are capable to progress further innovation management due to its advantageous moderate conditions compared to western China. Dang and Motohashi (2015)[4] underscore the role of patent subsidy and granting in innovation process with both descriptive and empirical data. They regard the patent programs as the indicative attribute of innovative activities in China, but largely affected by the patent policies according to different regions. Savitskaya et al. (2010)[5] interprets the involvement of R&D level and the cultural tradition of China firms in innovative performances. According to the study, the surplus of technologies (high level of R&D) actually slashes the engagement of firms' innovation process. Besides, the national culture also affects the action taken by firms.

Although the existing literature is already quite rich, there is relatively little literature examining the employment effects of urban innovativeness. Jinsheng Zhu and Die Li (2020)[6] select panel data of 34 industrial sub-sectors in China from 2007-2015 to establish PVAR model. On this basis, they study the relationship between technological innovation and employment growth via impulse response function and variance decomposition. In their research, technological innovation has the effect of first inhibiting and then promoting labor employment and countermeasures are proposed. In other words, the technological innovation has a negative effect on labor employment in the early stage and a positive effect in the later stage. Marco Vivarelli (2007)[7] makes a detailed survey of the theoretical and empirical literature on the subject. Based on the study, although initial labor-saving impact of process innovations is always working, the complete counter-balancing of dismissed workers cannot be assumed ex-ante. Mariacristina Piva & Marco Vivarelli (2005)[8] find a significant positive relationship between innovation and employment by applying GMM-SYS to an employment equation augmented for technology with a dataset of 575 Italian manufacturing firms over the period 1992–1997. John Van Reenen (1997)[9] uses British firm-level panel data on actual innovative activity drawn from different statistical sources to identify the effect of technical change on jobs. In this study, innovations have a positive and significant effect lasting over several years on employment even under controlling for fixed effects, dynamics, and endogeneity. Using firm-level micro-data for the period 1998–2001, José Miguel Benavente and Rodolfo Lauterbach (2008)[10] find that product innovations affect employment positively and significantly. On the other hand, there is no evidence to suggest that process innovations significantly influence employment after controlling for investment and sectorial patterns.

3. DATA AND MODEL

3.1. Data resources

In order to study the impact of innovation abilities of cities on employment, this paper selects related data of cities across China in 2018 to conduct a quantitative analysis according to relevant databases of China City Statistical Yearbook and China Regional Innovation and Entrepreneurship Index in China. Indicators related to employment consist of Persons Employed in Urban Units at Year-end and Persons Employed in Private Enterprises and Self-Employed Individuals in Urban Areas. Indicator of cities' innovation ability is the ratings innovation ability. Due to the deficiencies and the faultiness of data of some cities, the ultimate sample includes 267 cities after deletion.

3.2. Descriptive statistics

Before constructing the models of quantitative analysis, descriptive statistics are required for variables, which are listed in Table 2.

Table2. Descriptive statistics for evaluating level of employment and innovation and logarithm of them

variable	Obs	Mean	Std.Dev.	Min	Max
city	267	134	77.22046	1	267
innovation value	267	50.38412	28.4131	0.3412969	100
urban employment	267	510624.5	636523.2	34681	6135401
private employment	267	699720.9	833051.2	13579	5618493
ln(urban employment)	267	12.73993	0.8549903	10.45395	15.62959
ln(private employment)	267	13.00204	0.947725	9.51628	15.54157

In order to further observe the relationships between variables, Fig.3 and 4 depict the scatterplots for urban and private employment as function of innovation abilities ratings.

