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Fiscal Countermeasures of Population Aging for Economic Development Based on Big Data Algorithm

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ABSTRACT

Like money or gold, data has emerged as a new class of economic commodity. Big data is now a factor of production on par with other material resources, having permeated every aspect of today's economy and society. Social development inevitably leads to population aging, which affects all facets of social life, particularly social and economic development. Nevertheless, systematic and thorough study on how population aging affects economic development is still lacking. The economic and fiscal policy trade-offs of aging on economic growth are the main emphasis of this article, which is based on big data techniques. This study examines the effects of population aging on economic development from the perspectives of economic growth, social security, and financial pension expenses, based on an analysis of the current state of population aging and its drivers. It was designed to address the aging of province A's population and discovered that it not only caused the share of the working-age population to decrease, but also decreased the resources available to the labor force. The proportion of tax revenue in total fiscal revenue will continue to be over 82% by 2021, with 73% of the population being between the ages of 15 and 64. The scale of fiscal pension expenditures in Province A has shown a clear upward trend.

Keywords: Big Data Algorithm, Population Aging, Fiscal and Taxation Measures, Fiscal Revenue

1. Introduction

Economic development is an important goal of a country's development, how to make the economic development of a virtuous circle, fiscal policy is a crucial link. First of all, in the process of rapid economic development, fiscal policy promotes economic development by regulating and guiding economic development, improving economic structure and improving investment environment [1]. In the aspect of tax policy, reducing the tax burden of enterprises can promote the development of enterprises, while increasing the tax burden may restrict the motivation of enterprise development.

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In addition, fiscal policy can also promote the development of emerging industries by optimizing tax policy to drive the overall economic development [2-3]. Secondly, in the field of public finance, fiscal policy can promote economic development by adjusting the structure of fiscal expenditure and moderately increasing fiscal expenditure, and at the same time, it will have a positive impact on most of the people [4-5]. Taxation and fiscal policy can also promote economic development by adjusting interest rates, exchange rates and other aspects, in order to improve the welfare of the whole society and the overall economic level [6-7]. Finally, the impact of different types of policies on economic development is also different. For example, a moderate increase in public investment by fiscal policy can help promote economic development, while an excessive increase in fiscal spending may lead to inflation and undesirable debt [8-9]. In addition, the guiding role of tax policy requires reasonable trade-offs, through the reasonable regulation of corporate income tax and consumption tax and other policies to mobilize the innovation and labor power of individuals and enterprises, which promotes the rapid and stable development of the whole economy, while an excessive increase in taxes may affect the virtuous cycle of the economy and the long-term development of the economy [10-11].

Population aging is a reflection of a country's medical level improvement, people's living conditions and economic development [12]. With the deepening of population aging, the needs of the elderly population for healthcare, pension, and services will increase, putting more pressure on the social welfare and healthcare security systems. The ensuing decline in productivity, increase in production costs of enterprises, slowdown in economic growth, and increase in the financial burden of the state and a series of other problems will have a greater impact on the healthy and stable development of society, and ultimately affect the process of economic development [13]. However, population aging also brings some new opportunities and potentials. With the rise of the aging industry, the longevity economy has become a new economic growth point, and the development of service industries such as nursing homes, rehabilitation centers, and senior tourism has provided a new impetus for employment and consumption [14-15]. At the same time, the improvement of the consumption ability of the elderly group has positively promoted the consumer market [16]. In addition, there is a huge potential for innovation latent in the elderly group. With rich experience and knowledge, they are able to create value for the society. With appropriate policy support and social environment, the elderly can actively participate in economic activities through entrepreneurship, cultural and artistic creation, etc., injecting new impetus to economic growth [17]. The potential of older people needs to be fully utilized to build a society that adapts to population aging and achieve sustainable economic development. And sustainable economic growth necessarily requires an understanding of its fiscal and tax policies.

2. Fiscal and Taxation Strategies for Population Aging to Promote Economic Development Based on Big Data Algorithms

2.1. Big Data Algorithm Theory

A computer program that analyzes large amounts of data is called a big data algorithm. The technique of grouping items into several categories based on predetermined standards and guidelines is known as clustering. In other words, the dataset is separated into several groups according to a particular metric in order to make the data in the first column as similar as feasible and the data in the other columns as diverse as possible. Figure 1 illustrates the cluster analysis procedure.

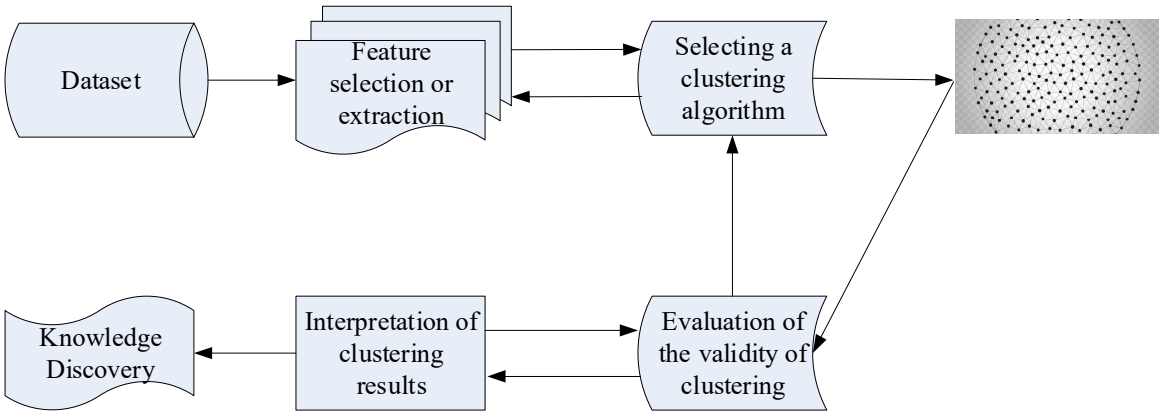

Fig. 1. The process of cluster analysis

The CURE algorithm can handle big and arbitrarily shaped datasets by using proxy points. As illustrated in Figure 2, where triangles and circles represent the two classes, a predetermined number of uniformly distributed points are chosen as class representative points in this algorithm. These representative points more precisely capture the distribution and shape information as a whole. Following the selection of the representative points, the algorithm uses the positions of the consumed points and consumes the representative points proportionate to the center of mass for each class (consumption factor). During the clustering phase, the representative points of each class are represented by the positions of the loss points. The addition of the reduction factor enhances the algorithm's capacity to ascertain the density of the various classes while also lessening the impact of noisy points on the clustering outcomes.

