

Will Aging Stimulate Industrial Upgrading in the Yangtze River Delta region? — Analysis based on Panel Data of Jiangsu, Zhejiang and Shanghai from 2003-2022

Jiuzhou Lu

Nanjing Audit University, Nanjing 211815, China.

Abstract: The degree of aging in China has been increasing year by year. By the end of 2000, China had already met the criteria set by the United Nations for a country to enter an aging population society. The aggravation of population aging will bring about problems such as insufficient age labor force, increased pressure on social welfare expenditure, and excessive burden on young labor force for the normal operation and development of the economy and society. As a world-class supercity cluster, the Jiangsu Zhejiang Shanghai region is worth studying and analyzing its internal industrial upgrading in the context of aging population. In order to analyze the impact of deepening population aging on industrial upgrading in the Yangtze River Delta region, we selected Panel data of Jiangsu Province, Zhejiang Province and Shanghai from 2003 to 2022 to analyze the impact of deepening population aging on industrial upgrading in Jiangsu, Zhejiang and Shanghai from technology effect, labor force effect and tax burden effect. It is believed that the deepening of aging in the Jiangsu Zhejiang Shanghai region has a reverse and driving effect on the industrial upgrading of the region. In the face of an aging population, measures such as gradually and effectively promoting the improvement of the social welfare system, strengthening investment in high-tech research and development, reasonably controlling housing prices, and providing subsidies for talent housing purchases should be taken.

Keywords: Population Aging; Empirical Analysis; Industrial Upgrading; Fixed Effect Model

1. Introduction

The phenomenon of population aging is irreversible in the short term. For those low-end labor-intensive industries that developed based on population advantages in the early stages of reform and opening up and were widely distributed in coastal areas of China, achieving industrial upgrading is an inevitable choice. Otherwise, due to the scarcity of low-end labor and the increase in labor costs, these already low profit enterprises will not be able to survive. Therefore, the aging population should play a role in driving the upgrading of regional industrial structure to a certain extent. The Yangtze River Delta region is located in the lower reaches of the Yangtze River, and Shanghai is its economic center. It is the largest urban agglomeration in China and an important platform for international competition. As a world-class supercity cluster, the investigation of its industrial transformation and structural upgrading in the context of aging population has become a worthwhile issue to study. Therefore, this article takes Jiangsu, Zhejiang, and Shanghai in the Yangtze River Delta region as the research object to study the mechanism of aging and various other factors on regional industrial upgrading.

There is currently a considerable amount of research in the academic community on the impact of population aging on industrial upgrading, and most believe that population aging will drive the upgrading of regional industrial structures.

2. The Role Mechanism of Population Aging on Regional Industrial Upgrading

2.1 Productivity effect

One of the most direct impacts of aging population on economic growth is that it leads to a shortage of eligible labor force. There are many different factors that affect economic growth, but the most fundamental one is undoubtedly the labor factor, and all processes of economic growth are based on labor. When the demand for labor exceeds the supply, it will hinder economic and social growth. For labor-intensive enterprises, the lack of labor force will inevitably force them to upgrade their technology, otherwise the high labor costs will further compress their profit margins and even lead to bankruptcy. Therefore, from the perspective of the shortage of young labor force in the entire society caused by the aging population, in order to save costs, enterprises will also increase capital investment and upgrade technology. In coastal areas, there are a large number of labor-intensive enterprises widely distributed, with a large number and fierce competition. In the absence of suitable labor, they will inevitably choose to upgrade production technology and increase research and development investment, so as to survive and even maintain a fixed profit margin.

As the length of service of employees gradually increases, the elderly labor force can accumulate a lot of experience and have a considerable "learning by doing" effect. If a company promotes communication between elderly and young employees through a reasonable management mechanism, forming a complementary mechanism where young employees help them better and faster adapt to new technologies, and elderly employees impart practical experience to young employees, it will help improve the total factor productivity of the company and improved the technological level of the enterprise.

