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A Study on the Impact of Science and Technology Innovation on Employment in the Service Sector - An Analysis Based on Urban Panel Data

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Abstract

Science, technology and innovation have a profound impact on the labor market in a wide range of areas. As a core sector of the country's economic growth, the employment situation in the service sector is of great significance to the country's economy and people's livelihood. This paper focuses on the question: does STI have a positive impact on employment in the service sector? Based on this, this paper firstly combs through the literature related to the theory of science and technology innovation and employment. Then, it briefly introduces the characteristics of STI and service industry labor force changes in China, and uses the number of invention grants and patent grants at the prefecture-level city level for the three years from 2017-2019 as the panel data, which is used as a quantitative indicator of the level of STI. Then the impact of STI on service industry employment is empirically examined, and how this impact changes over time is explored, along with a robustness test. The main conclusions of this paper are as follows: first, there is a positive association between STI and the amount of employment in the service sector. However, we also find that greater STI is needed over time to keep increasing the level of employment in the service sector. Second, the robustness test finds that the result that STI has a positive and significant effect on employment in the service sector is robust.

Keywords

STI, service sector employment, urban panel data.

1. Introduction

1.1. Background

The employment situation is related to the prosperity of the country and the well-being of people's livelihood, and is of great significance for maintaining social stability.In 2023, China's new urban labor force reached about 12.44 million, of which the number of college students was as high as 11.58 million, which is a record high. At the same time, to ensure the smooth return of military personnel to the workplace after retirement and to provide adequate job opportunities for nearly 300 million migrant workers, the employment pressure in the labor market remains high. By observing the relationship between supply and demand in the labor market, it can be found that although the overall demand for jobs exceeds the number of job seekers at this stage, the overall employment boom in China is still facing the risk of a possible downturn. Against this backdrop, the pressure on employment in the country remains, and studying how to effectively promote employment remains a priority for the Government's administration.

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1.2. Research Methods

(1) Empirical analysis method. This paper uses R language software to carry out empirical analysis, taking the total employment in the service industry as the explanatory variable, and the number of invention authorizations as a measure of scientific and technological innovation as the main explanatory variable, and taking the data of prefecture-level cities in China from 2017 to 2019 as the research object, to empirically analyze the impact of scientific and technological innovation on the number of service industry employment. In addition, the sample is divided into subgroups by year to regress again to examine how the impact of STI on service industry employment changes over time as a way to capture possible heterogeneous effects. Finally, in order to verify the robustness of the model, this paper replaces the main explanatory variable with the amount of patents granted, and removes the data of Beijing, Tianjin, Shanghai, and Chongqing from the main explanatory variable to use two robustness tests of the amount of patents granted at the level of the remaining prefectural cities, which are used to verify the robustness of the views and conclusions of this paper.

2. Concepts and Research Status

2.1. Relevant Concepts

2.1.1. The concept of science and technology innovation

Science and technology innovation is to explore and improve the existing technology, apply the new knowledge and technology obtained from the research to reality, and then produce the effect close to the established goal. Specifically, technological innovation refers to the adoption of newer manufacturing methods, upgrading of production tools and introduction of new products, i.e. the advancement of technological equipment in a narrower sense: from a broader perspective, technological innovation also encompasses the enhancement of workers' own knowledge and skills, and optimization of management, i.e. the enhancement of technological services. The article refers to the latter, i.e., the other key elements that contribute to the increase in product output, without the influence of labor and capital (Zhao, 2006).

The paths of technological innovation are mainly divided into two categories: independent innovation and the introduction of external technologies. The degree of economic development of a country or region is an important factor in its choice of technological innovation route.