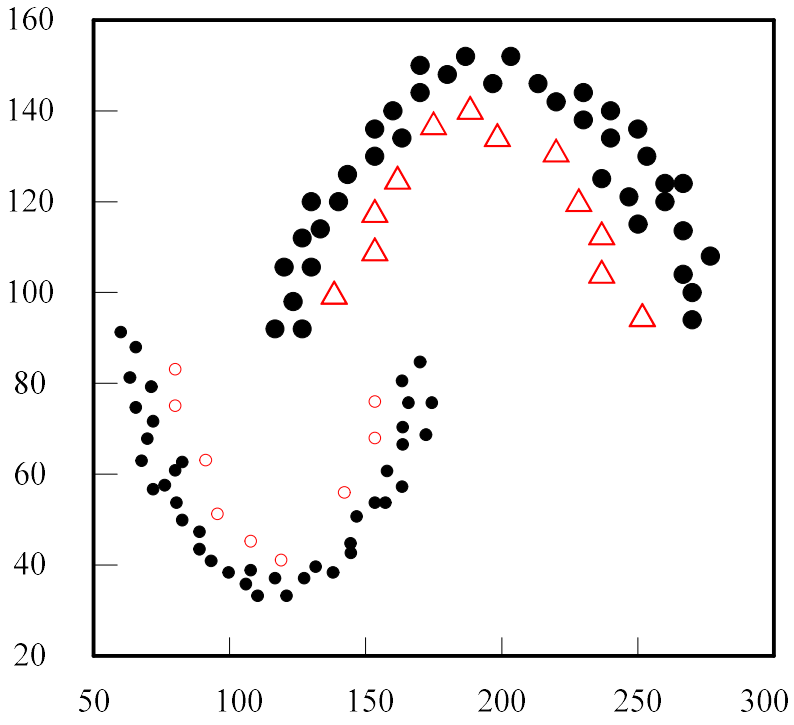

Fig. 2. Selection of representative points in the CURE algorithm

When dealing with large datasets of arbitrary shape, the CURE algorithm also combines random sampling and data partitioning, combining the quality of clustering with the efficiency of the algorithm.

First, randomly sample the large data set (generally medium-scale sampling is sufficient) to obtain a sample set; then divide the random sample set, and perform local clustering on each partition; then perform global clustering on all local clusters in the partitions Cluster until a given number of classes is reached. Finally, the unsampled data points are divided into the closest categories until the clustering of all data points is completed. The general process is shown in Figure 3. The CURE algorithm improves the shortcomings of clustering algorithms based on single representative points, so it can handle non-convex data sets, widely different classes and noisy points.

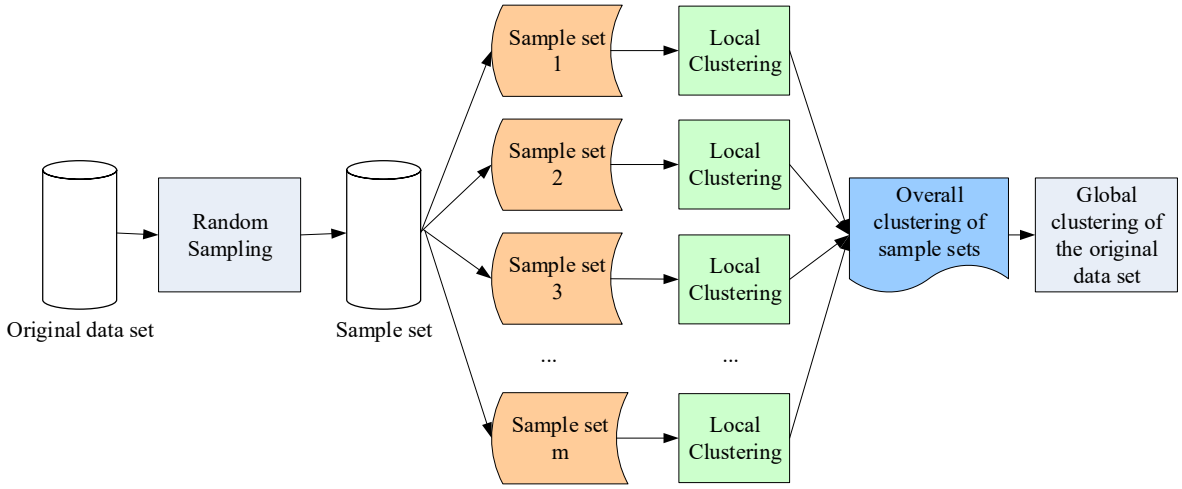

Fig. 3. The clustering process of the CURE algorithm for large datasets

China's big data industry has initially formed a triangular total structure, as shown in Figure 4. They are traditional IT companies, including Lenovo, Huawei, etc.; Internet companies, including Baidu, Alibaba, JD.com, Tencent, etc.; big data companies, including Beijing Tengyuntianxia, Datatang and other companies. The development of China's industrial chain structure is uneven. In the initial data source stage, there are more storage and computing services for massive data, while in the middle-end data mining processing and end-end analysis visualization, the market scale is small.