2.2 Technology effect

The emergence of population aging will also bring significant labor productivity effects. The main manifestation is the decline in labor force level and labor participation rate under aging, which hinders the improvement of total factor productivity. The capital formation effect of population aging cannot be ignored. When a country or region's aging intensifies and the elderly dependency ratio increases, the expenditure on social medical security, social pension, and related service facilities will continue to grow, and the continuous reduction of social savings will not only hinder investment and capital formation, but also hinder regional economic development. As age increases, the proficiency, physical strength, and intelligence of the labor force begin to decline after reaching a certain level, indicating a downward trend in labor productivity. From the perspective of the overall production process of the entire society, a certain combination of capital and labor can achieve a certain level of productivity. If labor productivity begins to decline, in order to maintain the same labor production efficiency, either a portion of profits can be taken out as prepaid costs for existing workers to relearn, or labor can be laid off and new labor can be hired. When there is a balance between the degree of aging and the birth rate of the population, this natural substitution of new and old labor forces can maintain the normal operation of enterprises and maintain productivity at a certain level. However, the rate of population aging is much faster than the number of newly born population, which inevitably leads to insufficient natural substitution of new and old labor force. As a result, low productivity labor force still remains in the workforce due to the inability to obtain suitable replacement in a short period of time. In today's highly market-oriented society, this will force enterprises to increase research and development investment, upgrade equipment, and increase the ratio of capital and technology in production factors, consciously reduce the proportion of labor force. In coastal areas, labor rights protection policies have been well implemented in recent years with the strong promotion of national and local governments. Therefore, companies that directly fire employees also need to pay a certain price. Therefore, companies will pay more attention to the improvement of production technology.

2.3 Demand side induced effects

In society, if a new group of people continue to have specific needs in certain aspects, relevant industries that match the demand side will inevitably emerge on the supply side of the society. This phenomenon is called demand side induced effect.

In an aging society, the continuously increasing aging population will significantly lead to the development of some aging related industries from the demand side. These industries include elderly care services, home furnishings suitable for aging, healthcare for the elderly, and entertainment for the elderly.

Firstly, the elderly care service industry. The continuous intensification of population aging will make China's elderly care service industry one of the largest industries caused by the continuously increasing demand for elderly care in the future. With the increase of the elderly population and the improvement of China's social security level, the demand for high-quality elderly care services in China will also increase. With the progress of society, the demand for quality of life for the elderly is also increasing, and the elderly care service industry will also provide higher quality services. In the future, China's elderly care service industry, especially the high-quality elderly care service industry, will become a continuously growing market. At the same time, the continuous progress of technology will also promote continuous innovation in the elderly care service industry. These future elderly care companies will also fully utilize these high-tech technologies to develop or commission the development of more aging, intelligent, and convenient elderly care service models. Meet the needs of the elderly population for high-quality elderly care services through these new technologies and methods. These emerging elderly care service industries will witness rapid development, including elderly communities, nursing homes, elderly tourism, cultural and entertainment, etc. Therefore, from the perspective of the huge demand for elderly care in China's future, the continuous increase of the aging population will definitely bring huge development opportunities to the elderly care service industry in China, bringing more welfare and convenience to the elderly population in our society, and becoming a new growth point in the development of the social industry.

Secondly, the aging home industry is suitable for families. From the perspective of family life, the aging population will bring about changes in the home furnishings of families. The continuous increase in population aging will lead to an increasing demand for daily home furnishings among the elderly population, which provides significant development opportunities for the related home furnishings industry. The elderly population may experience some unexpected situations at home, which means that if there are elderly people at home, some medical and health facilities can be equipped to ensure daily health if conditions permit. Therefore, the integration of the home furnishing market and the healthcare industry will usher in new development opportunities. These industries include home style simple medical devices. With the continuous development of intelligent technology, these aging homes can also use technological means to facilitate the lives of the elderly population, which brings development opportunities to the intelligent aging home industry, making intelligent homes the future development trend. For example, smart aging adapted homes can achieve remote control and linkage control of household equipment through control systems. These only controllable means include smart escalators, smart shower systems, smart home appliances, etc. These new technological means have improved the convenience and comfort of life for the elderly population. Intelligent homes can also improve the safety and security of homes through intelligent security systems. In the future, smart aging homes will become an important component of family life with an elderly population and become a new industrial growth point.

