Original Paper

The Impact of Population Aging on FDI Inflow in China—An Empirical Analysis Based on Provincial Panel Data

Xu Xinpeng[1], Huang Yunning[1], Gao Fuxia[1] & Ji Yanting[1]

[1] Research Center for International Business and Economy, Sichuan International Studies University, Chongqing 400031, China

Abstract

With the increasingly serious situation of population aging in China, the impact of population aging cannot be ignored. This study analyzes the effect of population aging on the attraction of FDI inflows in China through the construction of an empirical model. The results show that there is a significant "inverted-U" relationship between population aging and FDI inflows, and aging negatively affects foreign investment inflows after crossing the aging inflection point. Based on the findings, this study proposes policy recommendations based on the quantity and quality of the labor force, such as improving the policy of gradual delayed retirement, improving the level of human capital, and promoting the regional mobility of the labor force, to provide feasible research ideas to enhance the attractiveness of FDI in regions with different levels of aging.

Keywords

Population Aging, Foreign Direct Investment, Labor Supply

1. Problem Formulation

Since the gradual expansion of China's opening up, both the scale and quality of foreign investment have been greatly enhanced. In 2020, China's FDI flow reaches $163 billion, exceeding 2019 by more than $20 billion, reaching a historical peak in the 21st century, and China has surpassed the United States to be among the most attractive regions for foreign investment in the world. The impact of the rapidly developing population aging on China's socio-economy has received close attention from scholars, resulting in a wealth of theoretical achievements. Academic research on the impact of population aging on FDI regional inflows has focused on two perspectives: how investment costs and labor supply levels affect foreign investment inflows to different regions. Therefore, this paper sorts out the research on these two aspects separately.

(1) The aging of population makes the investment cost of enterprises rise, thus affecting the regional inflow of FDI.

The first view is that rising labor costs are not conducive to FDI inflows. For enterprises whose own human capital level is relatively dominant, the impact of rising labor cost is very weak. For those enterprises whose principal orientation is export, the rise of labor price in investment cost makes them have a new criterion for regional selection (Ma Shuang et al., 2020; Feng Wei et al., 2011). The second view is that the rise in labor prices attracts the influx of FDI in the region, and the level of labor prices is seen as an indicator of the level of human capital in the area, i.e., higher wages indicate higher quality of labor in the region (Ostu & Shibayama, 2022; Mody & Srinivasan, 1998). This would send a signal to investors that there is a large pool of quality labor in the region. The third view is that the impact of rising labor costs on FDI is non-linear. Feng et al. (2011) find that the inflection point of labor costs on FDI inflows is characterized by an inflection point, i.e., there is a long-term process of attraction to the deterrence of regional FDI inflows by the increase of labor prices, and the deterrence is more significant when a certain inflection point is crossed.

(2) The increase in population aging causes changes in the regional labor supply level, which has an impact on FDI regional inflows.

The smaller the degree of labor variation between regions, the higher the attractiveness of foreign investment. Therefore, the quantity and quality of labor supply can be used to enhance the degree of attractiveness to regional foreign investment (Chen et al., 2011; Zhou Junxu et al., 2012). In their study, Zhu Hongping and Zhu Wentao (2020) pointed out that the level of human capital is conducive to foreign investment inflows. Tie Ying et al. (2019) show through their study that the role of demographic change will gradually diminish as human capital improves. At the same time, this change process shows a clear role characteristic. Under the background of population aging, the development of China's foreign trade must shift from the "demographic dividend" to the "talent dividend".

The contribution of this paper is: based on the reality that population aging presents unevenness among regions, combined with the variability of FDI attraction strength among provinces, and based on the overall analysis, regression tests are conducted by sub-region according to the regional division of east, central and west. At the same time, this paper explores the emergence point of the inflection point of population aging in each region from the characteristics of population aging and foreign investment inflow. At the same time, it also gives some theoretical references for future policy-making.