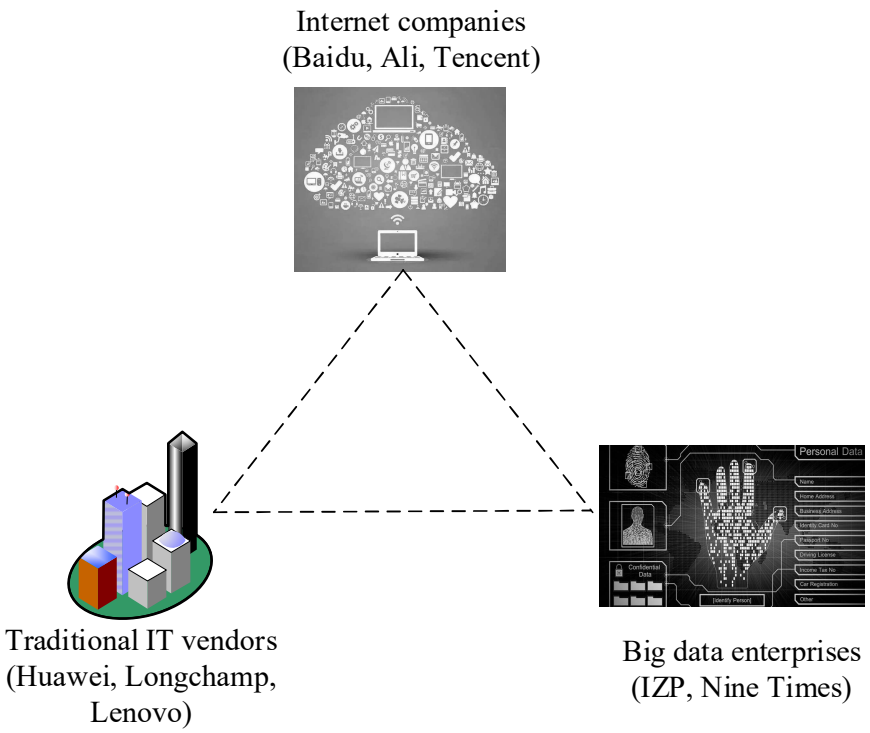

Fig. 4. Supply Structure of China's Big Data Market

2.2.Status Quo of Population Aging

France is the first nation in the world to have an aging population, according to historical records. The percentage of French citizens 60 and older surpassed 10% as early as 1895. Table 1 displays the global aging population's development status in 2010. It is easy to see that developing nations' aging trends have become more noticeable.

Table 1. Development status of world population aging in 2020 (unit: %)

Region	⩾60	⩾65	⩾80
World	12.5%	8.9%	2.1%
Developed countries	23.4%	18.7%	5.9%
Developing Countries	10.2%	7.3%	1.8%

Table 1 illustrates that population aging in rich countries has already begun, while the number of individuals aged 60 and over in developing countries is roughly 10.2% of the total population and is anticipated to increase to 19% by 2050 and 21% by 2100. %. This implies that the majority of nations will soon face labor shortages and aging populations.

Aging is not a social phenomenon in which one person lives for a long time, but the aging of a group of people. Aging is defined as more than 10 percent of the population aged 60 and over, or more than 7 percent of the population aged 65 and older. There are generally three types of indicators to measure aging: scale indicators, ratio indicators, and socioeconomic impact indicators. The degree of population aging is frequently gauged using the following indicators: 1) Old-age dependence ratio: The percentage of the population that is 60 years of age or older. 2) Median age: The age at which, when people are arranged in decreasing order of age, they are all in the center. 3) Age-Youth Ratio: The proportion of those older than 60 or 65 to children and adolescents between the ages of 0 and 14. In the survey, the proportion of the population aged 65 and over has been used to measure the extent of population aging. The specific international standards are shown in Table 2.

Table 2. International Standards for Types of Population Age Composition

Type of population age structure	Geriatric population factor	Population factor for children and adolescents	old to young ratio	Median age
Year Light	⩽4%	⩾40%	⩽15%	⩽20
Mature type	4%-7%	30-40%	15%-30%	20-30
Aged type	⩾7%	⩽30%	⩾30%	⩾30

Table 3 shows the birth rate, death rate and natural growth rate of China's population in recent years. The natural population growth rate dropped from 11.99% and 4.93% in 2015 to 8.52% and 1.45% in 2020, respectively. On the other hand, it is the main reason for the dramatic drop in population mortality. Socioeconomic development and improved healthcare will improve the quality of healthcare and increase the average life expectancy of the population. This will also lead to an increase in the proportion of older people.

Table 3. China's Birth Rate, Death Rate and Natural Growth Rate in recent years

Year	Birth rate	Mortality	Natural growth rate
2015	11.99	7.07	4.93
2016	13.57	7.04	6.53
2017	12.64	7.06	5.58
2018	10.86	7.08	3.78
2019	10.41	7.09	3.32
2020	8.52	7.07	1.45

1) Population aging factor.Supposing O_R is the number of elderly people, and L is the number of labor force in the total population. Here the total population only considers L and L_A, ignoring the number of juveniles and children, that is, the total population is:

$$N = L + L_R \tag{1}$$

Then

$$L = (1-\theta)N \tag{2}$$

The coefficient that defines the population aging factor in the economy is a, which can also be called the population aging rate:

$$A = \frac{L_R}{N} \tag{3}$$

2) Pension level coefficient.Assuming that the total social output T and the income allocated to the aging population is A. The rest is the available part of the labor force, denoted by B, that can be invested in reproduction.

$$T = T_R + T_L \tag{4}$$

Assuming that the pension level coefficient is λ, now define

$$\lambda = \frac{T_R / L_R}{T / N} \tag{5}$$

Among them: T_R / L_R represents the per capita income level of the elderly population, and T / N represents the per capita total income level. That is, λ is defined as the ratio of the average pension income of the elderly to the total level of per capita income in the economy. The average income at retirement is lower than the income level of the working population, and $0 < \lambda < 1$. The supply of labor mainly includes the supply of labor quantity and the supply of quality. The quantitative labor supply is mainly reflected in the quantity of labor. Its impact indicators also include the number of people of working age and participation rates.