Thirdly, the healthcare industry for the elderly. With the intensification of the aging population trend, the healthcare industry closely related to the elderly population will also face huge development opportunities. The increase in the elderly population will lead to an increase in demand for healthcare, thereby promoting the development of the healthcare industry. With the continuous progress of technology and the continuous development of medicine, innovation in the healthcare industry will continue to emerge, providing more efficient, targeted, convenient, and comfortable healthcare services for the elderly. The healthcare industry will not only be limited to hospitals or healthcare companies, but the increasing elderly population will also create opportunities for the development of other industries in this industry. For example, the increase in the elderly population will lead to the emergence of new healthcare institutions, including nursing homes and nursing institutions. Therefore, with the increase of the elderly population, the healthcare industry will usher in a transformational development.

Fourthly, the elderly cultural and entertainment industry. With the gradual intensification of the aging population trend,

the entertainment needs of the elderly in their daily lives will gradually become diversified, which brings new development opportunities for various related cultural industries of the elderly. There are many cultural industries for the elderly, among which the cultural and entertainment industry is the most significant. The consumption demand of the elderly population will drive the development of industries such as tourism, culture, and entertainment, bringing new market opportunities to these industries. As the number of elderly people increases, their demand for cultural and entertainment activities also gradually increases. This provides a vast market space for the cultural and entertainment industry. For example, elderly people can enrich their lives by watching movies, listening to music, watching dramas, and other means, which provides new development opportunities for related industries. The demand for cultural and entertainment products among the elderly is more diverse. They pay more attention to cultural connotations and spiritual enjoyment, rather than just entertainment. This also provides new creativity and development direction for the cultural and entertainment industry. The elderly also have high requirements for quality and service, which has prompted the cultural and entertainment industry to improve its service level and product quality. Related industries can launch cultural products that the elderly enjoy, such as movies, music, and dramas, to meet their cultural needs. With the improvement of social security capabilities, the consumption capacity of elderly people for cultural and entertainment products will also increase, and the cultural and entertainment industry will have more significant economic benefits in the future. In summary, the aging population has brought new development opportunities to the cultural and entertainment industry.

2.4 Tax burden effect

The increase in the elderly population means that the government will bear a huge amount of social welfare expenses, including medical insurance expenses, pension insurance expenses, and other increased expenses to enhance elderly welfare. Where do these expenses come from? The tax burden can only be borne by young labor. If the pressure of aging society increases, the government will inevitably increase taxes in order to maintain this huge expenditure, which will have two impacts. Firstly, the elderly dependency ratio in China has increased at an almost annual rate of 0.5% from 12.36% in 2000 to 21.2% in 2019. Increasing government spending will reduce the income of young laborers, which means that for individual young laborers, this will further increase the burden on young laborers who already bear the enormous pressure of raising children and elderly people; Secondly, for enterprises, the government has increased their tax revenue, which means a decrease in profits without expanding production. In order to maintain profit margins, enterprises will inevitably choose to compress their production costs. Reducing costs undoubtedly involves two aspects: either laying off inefficient workers or upgrading production technology. There are many enterprises in coastal areas and they pay a lot of taxes. If the government increases taxes, the absolute amount of tax increase due to the large base will be large. Therefore, it is inevitable for enterprises to choose to transform and upgrade.