2. Analysis of Theoretical Mechanisms

When a country's enterprises want to make cross-border investments in a country, the influencing factors taken into account are often multifaceted, and the choice of factors depends mainly on the enterprise's investment motives. There are three main forms of cross-border investment by enterprises. The first is market-oriented, where the size of the market is a consideration for foreign investment. Its important objectives lie in long-term profitability and centrality of fixity, as well as the need to take into account customers, competitive targets, and the synergy of cooperation between various functions. The second type is labor cost-oriented, which means that enterprises in a country want to obtain cheap labor from other countries by means of foreign investment, so as to reduce production and operation costs and obtain greater investment returns. Therefore, having cheap and abundant labor force is one of the main reasons why some regions in China attract large inflows of foreign investment. The third type is resource-oriented, which often focuses on the unique endowments of the host country, such as raw materials, land, consumer market, infrastructure conditions, etc. When the host country has specific resource conditions, multinational enterprises will greatly reduce the investment cost, thus making the profit space to improve.

Based on the previous combing and review of the theoretical foundation and literature review, combined with the analysis of the current situation of population aging and foreign direct investment, this study proposes the following two hypotheses:

H1: Population aging has a non-linear effect on regional FDI inflows.

First, the continued growth of the elderly population makes the size of the labor force challenging and discourages the inflow of labor cost-oriented FDI. As the pressure of labor force dependency increases, there is a tendency to meet the current production and living needs through lower savings. When capital accumulation is insufficient, there will be no incentive for outward investment and production, and the low marginal output of capital will be difficult to attract investors. For market-oriented and resource-oriented FDI, they prefer to shift their horizons to other alternative production areas, to obtain a higher return on capital and investment stability.

Second, population aging brings an increase in life expectancy per capita, and according to the life of savings hypothesis, an increase in the elderly population leads to a decrease in social savings and an increase in consumption. This will lead to more capital flow to the market, and thus the market size of the tertiary sector is expanded, which may attract market-oriented FDI inflows. However, on the one hand, the expansion of the market scale needs time to be verified, and on the other hand, the delayed retirement policy is only implemented in individual provinces. In addition, the effect of the "two-child" and "three-child" policies needs to be tested for a long time. Therefore, the positive effect of increasing life expectancy is difficult to be reflected in the short term, and the positive effect mechanism on FDI inflow to different regions is weak, so there may be a non-linear effect of population aging on FDI inflow to different regions in China.

H2: There is significant variability in the impact of population aging on FDI inflows in the eastern, western, and central regions.

The aging of the population shows a more obvious spatial aggregation characteristic, and in general the aging of the population tends to decrease in three directions from east to west. The declining share of the young labor force means that the previous regional advantage of high quality and low cost labor-intensive will be challenged. For foreign investment, there is a natural tendency to choose regions with more abundant labor endowment, cheaper labor costs, and a higher level of labor quality to

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develop new business and trade. For the central and western regions, on the one hand, the poor geographical location, significant-quality talent outflow characteristics, and small market size do not have an advantage in total FDI; on the other hand, the population in the western region is aging significantly faster than that in the eastern region, and the serious aging population burden and the reduction of labor supply also have a certain degree of negative impact on the inflow of FDI. Therefore, the effect of population aging on the attractiveness of foreign investment in different regions is worth further investigation.

3. Research Design

(1) Selection of indicators

The explanatory variable is foreign direct investment, and the actual FDI used is multiplied by the average exchange rate and converted into RMB. On the other hand, it is necessary to overcome the price instability effect, calculate the GDP deflator by year, use the amount of FDI divided by the deflator to make the data results more accurate, and finally use the proportion of the actual amount of utilized FDI in the GDP of each province and city to express. The explanatory variable is population aging, and this paper selects the first old-age dependency ratio as the explanatory variable of the study, and the second aging measure is selected to further verify the robustness of the results using the method of substitution variables, to enhance the feasibility of the model. The control variables are selected based on the theory of cross-country investment motives, and the first one is the level of regional investment, measured by the amount of fixed asset investment per capita in each province. The second is the level of openness to the outside world, measured by the total imports and exports of each province divided by the GDP of each province. The third is the level of infrastructure, using the per capita urban road area as a specific measure. The fourth is the level of industrial structure, measured using the output value of the secondary industry divided by the GDP of each province. The fifth is the level of market size, measured using each province's GDP as a share of the national GDP.

