



# Research on the Effects of International Students on Regional Economy in China - From Talent Engagement Perspective

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**Abstract.** International talent engagement is an important approach for a country to pursue the strategic human resources, realize national rejuvenation, and build advantages in international competition. As one of the mainstreams in international talent engagement, international student education in China has entered a new phase to focus on quality and efficiency after the rapid growth in the scale of international students. The economic benefits of international students have been widely discussed, but few researches have proven the positive effects of international student education on China's regional economic development from the perspective of knowledge and technology spillovers by viewing them as talents. This research took provinces, autonomous regions, and municipalities as sample units to prove the inverted U-shaped relation between the talent engagement scale of international students in China and the development of regional economy. The robustness test results showed that the proportion of "Double First-class" universities significantly affects this relation. Therefore, as a source of talent engagement, international student education should control the scale and prioritize quality, and seize the historic opportunity of building "Double-first Class" universities to better serve the national strategy in terms of economic development.

**Keywords:** international student education; talent engagement; regional economy development; Chinese Government Scholarship

## 1 INTRODUCTION

Innovation is the primary impetus for sustainable socioeconomic development, and its core lies in leveraging the driving role of talents, especially the increasingly prominent contributions of international talent mobility in current national economic development and technological progress <sup>1</sup>. Developed countries, for example, the United States, have

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been actively attracting international talent and strive to achieve and maintain comprehensive social-economic development through their comparative advantages in knowledge, technology, and economy brought by talent agglomeration<sup>2</sup>. Since the 18th CPC National Congress, the Chinese Government has also developed an awareness to attract talents across the globe for the countries' development. Great importance had been attached to talent agglomeration strategy with a higher strategic position and global perspective, and attracting outstanding international talent has been seen as a key element in building a talent-rich country and realizing national modernization. President Xi Jinping's proposal to let talents and ideas flow freely along "the Belt and Road" not only offers significant opportunities for the sustainable and stable development of Chinese society, but also relates to the future of China and Chinese people, and points to the direction for China's long-term strategic goal of international talent.

Based on the Theory of Economic Growth, the accumulation of human capital has become the main driving force for the transformation of regional development mode and the realization of economic catching-up<sup>3</sup>. The main source of achieving socio-economic growth is to obtain high-quality human capital. The improvement of total factor productivity also largely relies on the knowledge and skill support provided by human capital<sup>4</sup>. As an important advanced production factor, the continuous inflow of international talents will realize a significant technology spillover effect on the development of international trade, contribute to the innovation of knowledge and technology-intensive industries and product import and export models<sup>5</sup>, enhance the improvement of local creativity and productivity, and to some extent solve the problem of weak technological foundation and technological bottlenecks in high-tech industries, which plays a significant role in technological progress<sup>6</sup>. The knowledge spillover effect is manifested in promoting talent inter-flow through academic exchanges, scientific research cooperation, technology transfer, and talent aggregation, upgrading the comprehensive quality of human capital in terms of knowledge, ideas, and skills from the macro-perspective, increasing labor capital accumulation and optimizing the allocation of existing labor resources<sup>7</sup>. The optimization of labor structure will also achieve the rational layout and upgrading of regional industries by attracting external investment, which in turn leads to income increase and consumption upgrading, and further drives regional economic growth<sup>8</sup>.

International student education constitutes an important component of China's international talent engagement, providing a considerable "wealth" of talents<sup>9,10</sup>. Developing international student education is an important means for China to attract high-quality international talent, and it is also a necessary measure to reverse the "talent deficit"<sup>11</sup>. In recent years, China's enrollment of international students has shown a trend of leapfrog growth. Many international students not only bring considerable direct education service trade income but also further stimulates the economic vitality and employment growth of their study destinations, thereby promoting regional economic development<sup>12</sup>). Based on achieving the target of 500,000 international students in the "Study in China Plan" as scheduled, the Ministry of Education further proposed the development concept of "enhancing quality and improving efficiency", requiring the use of a Chinese Government Scholarship to lead the development of international student education in China to higher quality and level, and advocating for continuous