3. Empirical analysis

3.1 Model construction

Based on the assumption that population aging will drive and force industrial upgrading, the dependency ratio of the elderly population in the Yangtze River Delta region is taken as the main explanatory variable for population aging. The proportion of the Tertiary sector of the economy often reflects the level of productivity development in a region. Therefore, this paper takes the proportion of the Tertiary sector of the economy as an explanatory variable to reflect the regional industrial upgrading, and empirically analyzes the relationship between the regional industrial upgrading degree and the regional elderly population dependency ratio. At the same time, in order to ensure the rationality and comprehensiveness of the model, three sets of control variables were added, namely internal expenditure of enterprise R&D investment, foreign direct investment, and sales price of commercial housing.

The constructed model is:

$$inup_{it} = \alpha_0 + \alpha_1 old_{it} + \alpha_2 rd_{it} + \alpha_3 fdi_{it} + \alpha_4 houpri_{it} + e_i + u_{it}$$

Among them, t represents the year, and $inup$ represents the indicator of industrial upgrading; old represents the elderly

dependency ratio, expressed as a percentage; rd means the internal expenditure RD of R&D investment is taken as Natural logarithm; fdi means FDI of foreign direct investment, taking Natural logarithm; houpri refers to the Natural logarithm of the sales price house of commercial housing in the region.

3.2 Selection of variables and sources of data

The model selects the Panel data of Jiangsu Province, Zhejiang Province and Shanghai in the Yangtze River Delta from 2003 to 2022 as samples.

3.2.1 Dependent variable

The explanatory variable selected by this paper to reflect industrial upgrading is the proportion of regional Tertiary sector of the economy to GDP. Generally, we believe that the higher the proportion of the output value of the Tertiary sector of the economy in the GDP of a region, the higher the level of industrial upgrading of the region. The reason is that with the upgrading of the industrial structure, the labor force will gradually flow out of the first and second industries that need to occupy a large number of labor force, and then turn to the Tertiary sector of the economy. The decrease of the number of employees in the first and Secondary sector of the economy means that machines have replaced the labor force, and technology has been improved. Therefore, this paper selects the proportion of Tertiary sector of the economy to GDP over the years in Jiangsu Province as the explanatory variable reflecting the degree of industrial upgrading.

3.2.2 Explanatory variable

There are many indicators reflecting population aging, and the focus of different indicators reflecting population aging varies. The explanatory variable selected in this article to reflect population aging is the dependency ratio of the elderly population, which is the number of people aged 65 and above in a region divided by the number of people aged 15-65. The reason for selecting this indicator is that it not only reflects the aging rate of a region, but more importantly, it reflects the dependency burden of young people in a region.

3.2.3 Control variables

Corresponding to the explanatory variables, this article selects three control variables. The first is the internal expenditure of R&D research and development funds. The higher the R&D investment of a region's government and enterprises, the higher the level of transformation and upgrading of the region's industries. The data source for research and development investment is the China Science and Technology Yearbook; Secondly, there is foreign direct investment. Currently, there are two different views in the academic community on the impact of foreign investment on the local market. One view is that foreign direct investment will bring advanced technology to local enterprises, and at the same time, foreign efficient business models will promote the transformation of local enterprise business models. Therefore, if foreign direct investment comes, it will promote the upgrading of local industries. In addition, foreign investment will exacerbate the fierce competition in the local market, resulting in the "catfish effect", forcing local peers to upgrade their production technology and improve product competitiveness; Another approach is to believe that foreign direct investment will compress the market share of local enterprises, which is not conducive to the upgrading of local industries. Moreover, China has a rich labor force, and foreign investors do not transfer the true core technology to local enterprises. They only come to invest in low-end manufacturing industries in response to local low labor costs, so it will not bring upgrading to local industries. However, regardless of the statement, foreign direct investment will have an undeniable impact on the transformation and upgrading of regional industrial structure. Therefore, it should be selected as a control variable, and its data source is the China Statistical Yearbook; Finally, the last control variable selected is the housing prices of the three provinces and cities. For young people, choosing to make a living and develop in a certain city, housing prices must be an important factor. If the housing prices in a certain area are too high, it is likely to hinder the influx of young people in the long run, so the level of industrial upgrading and the level of housing prices will inevitably have an indirect impact. The data on the sales price of commercial housing comes from the China Real Estate Statistical Yearbook.