(2) Data analysis

Given that China entered the aging society in 2000, this paper uses data for the 20-year period from 2000 to 2019 for the analysis, covering a total of 600 observations in 30 provinces, municipalities and autonomous regions of China (excluding Hong Kong, Macao, Taiwan, and regions, and also excluding Tibet because more data are missing). Table 1 shows the results of descriptive statistics of each main variable.

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Table 1. Descriptive Statistics of Main Variables

Variable	Obs	Mean	Std.Dev.	Min	Max
FDI	600	0.0205	0.0209	0.000068	0.146
Older	600	0.128	0.0305	0.0665	0.238
Age	600	0.0932	0.0222	0.0425	0.164
Open	600	0.295	0.340	0.0114	1.669
Lninv	600	8.516	1.304	5.018	10.99
Lninfra	600	12.80	4.733	3.851	26.20
Structure	600	0.451	0.0828	0.162	0.664
Mark	600	0.0346	0.0266	0.00266	0.121

To verify the degree of association between the variables, this study conducts correlation analysis on the explanatory variable FDI inflow, the explanatory variable population aging, and several key control variables, as shown in Table 2.

Table 2. Correlation Coefficient Matrix of Major Variables

Variable	FDI	Older	Open	Lninv	Lninfra	Structure	Mark
FDI	1						
Older	0.095*	1					
Open	0.582**	0.139**	1				
Lninv	-0.168**	0.573**	0.115**	1			
Lninfra	-0.111**	0.288**	-0.088*	0.558**	1		
Structure	-0.239**	-0.125**	0.011	0.179**	-.184**	1	
Mark	0.256**	0.255**	0.563**	0.482**	0.229**	0.292**	1

According to Table 2, it can be seen that none of the correlation coefficients between the variables involved in the study reached 0.75, which represents that these variables are not particularly strongly correlated to a degree that also implies that their potential for multicollinearity is not high. To further verify the validity of the results, the test for multicollinearity between the variables was continued. The variance inflation factors were all found to be less than 10.0 during the test, which indicates that there is no strong multicollinearity between the variables and can be analyzed in the next step of the study.

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(3) Model construction

$$FDI_{it} = \alpha_0 + \alpha_1 Older_{it} + \alpha_2 Older^2{}_{it} + \alpha_3 X_{it} + \gamma_i + \delta_t + \varepsilon_{it}$$

In the above formula, α_i denotes the parameter to be estimated, and $Older^2{}_{it}$ it is the quadratic term of old-age dependency ratio, which measures the nonlinear effect of population aging on FDI inflows. If the coefficient α_2 is significantly negative, it indicates that there is an "inverted U" type relationship between population aging and FDI inflows, and if the coefficient is significantly positive, the relationship between the two shows a significant "U" type relationship.

For better regression analysis of the data, this study determined the fixed-effects model and random-effects model in the form of model for analysis and comparison. After passing the Hausman test, the corresponding result showed that the p-value was 0.0000, which was less than the value of 0.05, so the original hypothesis was rejected. Therefore, it was determined that this study used a fixed-effects model as the model form on which to control for province and time to further improve the credibility of the data.