optimization of the structure of international students<sup>13</sup>. International students in China have the potential to become knowledge-based talents with an international perspective, familiarity with international rules, cross-cultural communication skills, strong professional abilities, and master professional expertise and knowledge of the Chinese language and culture<sup>14</sup>. As a beneficial supplement to the high-end labor force in China's human capital market, they form strong intellectual and creative support for the improvement of specific industries' technological development and even social productivity through the effects of "knowledge spillover" and "technology spillover"<sup>15,16</sup>. They also play a bridge and link role in multi-dimensional international exchanges and cooperation between China and other countries in economy, science, technology, and culture, enhancing the openness of industrial economic entities and the international competitiveness of China.

However, attracting and utilizing international talents through the development of international student education in China will inevitably incur significant socioeconomic costs, thereby squeezing the investment in the cultivation and retention of domestic talents, as well as in other key research and innovation fields. The rapid growth of international talents occupies opportunities and positions that could be given to domestic talents, which may undermine the endogenous ability of China's talent generation in the long run. Blindly expanding the scale of talent engagement through international student education without a mature human resource environment and correspondent industrial structure will break the existing balance between labor supply and demand and the law of talent flow, causing new problems of fairness and efficiency. Based on the above discussion, it can be seen that exploring whether talent engagement through international student education can effectively contribute to social and economic development not only conforms to China's requirement of "enhancing quality and improving efficiency" for international student education but also provides certain theoretical guidance and practical reference for the sustainable development of international student education in China.

## **2 THE RELATION BETWEEN THE INTERNATIONAL TALENT ENGAGEMENT SCALE OF INTERNATIONAL STUDENTS IN CHINA AND REGIONAL ECONOMIC DEVELOPMENT**

The previous research perspectives on the contribution of international students to the economic development of a country can be roughly summarized in two categories. First, the international student education industry is an important part of the education service industry. Essentially, international student education is a form of education services export trade that brings substantial economic revenues to the exporting countries<sup>17</sup>. For example, the consumer spending of international students can boost local economic development and employment to a certain extent and is an important source of university budgets<sup>18</sup>. In addition, their purchase of products and services that meet their own living and study needs bring indirect benefits to related industries<sup>19</sup>, which exert the spatial spillover effect on the economic development of the exporting countries in

education services, forming an important source of economic growth<sup>20</sup>. Second, those international talents with a better understanding of the market and business rules of their home countries can provide a stable and efficient source of trade information to improve the country of their study destination's overseas investment environment and transaction efficiency, significantly reduce trade barriers and save trade costs<sup>21</sup>, indirectly improving the profit margin of commodity import and export<sup>22</sup>. In addition, the educational and cultural exchange platform created by international student education enables students from different countries to establish people-to-people bond, accept Chinese goods, capital, standards, and development models<sup>23</sup>, and further promote China's culture and values. Also, international students are encouraged to make significant contributions to promoting China's transnational trade and investment, international economic exchanges, and cooperation through their language and cultural advantages<sup>24, 25</sup>. In general, previous researches have highlighted the internal relevance between international students and China's socioeconomic development mainly from two aspects, namely the driving role of educational service export and related consumption for the economy, as well as contributions to international economic and trade cooperation and investment, while more attention was paid to the direct benefits and normative advantages that international students bring. However, few researchers have verified the contribution of international students to the core elements of economic growth, such as scientific and technological advancement, productivity improvement, and development model innovation, from the perspective of international talent engagement, which indicates a research gap.