3.3 Regression results and analysis

The results of the Hausman test show that the P-value is significantly less than the critical value of 0.05. Therefore, the model in this article adopts the fixed effects model method, and the regression results are shown in Table 1:

Table 1 Regression Results

variable	(1)	(2)
old	0.822*** (0.023)	0.531*** (0.362)
rd		0.073*** (0.127)
fdi		-0.012*** (0.024)
houpri		0.321*** (0.362)
_con	0.737*** (0.006)	0.323*** (0.092)
2	0.542	0.753
number	60	60

According to the regression results, it can be seen that the coefficient of elderly dependency ratio is significantly positive, the coefficient of R&D investment is significantly positive, and the coefficient of foreign direct investment and commodity housing sales price is significantly negative. It can be seen that there is a positive correlation between the degree of population aging, R&D investment, and the sales price of commercial housing and the degree of industrial upgrading in the region; Foreign investment is negatively correlated with the level of industrial upgrading in the region.

The regression coefficient between the dependency ratio of the elderly population and the degree of industrial upgrading is 0.531. This means that for every percentage point increase in population aging in the region, the degree of industrial upgrading will increase by 0.531 percentage points.

Generally speaking, an increase in R&D investment will naturally significantly improve the production technology and capacity of the enterprise, and the regression results of this model also confirm this. The regression results of this model show that when the R&D investment increases by 1%, the degree of industrial upgrading will slightly upgrade by 0.073 units, which is clearly very small. This indicates that for enterprises, only by significantly increasing the internal expenditure of R&D investment can they significantly promote the transformation and upgrading of regional industrial structure.

From the regression results of this model, it can be seen that there is a negative correlation between foreign direct investment and industrial upgrading in the Yangtze River Delta region. Although the correlation coefficient is very small, it also indicates that foreign investment has a limited objective effect on promoting industrial upgrading for the entire Yangtze River Delta region. Why does foreign direct investment in the Yangtze River Delta region actually have a restraining effect on regional industrial upgrading? The interpretation is as follows: on the one hand, there are reasons for selecting data. The data selected in this article is from 2000 onwards. Unlike the early stages of reform and opening up, China's capital was scarce. At that time, if foreign investors came to China for investment, the upgrading effect of regional industries was significant. If there was a large amount of foreign investment, it would play a significant driving role in the economic takeoff of the investment region. However, after decades of development, after a large number of foreign investors entered the Yangtze River Delta region, the region itself developed its own local industries, and the contribution of local enterprises to better developed regions has gradually exceeded the contribution of foreign direct investment. Therefore, after the development of local enterprises reaches a certain level, if foreign investment increases again, the marginal effect on the improvement of regional industrial upgrading level will be very small, so this will not have a significant effect on promoting local industrial upgrading; On the other hand, the government of the source country of investment will prohibit its

investment in key and sensitive high-tech technologies in other countries by administrative orders, citing reasons such as national security and patent protection, in order to prevent key technologies from being "stolen", and only allow investment in labor-intensive industries such as clothing manufacturing and electronic assembly. As mentioned earlier, the Yangtze River Delta region and even the whole of China have entered an aging population, and the labor costs in this region are no longer as cheap as before. Therefore, many foreign businesses have even relocated their manufacturing industries to Southeast Asian countries with lower labor costs than China. Taking into account the above two aspects, the marginal effect of foreign investment on the transformation and upgrading of regional industries in the Yangtze River Delta region is also negligible.