So

$$\lambda = \frac{T_R / L_R}{T / N} = \frac{1}{A} \frac{Y_R}{Y} \tag{6}$$

By further derivation, it can be obtained:

$$T_R = \lambda A T \tag{7}$$

$$T = T_L + \lambda A T \tag{8}$$

$$T_L = (1 - \lambda A) T \tag{9}$$

The uneven distribution of population ageing is mainly reflected in differences between rural and urban areas, between coastal and inland areas, and between central and western regions. Generally, the southeastern coast is the oldest type, while the inland and western regions tend to be the most mature. Cities tend to be the oldest type, while rural areas tend to be the most mature. China's aging population is characterized by two important differences between urban and rural areas. On the one hand, cities have better implemented family planning policies, improved healthcare and quality of life, leading to increased life expectancy and aging populations in large cities. In recent years, the outflow of young and strong labor from rural areas has led to an aging population in rural areas. The large number of elderly people in rural areas will be the areas with the most aging population in China in the future.

2.3. The Effect Mechanism of Tax Policy on Economic Development

In the past 30 years, China's economy has grown rapidly, becoming the world's second-largest by GDP. Fiscal policy, through spending and tax multipliers, influences economic growth by affecting aggregate demand. Governments use fiscal policy to stabilize the economy, mitigate fluctuations, and maintain near-full employment.

Government revenue mainly comes from taxes levied on individuals and businesses. The main taxes are personal income tax, corporate income tax, sales and property tax, and social security tax. Taxes can be further divided into indirect and direct taxes. The former mainly includes sales tax, license fees and fines, while the latter is personal income tax and corporate income tax. Taxes impose an economic burden on the citizens of a country, the tax burden. It is usually measured by a country's macroeconomic tax burden level, that is, the percentage of total tax revenue in the total national economy in the same period.

Regional economic entities include enterprises, (resident) households and public institutions (government). Firms and (resident) households are micro-actors and agents of economic activity in the regional economy, exchanging labor and wages, and providing goods and services. Public institutions (governments) are the macro-regulators and managers of regional economic functions, with dominance, exchanging labor and wages with (resident) families, and exchanging commodity information with enterprises. Between these three main actors, the tax burden is measured in the usual way. Figure 5 illustrates the interactions between these three main actors. The role mechanism of fiscal policy in regional economic development is mainly reflected in the adjustment of resource allocation and industrial structure. In particular, by adjusting the costs and benefits of the three main economic entities in the region, households (residents), enterprises and the government, it affects their economic decision-making and affects the region's resource allocation and industrial structure.

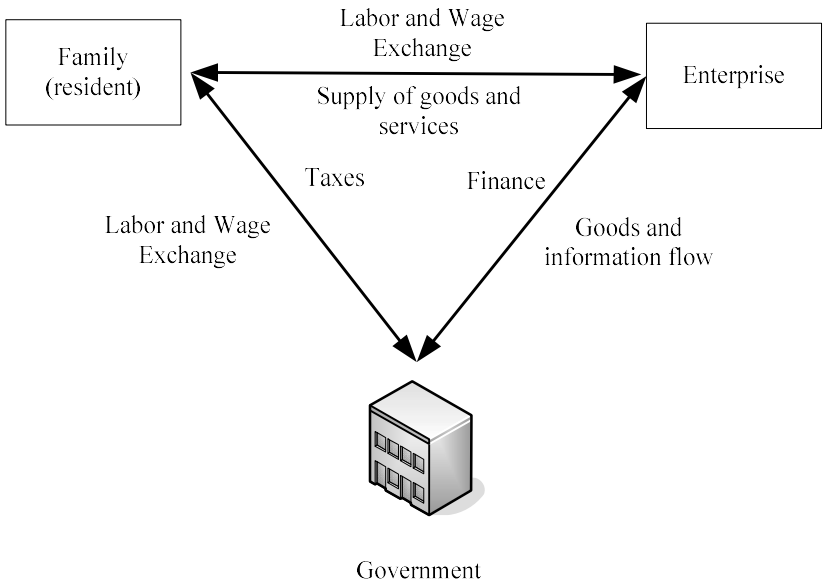

Fig. 5. The relationship between regional economic actors

Taxes also play a role in adjusting the industrial structure. The main actors are consumers and producers. This paper mainly analyzes the mechanism of taxation on regional industrial structure from the perspective of producers. Specifically, when the government treats different goods differently as taxed or untaxed, heavily taxed or lightly taxed, it reduces the profits from producing taxed and heavily taxed goods. This causes producers to increase the output of untaxed or lightly taxed goods and reduce the output of taxed or heavily taxed goods. As shown in Figure 6.

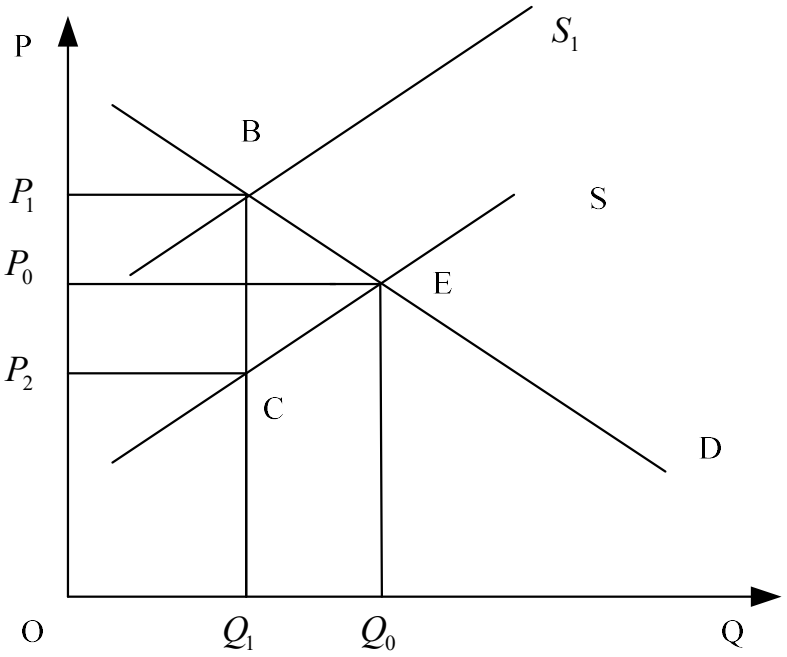

Fig. 6. Producer Effects of Taxes

Before the government levies the tax, the supply line S and the demand line D for the commodity intersect at point E. At this point the market equilibrium is reached. After the government imposes a tax on the commodity, the price paid by the consumer drops from P_0 to P_2. If a specific tax is levied,