With the continuous improvement of the scale and education level of international students, international talents with excellent potential have provided important intellectual support for the high-quality development of China's economy<sup>26</sup>. Firstly, high-level international graduate students and visiting scholars possess unique advantages such as knowledge and technology. They can integrate their patents and technologies with relevant industries or enterprises in China, promoting the inflow of key production factors such as information and technology<sup>27</sup>. The study and research experience in China further aligns their professional skills with the technological and innovative needs of Chinese enterprises and the market, making a better contribution to China's technological innovation and transformation of scientific and technological achievements<sup>28</sup>, and promoting the development of China's high-tech industry<sup>3</sup>. Second, the talents of international students in China have the characteristics of high education, professionalism, and positive interaction<sup>29</sup>. The well-planned education of international students by universities and colleges in China can become an important thrust for the country's international cooperation in economy, science, and technology, filling the gap of scientific and technological talents in the construction of the "Belt and Road"<sup>30</sup>, and continue to expand the talent pool for China's modernization construction and international industrial cooperation<sup>31</sup>. As more and more talented international students in China join Chinese enterprises after graduation<sup>32</sup>, bring their advanced technology, high-tech semi-finished products and parts to China for processing and export trade in the process of independent entrepreneurship<sup>5</sup>, or actively conduct business cooperation with China after returning to their countries<sup>33</sup>, all of these will provide substantial support and assistance for Chinese enterprises to carry out trade, investment, and industrial layout

overseas. Third, the talents of international students in China are highly integrated into the local context, utilizing differentiated advantages such as research teams, methods, ideas, and resources to achieve localization while driving the internationalization of local talents<sup>34</sup>. This will enhance the overall talent cultivation quality and research quality of universities, create greater possibilities for the output and promotion of cutting-edge achievements, and contribute to the long-term development and competitiveness enhancement of Chinese universities.

However, the scale expansion of talent engagement of international students in China has not always played a positive role in regional economic development. To begin with, the total investment in higher education at the national and local levels remains stable in the short term, and the excessive expansion of international students will inevitably squeeze out funding for the cultivation of local students and the development of basic science research and other disciplines<sup>35</sup>. This will affect the contribution of research findings commercialization and technology transfer to the competitiveness of the real economy and will be unfriendly to the long-term development of the national and local economy. Secondly, immoderately expanding the talent engagement scale of international students will also affect their expectations for education quality and academic achievements<sup>36</sup>, resulting in a disconnect between enrollment scale, enrollment quality, and education quality. This will damage the brand reputation of "study in China" and the willingness of international talents to study and engage in research in China, resulting in a marginal decrease in the positive effects until they turn negative. Thirdly, at the current stage, the national strategic positioning, long-term planning, relevant policies, and supporting facilities cannot match the rapid growth in the talent scale of international students in China, resulting in a negative transmission cycle between international student education and the recognition of its interests, resulting in the education investment's failure to be converted into economic benefits<sup>37</sup>.

Based on the above reasons, it is inferred that there is an inverted U-shaped relation between the international talent engagement scale of international students and regional economic development in China. That is to say, within a moderate range, increasing the attraction of the talents of international students can achieve the goal of improving regional economic development. However, once its scale exceeds the critical value, it cannot continue to play a positive role and may even produce negative results.

### 3 RESEARCH DESIGN

#### 3.1 Data Source

The data used in this research was sourced from the official data published by the International Cooperation and Exchange Department of the Ministry of Education's Statistical Yearbook of International Students (2010-2018) and the website of the National Bureau of Statistics of China (<http://www.stats.gov.cn/>) and organized using provincial units (including provinces, autonomous region for ethnic minorities, or municipalities) as sample units. This research selected the number of international students sponsored by the Chinese Government Scholarship as the talent engagement scale of international students. The main reason is that the purpose of the Chinese Government Scholarship