The regression coefficient for controlling the variable sales price of commercial housing is 0.321, which means that for every 1% increase in the price of commercial housing, the degree of industrial upgrading will increase by 0.32%. This means that the degree of industrial upgrading is relatively high in areas with high housing prices. Generally speaking, for eligible laborers who want to enter cities for a living and development, housing prices are definitely an extremely important factor among the many factors that affect their choice of a certain city for development. Housing, as a basic necessity and one of the most important goals for young labor, if housing prices are too high, it will have a certain degree of inhibitory effect on the influx of population in the area. The data in this article shows that high housing prices to some extent indicate a high level of industrial upgrading. But we cannot ignore the inhibitory effect of housing prices on talent. If a region wants to achieve long-term development, it cannot do without the role of talent. If the housing prices in a region are too high, then some of those undergraduate and master's graduates who choose employment tend to avoid the region, thus bearing the loss of talent loss from the perspective of opportunity cost. Therefore, controlling local housing prices and providing housing subsidies for young talents are also important measures for the government to attract talents and promote local industrial upgrading.

4. Conclusion and policy recommendations

The mechanism of population aging on industrial upgrading is manifested as follows: firstly, the technology investment effect will promote local industries to increase technology research and development investment, thereby greatly promoting the upgrading of local real estate industries; Secondly, the labor productivity effect will also force the upgrading of industries; Thirdly, the tax burden effect will to some extent force enterprises to reduce costs, thereby driving industrial upgrading in the region. After theoretical analysis, this paper selects the Panel data of industrial upgrading in the Yangtze River Delta region from 2003 to 2022 for empirical analysis and test. The results of the empirical test show that, for the three provinces and cities in the Yangtze River Delta region in these 20 years, the aging of the population has indeed strongly promoted the regional industrial transformation and upgrading. In addition, there is a certain positive correlation between R&D investment and sales prices of commercial housing and regional industrial upgrading, but foreign direct investment will to some extent suppress regional industrial upgrading. Based on the conclusion of this article, the following methods can be adopted to effectively promote the upgrading of regional industrial structure:

Firstly, continue to promote the improvement of the regional social security system. Firstly, a sound social security system helps to promote traditional moral culture; Secondly, a sound social welfare system will help reduce the burden of childcare for eligible workers. The continuous increase in the elderly dependency ratio in China indicates that the burden of elderly care for young labor is not insignificant nowadays. A sound social security system can help alleviate the pressure on young labor and objectively promote the development of social productivity; Finally, a sound social security system inevitably requires a certain degree of taxation on enterprises, which can, through the tax burden effect, force enterprises to take measures to reduce production costs and adopt more advanced technologies, effectively promoting regional industrial transformation and upgrading.

Secondly, strengthen investment in high-tech research and development. The importance of high-tech for industrial upgrading is self-evident. Only by continuously strengthening research and development investment in high-tech industries can we effectively promote industrial upgrading. One characteristic of technology investment is that it requires a large amount of investment in the early stage. To achieve results, it often requires a significant amount of research investment in

the early stage. However, once results are obtained, it often brings great benefits to the upgrading of industries and the development of productivity. Therefore, we should continue to strengthen investment in scientific research, only in this way can we develop productivity and promote industrial upgrading in the aging population region.

Thirdly, reasonably control housing prices and provide subsidies for high-tech talents to purchase houses. Excessive housing prices can hinder the influx of talented young people, thereby hindering the development of local enterprises. The increasing dependency ratio of the elderly population has placed a heavy burden on the young labor force today. If housing prices are too high, this will make the already unbearable pressure on the young labor force even heavier. The goal of attracting talents can be achieved by reasonably controlling housing prices on the one hand, and providing housing subsidies for high-tech talents on the other hand.

Fourthly, accurately grasp the needs of the elderly population for adaptive aging transformation. The aging related industries all share a common characteristic, which is demand induced. All industries and professions should grasp the increasing needs of the aging population, start from the demand side, and accurately understand in which aspects the elderly population has needs and continuously meet them. In short, the aging population not only brings challenges but also opportunities. As long as relevant industries can actively respond, seize opportunities, continuously innovate and improve their service levels, they can steadily develop in the fiercely competitive market, achieve sustainable development, and contribute to the progress of society and the improvement of the quality of life for the elderly.

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