4. Empirical Analysis

(1) National regional empirical results and analysis

When only the explanatory variables are included in the primary regression equation at one time, the p-value is 0.0007 by RESET method test, which is less than the statistical value of 0.05, and the original hypothesis is rejected, which means that there is a setting error in the primary regression equation. Combined with the actual situation of China's complex and vast geography, uneven distribution of FDI inflows, and significant differences in regional population aging, the model was re-estimated by introducing the quadratic term of the explanatory variable population aging into the regression equation, and the RESET test results showed that the P-value was 0.5465, which was greater than 0.05, i.e., the original hypothesis of the existence of error-free model setting was accepted, and the model was further revised.

A double fixed-effects model was used for estimation, and the data were analyzed by combining different variables, and the results are shown in Table 3. The data results show that the coefficient of the primary term (Older) and the coefficient of the second term (Older^2) of the explanatory variables are always significantly positive and negative, which means that there is an obvious "inverted U" correlation between population aging and regional foreign investment inflows. In other words, during the process of population aging with an upward trend, the FDI inflow shows a change characteristic of increasing and then decreasing.

According to the calculation in column (3), the inflection point of population aging is 0.1939, which indicates that when the old-age dependency ratio is less than 19.39, population aging will promote the inflow of foreign investment; after it is greater than 19.39, population aging will have a limiting effect on the inflow of foreign investment in the region. From the descriptive statistics in Table 2, the mean value of population aging is 0.128, which has not yet reached the inflection point, but the maximum value is 0.238, which has long crossed the inflection point. In terms of the degree of population aging in recent years, eight provinces in the country have exceeded the inflection point, which implies that there is variability in the impact of population aging on regional FDI inflows. The degree of population aging in some regions is at the stage of promoting FDI inflows, while some regions are in the process of inhibiting the stage of FDI inflows.

Table 3. Impact of Population Aging on China's FDI Inflows

	（1）	（2）	（3）
	FDI	FDI	FDI
Older	1.030***	1.036***	0.977***
	(4.85)	(4.81)	(4.97)
$Older^2$	-2.648***	-2.661***	-2.519***
	(-4.02)	(-3.97)	(-3.94)
Open	0.022*	0.022*	0.021*
	(1.84)	(1.79)	(1.70)
Lninv	0.011**	0.011**	0.014**
	(2.14)	(2.08)	(2.25)
Lninfra	0.001	0.001	0.002
	(0.23)	(0.19)	(0.44)
Structure		0.003	0.012
		(0.12)	(0.44)
Mark			-0.526
			(-1.38)
_cons	-0.127***	-0.127***	-0.133***
	(-3.62)	(-3.61)	(-3.38)
Time FE	YES	YES	YES
City FE	YES	YES	YES
N	600	600	600
r2_a	0.456	0.455	0.464

Note. (i) Parentheses are the t-statistics corresponding to the estimates; (ii) ***, **, * indicate significant at the 1%, 5%, and 10% levels; (iii) YES in the table indicates that both provinces, cities and years were fixed.

(2) Empirical results and analysis by region

Due to the variability of different regions in terms of economic development level, infrastructure construction and market size, this study combined the information published in China's statistical bulletin and health statistics to divide China's regions into three main parts: the east, the center and the west. According to the above regional division, the data of each province were analyzed, and the regression results are shown in Table 4. It shows that the regression results of population aging on FDI inflows in different regions are more significant, and the p-values pass the test. The regression results for the eastern, central, and western regions all show an "inverted U" type non-linear relationship between population aging and FDI inflows, which is consistent with the nationwide situation. However, there is some variation in the significance of the explanatory variables across regions.

For both the primary and secondary terms of population aging, the eastern region passes the test at the 5% level, and the western region passes the test at the 5% and 10% levels, respectively. However, the regression results for the central region are less significant, with only the primary term of the explanatory variable passing the test at the 10% level, and the sign of the coefficient of the secondary term does not show a significant correlation, although it is consistent with the national results. At the national level, the regression results of both the primary and secondary terms of population aging pass the significance test at the 1% level. The inflection point of population aging in the eastern region, which is the most mobile and concentrated region, is 0.212. This implies that when the old-age dependency ratio is less than 21.2%, the increase in population aging promotes the inflow of FDI to the region. However, when the old-age dependency ratio exceeds 21.2%, the continuous increase of population aging will have a negative effect on the inflow of regional FDI.