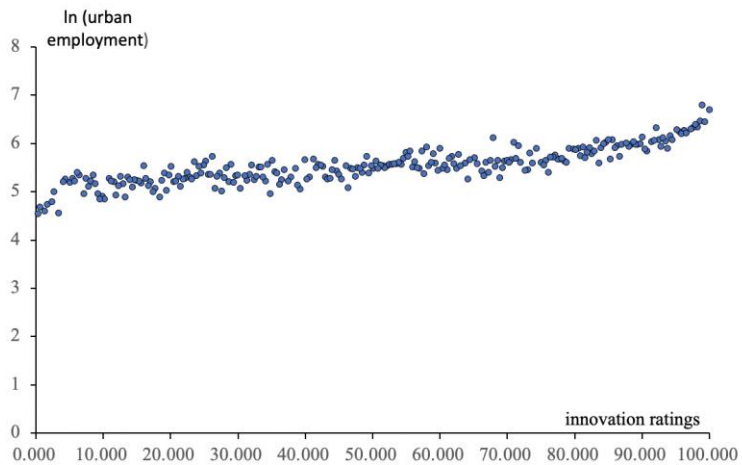

Figure3. Relationship between innovation ratings and logarithm urban employment

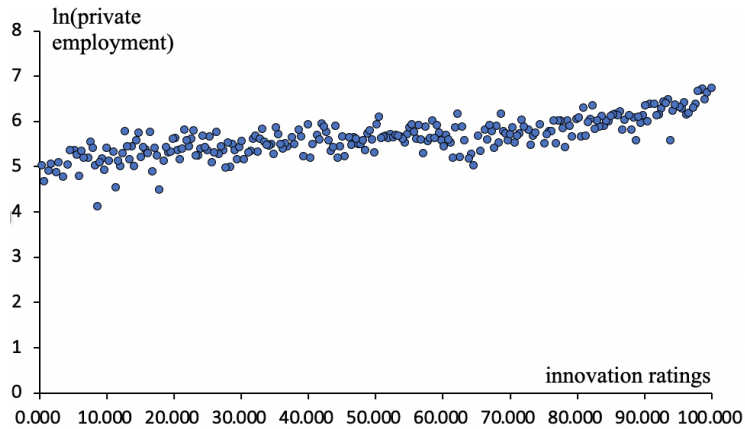

Figure4. Relationship between innovation ratings and logarithm private employment

3.3. Model

With the basic introduction of data sources and the descriptive statistics of variables, simple least square regression models are established to analyze the innovation ability effect on employment quantitatively. Due to the distinctive magnitudes of explanatory and response variables, response variables are processed in logarithm, i.e., establishing the following regression models:

$$\ln(urban\_employment)_i = \alpha_1 + \beta_1 innovation\_value_i + \varepsilon_i \quad (1)$$

$$\ln(private\_employment)_i = \alpha_2 + \beta_2 innovation\_value_i + \mu_i \quad (2)$$

The results of regression are listed in Table 3.

Table3. Descriptive statistics of innovation value and logarithm of urban employment and private employment

Dependent variable	ln (urban employment)	ln (private employment)
Innovation value	0.0112*** (-0.00048)	0.0114*** (-0.000599)
Constant	4.969*** (-0.0264)	5.074*** (-0.0346)
Observations	267	267
R-squared	0.734	0.616
Correlation	0.8565632	0.78508268

Note: *** indicates that the results are statistically significant.

According to the regression results in Table 3, it is indicative that city innovation ability affects employment in not only urban area but also private enterprise positively. Besides, one additional unit of innovation ability leads to 1% significant increment on employment in urban and in private enterprise. Therefore, city innovation ability influences employment with positive effects and no structural differences.

4. ROBUSTNESS ANALYSES

To examine the robustness of the primary regression result, employment levels of urban and private enterprise are transferred into equating level value to analyze. Besides, it reflects the equating level effect of urban innovation ability on employment. The results are shown in Table 4.

Table4. Descriptive statistics for equating level of urban and private enterprise employment

Dependent variable	Urban employment	Private employment
Innovation value	14,042*** (-1679)	18,992*** (-2020)
Constant	-196,858*** (-59370)	-257,169*** (-71816)
Observations	267	267
R-squared	0.393	0.42
Correlation	0.6267966	0.6477619

Note: *** indicates that the results are statistically significant.

The regression results are still significant. After changing the measurement index of employed population, where city's innovation ability still has a positive effect on employment. Therefore, the main regression results of this paper are robust.