$$P_1 = P_2 + T \tag{10}$$

If an ad valorem tax is levied, then

$$P_1 = P_2(1+t) \tag{11}$$

According to the extension of the neoclassical model, the convergence model can be expressed as:

$$S_x = f\left(x, x^*\right) \tag{12}$$

In the formula, S_x is the growth rate of per capita output, x is the current level of per capita output, and x* is the long-term or steady-state level of per capita output growth. Given x*, the growth rate S_x decreases as x increases. Given x, the growth rate S_x increases with the increase of x*. x* depends on a series of choices (choices in the private sector, choices in the government sector) and environmental variables. According to the above ideas, the model can be expanded in detail.

It expands output per capita log-linearly around its steady state:

$$\frac{\ln\left(X_{i,t}/X_{i,t-T}\right)}{T} = Y_i^* + \frac{1-e^{-\alpha T}}{T}\ln\frac{X_i^*}{X_{i,t-T}} + v_{it} \tag{13}$$

Among them, $X_{i,t-T}$ is the per capita GDP at the beginning, i is the economy of a certain region, t is a certain point in time, and T is the time span. $X_{i,t}$ is the final per capita GDP, Y_i^* is the per capita output growth rate under steady state conditions, and X_i^* is the steady state per capita output. α is the convergence coefficient, which indicates how fast Yi it approaches the steady-state output per capita. If α > 0, the regional economy tends to converge. If α < 0, the regional economy tends to diverge. Assuming that Y_i^* and X_i^* remain unchanged, after processing T, there is an estimation formula:

$$\ln\frac{X_i^*}{X_{i,t-T}} = \beta - (1-e^{-\alpha T})\ln X_{i,t-T} + u_{it} \tag{14}$$

Among them, β is a constant. The α value of the regression calculation represents the rate of convergence or divergence. Using $e^{-\alpha T} = \frac{1}{2}$, it can find the half-life T, which represents the time it takes for the gap between the poor and the rich to close by half.

As an important tool of tax policy, transfer payments increase the allocation of resources to backward regions and facilitate the flow of resources to backward regions. If it works, it should boost development in lagging regions, thereby reducing regional disparities. Therefore, when the intergovernmental transfer factor is considered, the control variable TP is added to formula (14), forming a new regression formula as follows.

$$\ln\frac{X_i^*}{X_{i,t-T}} = \beta - (1-e^{-\alpha T})\ln X_{i,t-T} + u_{it} + \beta_1 TP_{i,t} \tag{15}$$

In the field of economics, there are many indicators to measure regional economic differences. The most commonly used measurement indicators suitable for China's regional economy are as follows:

1) Extreme value difference.The measurement function expression formula is:

$$T_1 = x_{\max} - x_{\min} \tag{16}$$

Among them, $x_{\max}$ represents the maximum value of an economic indicator in the region, and $x_{\min}$ represents the minimum value;

2) Relative difference coefficient

$$T_2 = \frac{x_{\max} - x_{\min}}{\bar{x}} \times 100\% \tag{17}$$

Among them, $\bar{x}$ is the national average;

3) Coefficient of variation

$$k_{cv} = \frac{\sigma}{\bar{x}} = \frac{1}{x}\sqrt{\sum_{i=1}^{n}\frac{(x_i - \bar{x})^2}{n}} \tag{18}$$

Among them, σ is the standard deviation.

After the measurement indicators are determined, the measurement angle needs to be determined. Only in this way can the influencing factors of fiscal and taxation policies in regional economic development be more clearly displayed. Combined with the actual situation of Wenzhou's economic development, in the research of this paper, per capita GDP, regional industrial structure differences, regional fiscal revenue differences, and residents' living standard differences are selected as the main influencing factors. Combined with these factors, this paper analyzes the factors that restrict the coordinated development of regional economy in Wenzhou's relevant fiscal and taxation policies.

3. Fiscal and Taxation Strategies for Population Aging to Promote Economic Development

As shown in Figure 7, in Province A, population aging is increasing, with 73% of the population aged 15-64 by 2021. While the total population grows, the aging labor force has reduced labor resources and productivity. However, the rising proportion of working-age people won't have significant economic and social impacts in the short term.