2.1.2. The concept of service industry

In view of the differences in evaluation criteria, the categorization of services has shown a rich diversity. Common categorization methods include several aspects:First, according to the division of service objects, it can be distinguished into productive service industries for producers and living service industries for consumers. Productive services support the needs of the production sector, including transportation, modern logistics, financial information and other service areas, and their output is usually used as semi-finished products in production activities. In contrast, lifestyle services, which focus on consumer needs, provide products that directly satisfy final consumption needs, with common examples covering, but not limited to, hotels, food and beverage, recreation and leisure and sightseeing tours, education, etc., and such services are also considered to be consumption-based services. Secondly, services can be categorized into traditional and modern types according to the level of technology involved. Those services that are indispensable to daily life, such as hotels and accommodations and transportation, are classified as traditional services with a relatively low level of technology; on the other hand, those based on technological knowledge and high-level human resources, such as the financial industry, education, and the cultural and creative industries, are classified as modern services with a higher level of technology.

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2.1.3. The concept of employment

According to the concept set by the International Labor Organization, a person who has the ability and desire to work, and is of the right age to do so, is considered to be employed if he or she participates in economic work for a wage.

3. Introduction to the data section of the thesis

3.1. Introduction of sample data

3.1.1. Introduction of variables

Take 1n (the total number of people employed in China's service industry each year), written emp3 in the table, as the explanatory variable, which is measured by the total number of people employed in China's service industry from 2017 to 2019. For the measure of science and technology innovation, 1n(invention authorization) is used as the measure of science and technology innovation in the main regression, and 1n(patent authorization) is used as the measure of science and technology innovation in the robustness test. The control variables include GDP per capita and total population.

3.2. Descriptive results

Table 3-1 Descriptive Statistics

Statistic	Sample size	Mean	Standard error	Minimum	Maximum
Employment in the service sector	872	320,537.500	593,436.1	21,349	6,810,780
Patents Granted	842	7,364.814	16,487.430	2	166,609
Number of Inventions Granted	834	1,271.524	4,070.841	1	53,127
Population	863	441.338	312.892	19	3,410
GDP per capita	877	64,239.800	35,461.310	12,656	203,489
Year	877	2,018.011	0.815	2,017	2,019

Using descriptive statistics to analyze, we can learn that the mean of the number of people employed in the service sector is 320537.5, with a minimum value of 21349, a maximum value of 6810730, and its standard deviation is 593436.1.

The sample size of the number of patents granted for the explanatory variables totaled 842, with a minimum value of 1. This sample was used for logarithmic purposes resulting in a less severe missing sample, so taking logarithms is meaningful. The average value of patent grant is 7364.814, the minimum value is 2 for Wuwei City, and the maximum value is 166609 for Shenzhen City. The sample size of the number of patents granted for invention patents is 834 in total, and the minimum value is 1. This sample is used to take the logarithm resulting in the lack of samples is not serious, so it is meaningful to take the logarithm. The average number of patents granted reaches 1271.524, with the minimum value of 1 in Naqu City and the maximum value of 53127 in Beijing City, which reveals the significant imbalance of scientific and technological invention capacity in different parts of China, and at the same time highlights the importance of carrying out the research in this paper.

Based on the aforementioned descriptive research analysis, we can infer that there is a certain degree of fluctuation in the number of employees in the service industry, the number of patents granted and the number of inventions granted, which are the explanatory variables selected in

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this paper. This provides a basis for exploring the possibility of a relationship between total employment in the service sector and STI.

4. Empirical results and analysis

4.1. The impact of science and technology innovation on total employment in service industry

In the process of data processing, the number of service sector employment, the number of invention licenses, the total population and the GDP per capita in the sample data were logarithmically processed, and the regression analysis was applied to derive the impact of science and technology innovation represented by the number of invention licenses on the number of service sector employment. Table 5-1 shows the results of the regression of the number of inventions licensed on the number of people employed in the service sector.