5. DISCUSSIONS

For one thing, the mechanisms of process innovation on labor employment are mainly negative substitution effect and positive compensation effect. Process innovation will increase the productivity of the industry by using machines to replace workers. On the one hand, it reduces the demand for labor without the expansion of production scale in the industry. On the other hand, it makes the traditional sector decline and generates the emerging sector. Moreover, the mismatch between the skills of workers in the original traditional sector and the requirements of the emerging sector cause structural contradiction. Thus, it reduces the employment, which is negative substitution effect. On the contrary, the process innovation significantly reduces the cost of products produced by enterprises. Additionally, due to the price advantage and the attractiveness of new products, the demand for products is expanding. To meet the market demand, more labor is needed to produce these products, i.e., the employment demand grows showing a positive compensation effect. The result show that compensation effects exist all the time.

On the other hand, product innovation focuses on the way of job creation by product innovation implantation, since innovation leads to the development of new products and even the emergence of new sectors. It has a direct positive impact on employment, driving employment growth by increasing the demand for new products. For example, plenty of jobs were created by the invention of the automobile in the early 20th century as well as the invention of the personal computer later in the century. Technology has also created many new jobs never seen before. As a result of technological developments, all jobs in the field of outbound sales have recovered more substantially in new areas. However, the labor-friendly impact of product innovation may be enhanced or diminished depending on the circumstances though undisputed. In fact, the "welfare effect" of product innovation (creation of new products) needs to be balanced by the "substitution effect" (old products are replaced). In fact, the observed compensation effects resulting from the introduction of new products imply the growth of employment even when the replacement of old products is considered. In conclusion, the innovation increases the employment with the consideration of negative impact of them.

Employment level plays a crucial role for city's development. Because of the importance of the employment level, cities have to seek ways to enhance and boost the employment level. Therefore, according to the empirical results shown in this paper, improvement of urban employment level can be achieved by increasing the urban innovation capability.

Given the limited existed innovative resources, government are responsible to the efficient allocation of those resources to promote the intense innovation capability. This leads to the increasing competitiveness of cities for gaining more out-of-town investment funds as well as gathering talents and resources to the cities, i.e., supports the successful construction of innovative cities. Cities need to combine their advantages in environment and local industries to determine the suitable development direction. For example, technological advancements are able to help other industries (e.g., agriculture) to make great progress in sales revenue, which benefits agriculture-based regions.

Government ought to focus and emphasize the education with more budgets, e.g., the financial aids and the scholarships reward. Without the concerns on the financial aspects and with the lighter burdens, students are likely to put more efforts on studying. Additionally, schools should increase expenditure on the laboratory facilities and opportunity for field trips. For pupils, middle school students, and high school students, they can have more comprehensive development and obtain firm fundamental knowledge for further accomplishment in universities. With regard to undergraduate and postgraduate students, they can conduct more researches and experiments with the increment of not only technological endorsement but also financial support. Since government establish the colleges to stimulate the useful contribution of students to the development of the society and cultivate more talented people in different fields. Its aim is to expand the reserve of talents.

Moreover, government should supply subsidy, credits, and preferential policies as well as set up particular research tax loans and R&D funding for the high-tech companies, industries, and professional well-educated employees and experts. Government also dedicates to generate the atmosphere of encouraging innovation, e.g., building science high-tech parks, concentrating the relevant companies. These enable the capable companies and individuals to have effective and widen conditions and platforms to engage in the contributive activities and innovation of products and services. Besides, government needs to hold strict standards and criteria for project censoring. For example, Shanghai, one of the most economically developed cities, has created its own development concept and loosened the regulations to encourage economic activities. Cities with more high-quality patent applications tend to own stronger innovation ability, which is one of the embodiments.

6. CONCLUSION

In order to verify the influences of urban innovation ability on employment, the data of innovation capability and employment population is collected for 267 cities across China in 2018 to construct a cross-sectional sample and establish the estimation of least square model. With the empirical analysis, it shows that the improvement of innovation ability indeed drives the growth of the employment. Besides, the effect does not contain obvious heterogeneity for different occupational population, i.e., proves the reliability of the result. Furthermore, we conduct the analysis of robustness, where the primary regression results are still valid.

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