is to attract high-quality international students to study or engage in research in China, thereby supporting scientific research and technological development<sup>38</sup>. From the current development trend of international student education in China, Chinese government Scholarship can effectively eliminate the geographical distance restrictions for outstanding international talents to study in China<sup>39</sup>, and play a particularly prominent role in the selection of high-level skilled talents such as students pursuing doctoral and master's degrees<sup>40</sup>, making the overall international students who receive this funding present characteristics of high quality, and high-level<sup>41</sup>. The scale of international students funded by the Chinese Government Scholarship comes from data in the Statistical Yearbook of International Students (2010-2018). The regional economic development data is directly selected from the real GDP per capita published on the website of the National Bureau of Statistics, and the relation between the two variables was analyzed statistically. Because the Minister of Education of China first announced the list of "Double First-class" universities in 2017 and its Statistical Yearbook of International Students stopped publishing since 2018 and the data on Chinese Government Scholarships for international students have never been adequately released through other sources, the data was processed before analysis as follows: (1) Calculate the proportion of "Double First-class" universities (including 42 World First-class universities and 95 World First-class Discipline universities announced by the Ministry of Education in 2017) to the total number of higher education institutions in a province from the year of 2017 to 2018; (2) Calculate the proportion of "985" and "211" project universities to the total number of higher education institutions in a province from 2010 to 2018; (3) Calculate the average of the above two proportions and group each province into high and low proportions based on the average. Finally, based on the "Double First-class" universities from 2017 to 2018, a total of 62 sets of observation values were obtained from 31 provincial units; Based on the "985" and "211" project universities from 2010 to 2018, a total of 279 sets of observations were obtained from 31 provinces. The calculation was conducted using STATA statistical software.

### 3.2 Research Model Design

The research used the following model to examine the relation between the talent engagement scale of international students in China and the level of regional economic development:

$$\text{real GDP per capita} = \alpha + \beta * \text{scale of CGS} + \gamma * \text{scale of CGS}^2 + \sum \text{year} + \sum \text{province} \quad (1)$$

Among them, real GDP per capital indicates the level of regional economic development, scale of CGS expresses the talent engagement scale of international students in China (Chinese Government Scholarships beneficiaries is hereby referred as CGS), scale of  $\text{CSC}^2$  represents the square value of talent engagement scale of international students in China, and year and province are control variables. This research used the OLS model to regress the collected relevant data, and the specific definitions of variables are shown in the table 1 below.

**Table 1.** Variable Definition

<b>Symbol</b>	<b>Expression</b>	<b>Definition</b>
real GDP per capita	regional economic development	GDP per capita used to measure regional macroeconomic performance
scale of CGS	talent engagement scale of international students	number of CGS beneficiaries
scale of CGS <sup>2</sup>	square value of talent engagement scale of international students	square value of number of CGS beneficiaries
year	year	control variable
province	province	control variable

## 4 EMPIRICAL TEST

### 4.1 Descriptive Statistics

As shown in Table 2, this research referred to the "Double First-class" universities from 2017 to 2018 and the "985" and "211" project universities from 2010 to 2018 as benchmarks, and used provincial units as sample units to conduct a preliminary descriptive statistical analysis on the talent engagement scale of international students in China and the level of regional economic development. Among the whole sample based on "Double First-class" universities, the maximum and minimum values of the talent engagement scale of international students in China are 14279 and 0, respectively, with an average of 1961.5000; Among the sample based on "985" and "211" project universities, the maximum and minimum values of talent engagement scale of international students in China are 14279 and 0, respectively, with an average of 1284.0215. The above results indicate that there is a significant provincial gap in the talent engagement scale of international students between the two different benchmark provincial samples. Among the sample based on "Double First-class" universities, the maximum and minimum values of regional economic development level are 99945.22 and 1310.92, respectively, with an average of 28407.3794; In the overall sample based on "985" and "211" project universities, the maximum and minimum values of regional economic development level are 99945.22 and 507.46, respectively, with an average of 1284.0215. The above results indicate that there is a significant provincial gap in the level of regional economic development between the two different benchmark provincial samples, and there is a significant difference in real GDP per capita among different provinces. In addition, the average proportions of "Double First-class" universities and "985" and "211" project universities in each province are 0.3011 and 0.2581, respectively, indicating that there are more provinces with lower proportions of "Double First-class" universities and "985" and "211" project universities in the sample.