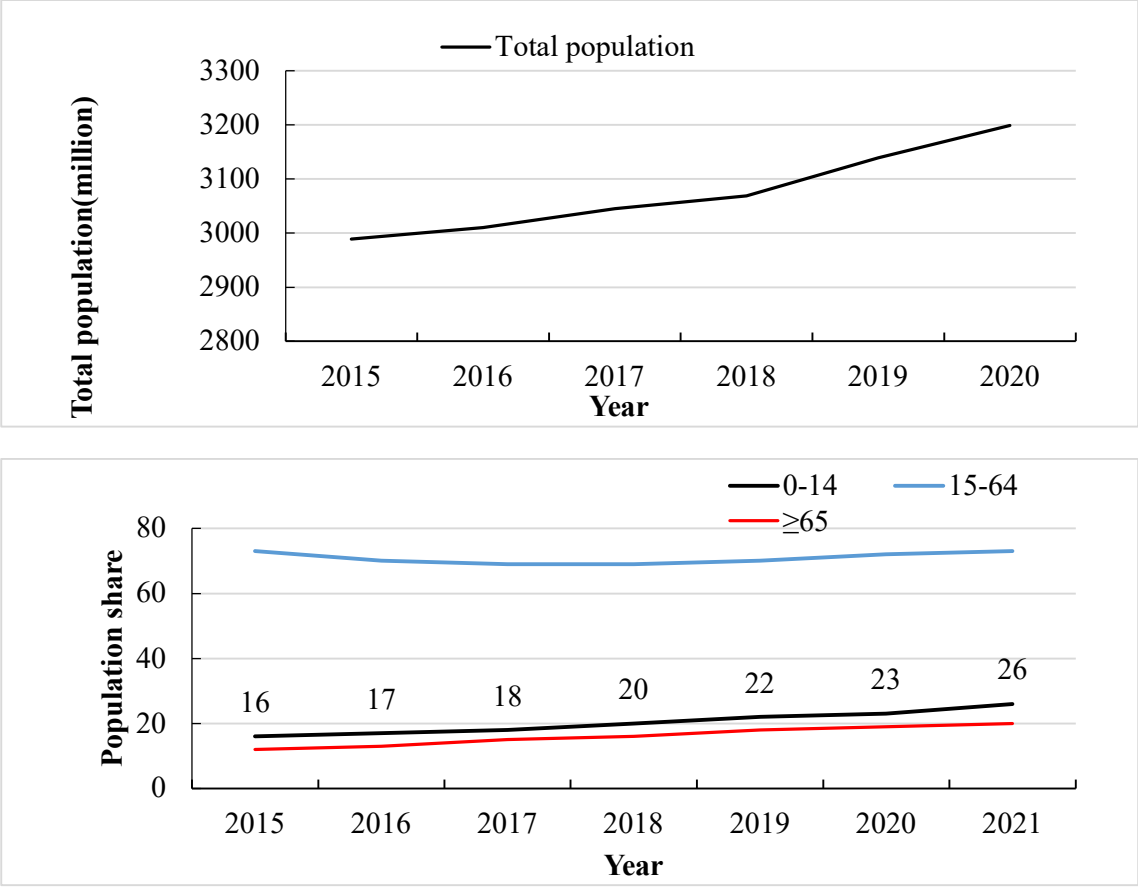

Fig. 7. Trends in the age structure of the population (the proportion of each age group in the population) over the years

Taxes affect saving and capital formation. In China, personal savings is the ultimate source of capital formation. The impact of taxes on personal savings is mainly achieved by affecting pre-tax income and savings returns. Taxing personal income will reduce personal disposable income, thereby reducing the size of savings. Taxing interest on savings would reduce the yield on savings, which would lower the cost of future consumption and discourage individuals from saving. The reduction in personal saving is not conducive to capital formation. The result will have a negative effect on economic growth. Figure 8 shows the trend of social fixed asset investment and savings deposits over the years.

As can be seen from Figure 8, the change trend is judged by analyzing the data of the residents' deposits in province A over the years. It can be concluded that, on the one hand, the total elderly population in Province A continues to rise, and the total saving of the province continues to increase. With the increase of the elderly population and the development of aging, the financial resources for the elderly population will increase. The country will devote more energy to the cause of aging, which will reduce social accumulation in terms of financial resources, energy and manpower. Under the premise that the elderly population in Province A is increasing, the savings of residents is increasing. The main reasons for this situation are: on the one hand, although the aging degree of province A is deepening, the economic development of province A is still at a relatively high level, the level of social security has been improved, and the level of endowment insurance for urban residents has been continuously improved with economic development. In the future, the proportion of the working-age population in the whole society will continue to increase. Objectively, it is conducive to the accumulation of personal savings and continues to increase social savings.