According to the China Statistics Bureau, Liaoning province in the eastern region will have an elderly dependency ratio of 24.4% in 2020, exceeding the national level by nearly 5 percentage points. The eastern region occupies 4 of the top 10 provinces in the national ranking of elderly population ratio, which means that more than one-third of the eastern provinces are past the inflection point of population aging. As the aging population further intensifies, it will significantly affect the overall attractiveness of foreign investment in the eastern region, thus reducing the regional inflow of FDI.

From the results of the regression analysis, no province in the central region has reached the inflection point of regional population aging for the time being, but three-quarters of the provinces have crossed the inflection point of national population aging. The central region with a large working population is the main source of labor force for developed coastal cities. Based on the mobility characteristics of the working population, the level of population aging in the central region will also have an impact on the overall FDI inflow.

The population aging inflection point in the western region occurs at 0.209. When the old-age dependency ratio is less than 20.9%, the population aging will have a positive impact on FDI inflows, while when the old-age dependency ratio exceeds 20.9%, the increase in the old-age dependency ratio will inhibit the regional FDI inflows. For the 2020 data, Chongqing and Sichuan provinces in the west cross the demographic inflection point by 4.6 and 4.4 percentage points, respectively. Based on the previous study, we know that although the process of population aging varies to a great extent among the western regions of China, the continued increase in the degree of population aging has had a significant dampening effect on FDI inflows to the most economically developed provinces in the western region.

Table 4. Analysis of Heterogeneity in Eastern, Central and Western China

	(4)	(5)	(6)	(7)
	National Region	Eastern Region	Central Region	Western Region
	FDI	FDI	FDI	FDI
Older	0.977***	0.959**	0.528*	0.316**
	(4.97)	(3.01)	(1.74)	(2.22)
$Older^2$	-2.519***	-2.257**	-0.956	-0.754*
	(-3.94)	(-2.25)	(-0.88)	(-1.73)
Open	0.021*	0.005	0.073***	0.031***
	(1.70)	(0.29)	(11.47)	(2.88)
Lninv	0.014**	0.016	-0.009***	0.002
	(2.25)	(1.61)	(-5.06)	(0.64)
Lninfra	0.002	-0.014*	0.004	0.009***
	(0.44)	(-1.86)	(0.61)	(2.70)
Structure	0.012	0.112	-0.015	-0.027*
	(0.44)	(1.66)	(-0.90)	(-1.65)
Mark	-0.526	-0.698	0.028	0.594*
	(-1.38)	(-1.71)	(0.31)	(1.90)
_cons	-0.133***	-0.123*	0.033	-0.039**
	(-3.38)	(-1.95)	(1.64)	(-1.99)
Time FE	YES	YES	YES	YES
City FE	YES	YES	YES	YES
N	600	600	600	600
r2_a	0.464	0.624	0.683	0.320

Note. (i) Parentheses are the t-statistics corresponding to the estimates; (ii) ***, **, * indicate significant at the 1%, 5%, and 10% levels; (iii) YES in the table indicates that both provinces, cities and years were fixed.

(3) Robustness test

To better explain the above results, the model was tested for robustness. First, we choose to replace the explanatory variables by replacing the old-age dependency ratio with the elderly population rate (Age) as the explanatory variable to re-compute the model, and the data are calculated by combining the Chinese Statistical Yearbook and the provincial yearbooks.