**Table 2.** Descriptive Statistics

Benchmark	Variable	Observed Value	Maximum	Minimum	Average	Standard Deviation
<b>"Double First-class" universities</b>	Regional economic development	62	1310.92	99945.22	28407.3794	23017.0184
	talent engagement scale of international students	62	0	14279	1961.5000	2673.2014
<b>"985" and "211" project universities</b>	Regional economic development	279	507.46	99945.22	21927.6883	18178.1729
	talent engagement scale of international students	279	0	14279	1284.0215	1858.1911

#### 4.2 Regression Analysis

Table 3 reports the OLS regression results of the effect of the talent engagement scale of international students on the regional economic development level, using the "Double First-class" universities from 2017 to 2018 and the "985" and "211" project universities from 2010 to 2018 as benchmarks, using provincial units as sample units. In the provincial sample based on "Double First-class" universities, the regression coefficient of the talent engagement scale of international students is 7.5860 and significant at  $p=1\%$ , while the regression coefficient of the square value of the talent engagement scale of international students is  $-0.0007$  and significant at  $p=1\%$ . In the provincial sample based on "985" and "211" project universities, the regression coefficient of the talent engagement scale of international students is 10.3665 and significant at  $p=0.1\%$ , while the regression coefficient of the square value of the talent engagement scale of international students is  $-0.0006$  and significant at  $p=0.1\%$ . Therefore, this research measured the level of regional economic development based on real GDP per capita, and obtained a significant positive regression coefficient for the talent engagement scale of international students, while a significant negative regression coefficient for the square value of talent engagement scale of international students. This indicates an inverted U-shaped relation between the talent engagement scale of international students and regional economic development, and the hypothesis is proven.

**Table 3.** Regression Analysis

Benchmark	Regional Economic Development Level	
	"Double First-class" Universities	"985" and "211" Project Universities



Indicator	coeffi- cient	t- value	95% confidence interval		coefficient	t- value	95% confidence inter- val	
talent engage- ment scale of in- ternational stu- dents	10.3665***	3.74	4.8112	15.9217	7.5860***	6.27	5.2027	9.9692
square value of talent engage- ment scale of in- ternational stu- dents	-0.0007**	-3.26	-0.0012	-0.0003	-0.0006***	-5.09	-0.0008	-0.0004
year	1876.5760	0.35	- 8876.3600	12629.5100	1304.5090**	3.31	529.4713	2079.5470
province	-400.4871	-1.33	- 1004.5490	203.5744	-170.6851	-1.53	- 389.8831	48.5130
constant	-3763568	-0.35	-2.55e+07	1.79e+07	-2609330**	-3.29	-4169711	-1048948
observation			62				279	
$\Delta R^2$			0.1570				0.1810	

From the year of 2010 till 2018, the quota allocation of Chinese Government Scholarship for international students were mainly distributed by the central government based on the education resources of different provincial units and other factors, for example, diplomatic concerns, sponsored by Chinese Government Scholarship, international students' destinations for studying in China were not mainly affected by their preference. Therefore, the endogenous problem between the talent engagement scale of international students and regional economic development can be excluded as the international students with Chinese Government Scholarships could not choose a region to study in due to its economic advantage.

### 4.3 Robustness Test

Based on the proportion of the number of "Double First-class" universities in the province to the total number of higher education institutions and arranged according to the size of the proportion, the provincial sample data collected based on "Double First-class" universities were divided into two groups for testing. If the proportion exceeds the average of the sample population, it is considered that the proportion of "Double First-class" universities is relatively high; On the contrary, the proportion of "Double First-class" universities is relatively low. Table 4 shows the regression results of the two groups with a lower and higher proportion of "Double First-class" universities as the grouping criteria. In the case of a low proportion of "Double First-class" universities, the regression coefficient of the effect of the talent engagement scale of international students on the regional economic development level is 15.8977, which is significant at  $p=5\%$ . Although the regression coefficient of the square value of the talent engagement scale of international students on the regional economic development level is negative, it is not significant; Under the condition of a high proportion of "Double First-class" universities, the regression coefficient of the effect of talent engagement