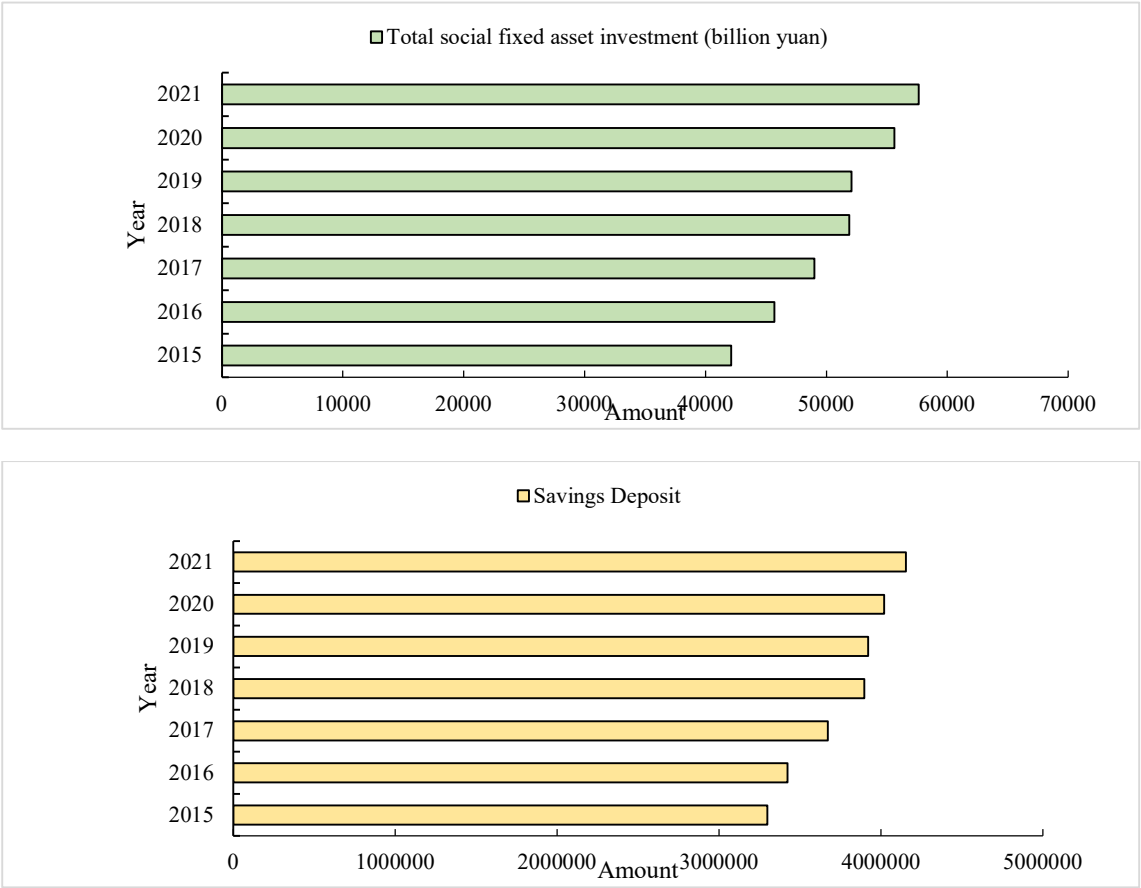

Fig. 8. Trends in social fixed asset investment and savings deposits over the years

Figure 9 shows the change trend of fiscal expenditure in A province and the change trend of fiscal pension expenditure. As can be seen from Figure 9, although the scale of fiscal pension expenditure in

Province A is not as large as the increase in the absolute scale of total fiscal expenditure, it is still in a clear upward trend on the whole. The graph shows a relatively flat curve, indicating that the growth rate of China's fiscal pension expenditure and total fiscal expenditure is basically the same. The annual growth rate of pension expenditure has also maintained a positive growth.

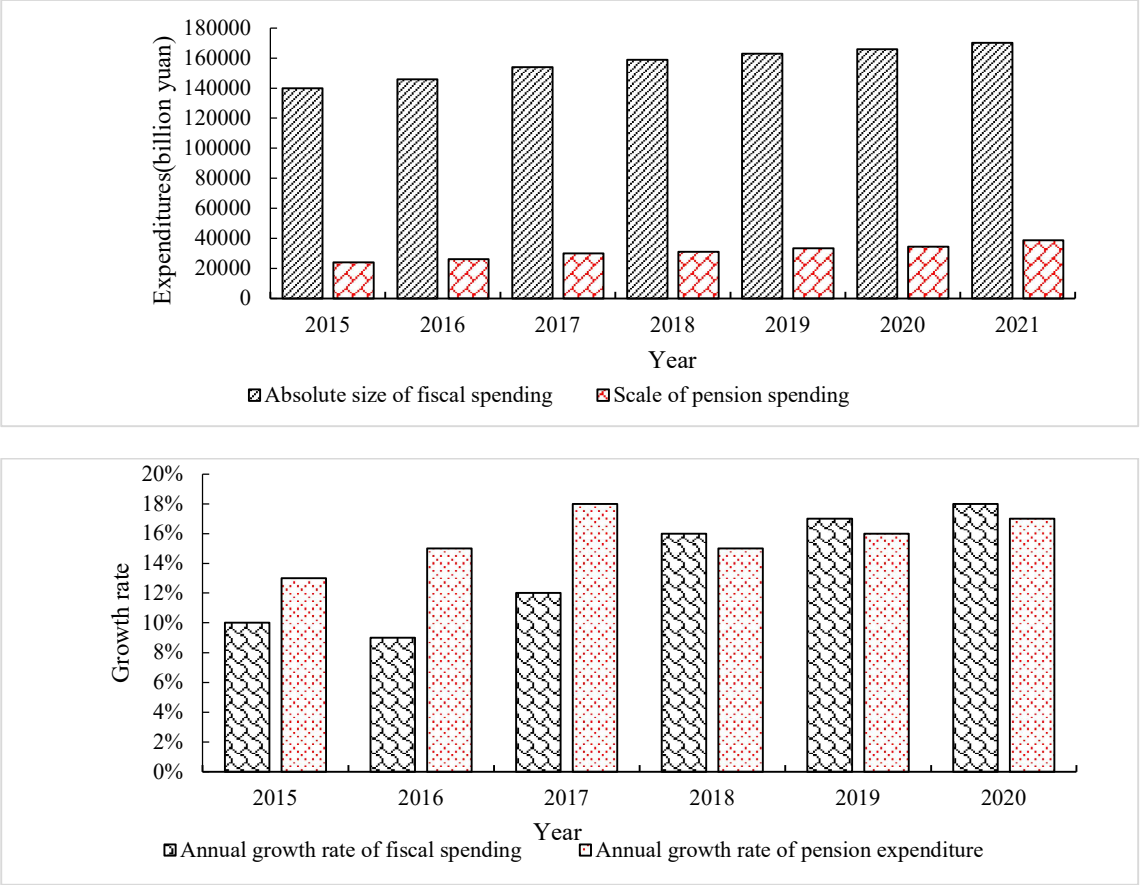

Fig. 9. The changing trend of fiscal expenditure in Province A and the changing trend of fiscal pension expenditure

Figure 10 shows the change trend of total tax revenue and the change trend of macro tax burden. The effect of tax policy is reflected in the tax burden. According to the general understanding, the economic development of the regions with high tax burden is more hindered. Areas with low tax burdens are more likely to attract the inflow of means of production and thus achieve development. The proportion of tax revenue to total fiscal revenue has remained above 82%. The annual growth rate of tax revenue is also relatively stable. As a strong pillar of China's finance, tax revenue is related to the national economy and people's livelihood, as well as social and economic stability. Therefore, it is difficult and impossible to change the fact that tax revenue is the main source of China's fiscal revenue in a short period of time. At the same time, the annual growth rate of tax revenue must be synchronized with the growth rate of fiscal expenditure to avoid serious fiscal deficits and hinder economic growth. The changing trend of small-caliber macro tax burden and medium-caliber macro tax burden is basically the same.