Table 4-1 Impact of STI on Total Employment in the Services Sector

	explanatory variable： ln（Employment in services）			
	(1)	(2)	(3)	(4)
ln（Number of inventions licensed）	0.348***	0.229***	0.150***	0.147***
	(0.010)	(0.009)	(0.013)	(0.013)
ln（Total population）		0.577***	0.678***	0.682***
		(0.023)	(0.025)	(0.025)
ln（GDP per capita）			0.320***	0.329***
			(0.037)	(0.038)
Year=2018				0.026
				(0.033)
Year=2019				0.101***
				(0.032)
Constant	10.362***	7.601***	3.935***	3.777***
	(0.056)	(0.117)	(0.444)	(0.457)
Observations	832	822	822	822
R2	0.598	0.772	0.791	0.794

Note: Standard errors in parentheses. *p<0.1; **p<0.05; ***p<0.01。

Column (1) regresses ln(invention licensing) on ln(service sector employment) and finds that a 1% rise in invention licensing will lead to a 0.348% rise in service sector employment. This aresult is statistically significant and seems to imply that STI helps increase service sector employment in the city. But it is possible that this result is driven by other third party factors. Therefore, in columns (2), (3), and (4), we try to control for ln(total population), ln(GDP per capita), and year fixed effects, :to further examine the relationship between invention licensing and service sector employment.

The results in column (4) show that after controlling for the relevant variables and year fixed effects, a 1% rise in the volume of invention licenses will lead to a 0.147% rise in the number of people employed in the service sector, a result that is still statistically significant. The above

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results are in line with the expectation that STI has a positive and significant effect on employment in the service sector

4.2. Heterogeneity analysis

This paper captures possible heterogeneous effects by conducting year-by-year regressions to examine how the impact of STI on services employment has changed over time.

Table 4-2 Heterogeneity Test

	explanatory variable： ln（Employment in services）		
	(1)2017年	(2)2018年	(3)2019年
ln（Number of inventions licensed）	0.198***	0.129***	0.098***
	(0.021)	(0.024)	(0.022)
ln（Total population）	0.623***	0.718***	0.735***
	(0.043)	(0.045)	(0.042)
ln（GDP per capita）	0.157**	0.394***	0.488***
	(0.062)	(0.068)	(0.069)
Constant	5.756***	2.981***	2.100***
	(0.739)	(0.807)	(0.809)
Observations	269	270	283
R2	0.777	0.800	0.811

Note: Standard errors in parentheses. *p<0.1; **p<0.05; ***p<0.01。

The above table reports the results of the corresponding heterogeneity tests. Among them,columns (1)-(3) show the regression results for 2017, 2018 and 2019 respectively. It can be found that a 1% rise in invention authorizations can lead to a 0.198% rise in service sector employment in 2017, and this effect declines to 0.129% and 0.098% in 2018 and 2019. This suggests that greater scientific and technological innovation is needed over time to keep increasing the level of employment in the service sector.

4.3. Robustness Test

Table 5-1 analyzes 1n (invention authorization) as an explanatory variable. Invention is the patent with the highest gold content, and in addition to invention, patent is also an important symbol of science and technology innovation. To ensure the reliability of the findings, we replace the core explanatory variable with 1n (patent authorization) at the prefecture-level city level for the robustness test. The results are reported in Table 5-3.

Table 4-3 Robustness test for patent granting in prefecture-level cities

	explanatory variable： ln（Employment in services）			
	(1)	(2)	(3)	(4)
ln（Patent grants）	0.390***	0.246***	0.121***	0.115***
	(0.011)	(0.011)	(0.015)	(0.016)
ln（Total population）		0.542***	0.708***	0.716***

		(0.026)	(0.028)	(0.029)
ln（GDP per capita）			0.437***	0.449***
			(0.037)	(0.039)
Year=2018				0.008
				(0.036)
Year=2019				0.068*
				(0.035)
Constant	9.244***	7.160***	2.358***	2.192***
	(0.085)	(0.121)	(0.423)	(0.454)
Observations	839	829	829	829
R2	0.603	0.739	0.777	0.778

*Note: Standard errors in parentheses.**p<0.1; **p<0.05; ***p<0.01。

The first column regresses ln (patent grants) on ln (service sector employment) and finds that a 1% rise in patent grants will lead to a 0.390`% rise in service sector employment, which is statistically significant and seems to imply that science and technology innovations can help to increase the number of service sector jobs in the city, but it is possible that this result is driven by other third-party factors, therefore, in the second column , the third and fourth columns, we try to add ln(total population), ln(GDP per capita), and year fixed effects to further examine the relationship between the number of patents granted and the number of service sector jobs

The second column regresses ln(total population) on ln(service sector employment) and finds that a 1% increase in total population leads to a 0.246% increase in service sector employment, a statistically significant result.