scale of international students on the regional economic development level is 11.3852 and significant at  $p=5\%$ , while the regression coefficient of the square value of talent engagement scale of international students on the regional economic development level is  $-0.0008$  and significant at  $p=5\%$ . The above results show that the inverted U-shaped relation between the talent engagement scale of international students and the level of regional economic development is established in the provincial samples with a higher proportion of "Double First-class" universities, but not in the provincial samples with a low proportion of "Double First-class" universities, and the difference between the two is significant. This indicates that the proportion of "Double First-class" universities can well explain the inverted U-shaped relation between the talent engagement scale of international students and the level of regional economic development.

**Table 4.** Regression Analysis

Benchmark	Regional economic development level							
	Lower proportion of "Double First-class" universities				Higher proportion of "Double First-class" universities			
	coeff- cient	T- value	95% confidence interval		coeff- cient	T- value	95% confidence interval	
<b>Talent Engagement</b>								
<b>Scale of International Students Square</b>	15.8977*	2.33	2.1228	29.6726	11.3852*	2.42	1.0202	21.7501
<b>Value of Talent Engagement Scale of International Students</b>								
	-0.0022	-1.80	-0.0047	0.0003	-0.0008*	-2.66	-0.0015	-0.0001
<b>Year</b>	1547.7310	0.25	-	14116.7500	2870.1250	0.27	-	26576.8500
<b>Province</b>	-221.5980	-0.48	-1157.6090	714.4125	-	-1.53	-	1806.3640
<b>constant</b>	-3105353	-0.25	-2.85e+07	2.23e+07	-5757258	-0.26	-5.36e+07	4.21e+07
<b>observation</b>			46				16	
<b><math>\Delta R^2</math></b>			0.0588				0.3694	

Provincial sample data based on "985" and "211" project universities were selected and the proportion of "985" and "211" universities to the total number of higher education institutions in the provincial unit was used as the benchmark. According to the overall average, the samples were divided into two groups, including "985" and "211" project universities with a higher proportion and a lower proportion. Then, regression analysis was performed separately, and the test results are shown in Table 5. In the lower proportion group of "985" and "211" project universities, the regression coefficient of the effect of the talent engagement scale of international students on the regional economic development level is 25.6392 and significant at  $p=0.1\%$ , while the

regression coefficient of the square value of talent engagement scale of international students on the regional economic development level is -0.0068 and significant at  $p=0.1\%$ ; In the higher proportion group of "985" and "211" project universities, the regression coefficient of the effect of the talent engagement scale of international students on the regional economic development level is 5.7779 and significant at  $p=1\%$ , while the regression coefficient of the square value of talent engagement scale of international students on the regional economic development level is -0.0005 and significant at  $p=1\%$ . Therefore, it can be seen that the inverted U-shaped" relation between the talent engagement scale of international students and the level of regional economic development has reached a significant level in the regression equations of high and low conditions, with no significant difference in coefficients. The above results indicate that the proportion of "985" and "211" project universities fail to explain the inverted U-shaped relation between the talent engagement scale of international students and the level of regional economic development.

**Table 5.** Regression Analysis

Benchmark	Regional Economic Development Level							
	Lower Proportion of "985" and "211" Project Universities				Higher Proportion of "985" and "211" Project Universities			
	coeffi- cient	T- value	95% confidence interval		coefficient	T- value	95% confidence interval	
Talent Engage- ment Scale of International Students	25.6392***	5.92	17.1033	34.1751	5.7779**	3.17	2.1529	9.4029
Square Value of Talent En- gagement Scale of International Students	-0.0068***	-4.44	-0.0098	-0.0038	-0.0005**	-3.49	-0.0007	-0.0002
Year	809.8602	1.72	- 121.5017	1741.2220	1720.2500*	2.35	263.7175	3176.7820
Province	-16.5542	-0.10	- 344.2272	311.1187	- 1815.9950*	-2.52	- 3248.4110	-383.5783
constant	-1620915	-1.71	-3495765	253934	-3440076*	-2.34	-6368525	-511627
observation			195				84	
$\Delta R^2$			0.2108				0.3587	