The test results show that the positive and negative signs and significance of the coefficients of each variable indicator did not change significantly after replacing the population aging measure. The coefficients of the primary terms of the explanatory variables pass the test at the 1% level and have a positive sign. The coefficients of the quadratic terms of the explanatory variables were negative under different combinations of control variables and passed the significance test at the 1% level. The coefficient magnitudes of some indicators changed, but the positive and negative coefficients remained consistent with the initial regression results. The model still shows a significant correlation after replacing the explanatory variables, and it can be seen that the original assumptions are sufficiently stable. The method is trustworthy and has sufficient credibility to further validate the "inverted U" correlation between population aging and regional foreign investment inflows.

Table 5. Impact of Population Aging on China's FDI Inflows

	（8）	（9）	（10）
	FDI	FDI	FDI
Age	1.802***	1.810***	1.699***
	(4.40)	(4.37)	(4.52)
Age^2	-6.663***	-6.686***	-6.278***
	(-3.88)	(-3.85)	(-3.91)
Open	0.022*	0.022*	0.022*
	(1.86)	(1.81)	(1.71)
Lninv	0.010*	0.010*	0.013**
	(1.99)	(1.92)	(2.07)
Lninfra	0.001	0.001	0.002
	(0.24)	(0.20)	(0.44)
Structure		0.003	0.011
		(0.12)	(0.42)
Mark			-0.471
			(-1.32)
_cons	-0.133***	-0.133***	-0.137***
	(-3.71)	(-3.70)	(-3.46)

Time FE	YES	YES	YES
City FE	YES	YES	YES
N	600	600	600
r2_a	0.465	0.464	0.471

Note. (i) Parentheses are the t-statistics corresponding to the estimates; (ii) ***, **, * indicate significant at the 1%, 5%, and 10% levels; (iii) YES in the table indicates that both provinces, cities and years were fixed.

5. Conclusions and Recommendations

In this study, the regression results of the dual fixed effects model show a nonlinear "inverted U" relationship between population aging and regional FDI inflows, both at the national level as a whole and at the sub-regional local level. After crossing the aging inflection point, there is a dampening effect on regional FDI inflows. From a regional perspective, the western region is the first region to face the inflection point of population aging nationwide. From the labor supply perspective, this study proposes the following countermeasures.

Firstly, based on the perspective of labor supply quantity: further improve the progressive and flexible delayed retirement system. There are three specific paths: First, for the design of the age of delayed retirement, a gradual and progressive approach can be adopted, with women first and then men. And then, the appropriate flexible division of people with different salary packages and job positions. Third, the retirement years are set flexibly. On the one hand, formulate policy arrangements in advance, increase publicity initiatives, gradually extend the retirement age and relax the number of years of policy implementation. On the other hand, according to the actual situation to set up incentives, for the initiative to apply for postponement of retirement employees to increase the pension, so as to drive the active participation of the whole society.

Secondly, based on the perspective of labor population quality: increase education expenditure and innovation investment to enhance the level of human capital and technological innovation. With the increasing aging of the population, the size of China's working population further shrinks, the reduction of the working population makes the wage level rise, and there is a certain degree of the sharp reduction in the profits of foreign companies investing in China, this reason forces foreign companies and joint ventures to turn their business eyes to other production regions, which has a dampening effect on the regional FDI inflow.

Thirdly, based on the perspective of labor mobility: solving labor mobility barriers, strengthening the construction of the labor market system, and improving relevant population policies. The direct impact of population aging in China under the current stage is the increase of the burden coefficient of the elderly population per unit of the labor force. To effectively alleviate the old-age burden of individuals and society, it is necessary to use less labor force to support more elderly population. Based on the results of the above data analysis, it is clear that the aging of China's population shows obvious regional differences, so it is a reasonable move to promote the inflow and reduce the outflow of the labor force in the western region. On the one hand, improving the attractiveness of talents in the western region requires policy support by introducing relevant policies, and on the other hand, it is necessary to further break down the barriers to the movement of the working population. At the same

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time, we should promote new urbanization and make full use of the surplus labor force in rural areas by strengthening technical training and improving household registration policies.

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