The third column regresses ln(GDP per capita) on ln(services employment) and finds that a 1% increase in GDP per capita will result in a 0.121% increase in services employment, a statistically significant result

The fourth column regresses ln(Services Employment) with year fixed effects and finds that after one year, this will result in a 0.115% increase in services employment, a result that is statistically significant.

As a result of the above analysis, it can be seen that the explanatory variables have a more significant effect on the results and meet the basic expectations of the thesis. That is, the variable of invention authorization has a positive and significant impact on the number of people employed in the service sector.

Meanwhile, in order to increase the robustness of the validation, we remove the data of Beijing, Tianjin, Shanghai, and Chongqing from the core explanatory variables, and use the patent grants of the remaining prefecture-level cities at the prefecture level as the panel data for the robustness test.

Table 4-4 Robustness test with patent grants of prefecture-level cities after removing some data

	explanatory variable： ln（Employment in services）			
	(1)	(2)	(3)	(4)
ln（Patent grants）	0.323***	0.212***	0.137***	0.134***

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	(0.010)	(0.009)	(0.012)	(0.012)
ln（Total population）		0.561***	0.658***	0.662***
		(0.022)	(0.024)	(0.024)
ln（GDP per capita）			0.307***	0.317***
			(0.036)	(0.036)
Year=2018				0.024
				(0.032)
Year=2019				0.099***
				(0.031)
Constant	10.477***	7.774***	4.243***	4.088***
	(0.055)	(0.113)	(0.423)	(0.435)
Observations	821	811	811	811
R2	0.567	0.758	0.779	0.782

*Note: Standard errors in parentheses.**p<0.1; **p<0.05; ***p<0.01。

The first column regresses ln (patent grants) on ln (service sector employment) and finds that a 1% rise in patent grants will lead to a 0.323% rise in service sector employment, a statistically significant result that seems to imply that STI helps to increase the number of service sector jobs in the city, but it is possible that this result is driven by other third-party factors, and therefore, in the second column, third and fourth columns, we try to add ln(total population), ln(GDP per capita), and year fixed effects to further examine the relationship between patent grants and services employment

The second column regresses ln(total population) on ln(service sector employment) and finds that a 1% increase in total population leads to a 0.212% increase in service sector employment, a statistically significant result.

The third column regresses ln(GDP per capita) on ln(services employment) and finds that a 1% increase in GDP per capita will result in a 0.137% increase in services employment, a result that is statistically significant

The fourth column regresses ln(Services Employment) with year fixed effects and finds that after one year, this will result in a 0.134% increase in services employment, a result that is statistically significant.

As a result of the above analysis, it can be seen that the explanatory variables have a more significant effect on the results and meet the basic expectations of the thesis. That is, the variable of invention authorization has a positive and significant impact on the number of people employed in the service sector.

Robustness test regression results of the impact of STI on the number of people employed in the service sector After the robustness test, the results of the regression analysis coincide with the results of the analysis demonstrated in the previous section, so it can be considered that the results of the core regression analysis in this chapter are reliable.

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5. Conclusions

On the premise of comprehensively exploring the existing studies and theories on the impact of technological innovation on employment, this study makes certain analysis on the current situation of China's technological innovation and employment in the service sector with the help of corresponding data, and selects the number of patents granted as a measure of the degree of technological development. Further, this paper applies econometric methods to explore the impact of S&T innovation on the overall employment quantity of China's service industry, and summarizes the following conclusions.

First, there is a positive correlation between scientific and technological innovation and the amount of employment in the service industry, i.e., the development of technology will help promote the growth of employment in China's service industry.

Second, the proportion of R&D investment and the number of patents granted, which represent the capacity of independent innovation, are significantly and positively associated with the amount of employment in the service industry.

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