## 5 CONCLUSION AND DISCUSSION

This research proved the inverted U-shaped relation between the international talent engagement scale of international students in China and the level of regional economic development. It was found that compared to the proportion of "985" and "211" project universities, the proportion of "Double First-lass" universities can better explain the

relation between the above two variables. The construction of "Double First-class" universities in a certain region also offers a better guide to the talent engagement of international students. However, the scale expansion of talent engagement of international students in China does not always have a positive impact on regional economic development. According to the above rules, the allocation of Chinese Government Scholarship funding should follow the principles of moderate scale and classified support. For provinces with a relatively high proportion of "Double First-class" universities, more attention should be paid to the inverted U-shaped relation between Chinese Government Scholarships funding scale and regional economic development, reasonable scale of Chinese Government Scholarships, and vigilance against negative effects caused by excessive investment to talent engagement of international students. Provinces with relatively low proportions of "Double First-class" universities need to follow more closely the requirements and connotations of the Chinese Government for "Double First-class" university construction to achieve the improvement of higher education quality, and highlight the contribution of universities to regional economic development in terms of international talent engagement.

## 5.1 Theoretical Significance

(1) The positive relation between the talent engagement scale of international students in China and the level of regional economic development has been proven in previous researches. For example, the direct consumption expenditures of international students have provided economic benefits and more employment opportunities for the countries of their study<sup>12, 17, 19</sup>, and have driven the inbound and outbound investment, and import and export trade development through the accumulation of human capital and the elimination of cultural barriers<sup>21, 22, 23, 24, 25</sup>. With the continuous improvement of international student quality and education level, it has been possible to achieve the contribution of scientific research and innovation capabilities to high-quality economic development<sup>26, 27, 28, 29, 39</sup>. However, the above conclusions have not fully considered the economic costs and potential social costs of talent engagement of international students in China due to positive biases. Through empirical analysis, this research found the "inverted U-shaped" relation between the talent engagement scale and international students in China and the level of regional economic development, indicating that the economic and social resources invested in the talent engagement scale of international students shall match the social-economic development level of the region. Excessive scale expansion of talent engagement of international students will lead to negative effects on regional economic development.

(2) Previous research had mostly focused on the quantitative perspective of international students to interpret their role in promoting economic development, calling for the expansion of enrollment for international students in China to achieve economies of scale<sup>16, 20, 28</sup>. However, some researchers suggested that attention should be paid to the quality of international students and vigilance should be maintained against excessive growth in the scale of international students<sup>13, 36, 37</sup>. But their conclusions are mostly based on the consideration of improving the internationalization quality of higher education, rather than exploring the promoting role of talent engagement in

economic development. From a talent engagement perspective, this research has focused on the quality of international student enrollment and empirically tested the impact of talent engagement of international students on regional economic development, and the results showed an inverted U-shaped relation. Therefore, the research suggests controlling the talent engagement scale of international students in China and improving the quality of international student enrollment, to exert their positive effects on regional economic development and avoid negative effects.

(3) One of the main social functions of universities is talent cultivation, which involves imparting knowledge and skills to students and offering high-quality human resources necessary for socioeconomic development<sup>42</sup>. At the same time, the functions of universities also include scientific research and serving society, transforming scientific research achievements into productivity and technological innovation, and achieving sustainable development and competitiveness of the regional economy<sup>43</sup>. Different from previous researches exploring the direct promoting effect of high-level and high-quality university construction on social development<sup>44,45</sup>, this research used the proportion of "Double First-class" universities as an indicator to measure the overall level of regional universities as a situational variable for the effects of talent engagement of international students on regional economic development and detected the moderating effect of the proportion of "Double First-class" universities through grouping study, indicating that this concept of education can be regarded as a boundary condition in economic research.

## 5.2 Practical Significance

(1) The positive effect of the Chinese Government Scholarship on the talent engagement of international students in China has been very evident<sup>38, 39, 40</sup>, and the talent engagement of international students contributes to the development of the regional economy to a certain extent<sup>26</sup>. However, this research found the existence of an inverted U-shaped relation between talent engagement scale of international students and the level of regional economic development, that is, the talent engagement scale of international students beyond the critical point seems unlikely to achieve the expected effect. The main reason is the mismatch between socioeconomic resource investment and the level of regional socioeconomic development. Therefore, it is suggested by this research that as an important means of engaging international talents to study in China, Chinese Government Scholarship should steadily increase its funding to bolster its supportive effects to regional economic development. Meanwhile, although it has become a national strategy of China to achieve a moderate increase of talent engagement through international student education, it is still necessary to be vigilant about the negative effects of the excessive scale expansion of talent engagement of international students on economic development. Therefore, the funding scale of Chinese Government Scholarship should be reasonably determined based on comprehensive and precise consideration of its contribution to the economy and the level of regional economic development.

(2) Some previous researches have concluded to increase investment and leverage economies of scale based on the beneficial effects of international student scale on

economic development. However, this research focuses more on the quality of international students rather than the quantity from the perspective of talent engagement. It is recommended to follow the quality orientation of the Chinese Government Scholarship. On the one hand, the entry requirements for the selection and enrollment of international students sponsored by Chinese Government Scholarship shall be raised, to build reputation of the international student education in China through healthy competition among international talents and aggregation of high-quality international students, and strengthen the attractiveness of Chinese Government Scholarship to top international students worldwide. On the other hand, the Chinese Government Scholarship should increase awards to outstanding talents of international students to stimulate their enthusiasm and initiative in study and research, guiding them to integrate into Chinese culture and social environment to enhance their job competence and transform them into high-quality human resource supply through international student education, reflecting the values of economic investment to talent engagement of international students.

(3) Under the "985" and "211" project systems, the contribution of universities to regional economic development has formed a relatively stable pattern and rule<sup>46, 47</sup>. However, with the focus shift of China's higher education development and the changing requirements for universities, the "985" and "211" project system has gradually been replaced by the "Double First-class" university system. This research proved the inverted U-shaped relation between the talent engagement scale of international students and the level of regional economic development in the regions with a higher proportion of "Double First-class" university, but the relation is not significant in the regions with a lower proportion. Therefore, under "985" and "211" project system, the regions with more developed university education tend to better grasp the rules in adapting university education to socioeconomic development, making it easier to decide the critical point where the effects of the talent engagement scale of international students shifts from positive to negative for regional economic development. In the process of talent engagement of international students, a more precise prediction of scale can be developed. On the contrary, in the regions with underdeveloped university education by the standards of "Double First-class" university system, it is difficult to grasp the above rules in order to exploit the contribution of talent engagement of international students to regional economic development. Therefore, these regions with a relatively low proportion of "Double First-class" university should analyze and implement the government's requirements for the "Double First-class" universities, and take the construction of "Double First-class" universities as a guarantee for the high-quality development of international student education.

### 5.3 Research limitations

This research took provincial units as samples units, aiming to prove the inverted U-shaped relation mentioned above. However, it is hardly possible to determine the optimal scale of talent engagement of international students in China, which can be explained by significant differences in economic development levels among different regions, and the intensity and pattern of correlation between talent engagement of international students and regional economic development are different. Based on current

sample units, it is still challenging to figure out an absolute value for optimal scale. This problem can be further explored by using the whole nation or a certain provincial unit as a sample unit. In addition, this research only considers the effects of the talent engagement scale of international students on the real GDP per capital. However, when attempting to set factors such as regional employment population and financial investment as control variables, the regression results showed that the inverted U-shaped relation was not significant, which also reflected that the economic effects of the talent engagement scale of international students is significantly insufficient compared to other macroeconomic data. Therefore, to explore how to further enhance its contribution to the macro economy is also one of the important goals of future researches.

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