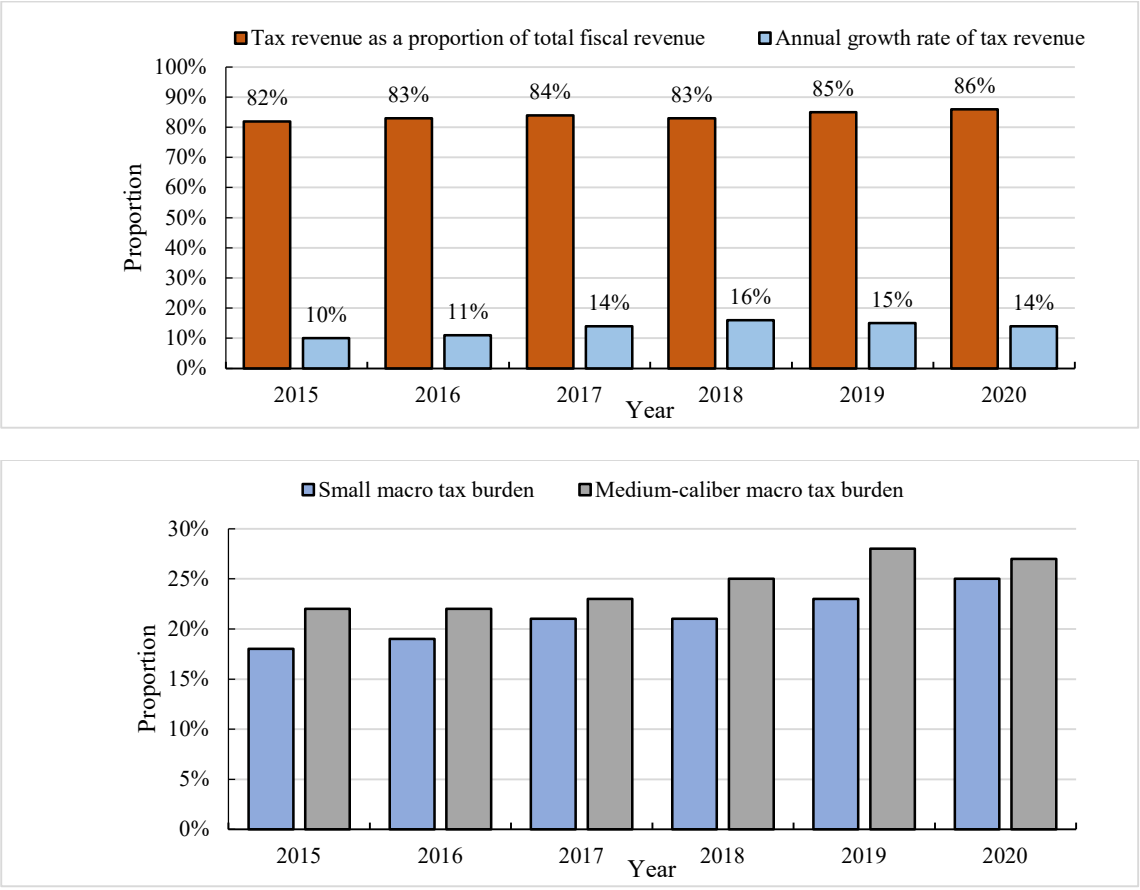

Fig. 10. The changing trend of total tax revenue and the changing trend of macro tax burden

4. Fiscal and Taxation Strategies for Population Aging to Promote Economic Development

An ageing population increases the demand for pensions and social security, which are the main sources of public finances. This increases the burden on the government budget. Expanding pension and social security spending for the elderly will inevitably lead to an outward shift of other public spending. In other words, assuming that budget spending reaches a certain level, an increase in pension spending means that spending in other areas must be reduced to keep budget spending below the baseline and avoid serious deficits. The main solution to the aging population is to develop the economy, make it more affordable, and establish a realistic pension model and system. The impact of aging on fiscal policy is closely related and similar to the impact on budget spending. This is because public spending is part of tax revenue, which is the main source of tax revenue. Tax spending and income, whichever one is aging, is diverted to the other through different channels. Aging means an increase in the proportion of older people in the population structure. To balance the tax, the government must increase government revenue, that is, raise the tax rate. On the other hand, an increase in the number of elderly people leads to a decrease in the real labor force, which inevitably leads to a decrease in income tax. If the level of taxation is constant, a reduction in one type of tax will inevitably require an increase in other taxes to compensate, thereby changing the tax structure. It stimulates economic growth through tax policies and relieves the economic pressure brought about by aging. It vigorously promotes aging through tax policies that promote investment in aging sectors. It promotes investment in various sectors of society through tax policy and increases social resources in various sectors.

In the long history of China's economic development, the abundant labor force has played an

indispensable role in China's economic growth. Large numbers of young workers and low wages keep labor costs low, allowing companies to profit in labor-intensive industries. However, as China gradually enters an aging society, the labor force is no longer abundant in number, and wages are also rising. This will undoubtedly make traditional labor-intensive industries in trouble. Therefore, China needs to accelerate the transition from primitive labor-intensive growth to labor-intensive growth based on technology and human capital. The tax structure has a positive effect on China's economic growth, but it is not obvious, indicating that China's tax structure can still be optimized at this stage. There is a weak positive correlation between the average tax burden and economic growth, while there is an obvious negative correlation between low tax burden and economic growth, indicating that China's tax revenue and GDP ratio are appropriate, while the proportion of tax revenue is too high. It is not conducive to economic growth, so China should appropriately reduce tax revenue and increase non-tax revenue. The proportion of direct and indirect taxes in taxation should be properly adjusted, so that the taxation system can shift from efficiency priority to social justice priority, and finally establish a taxation structure that takes into account fairness and efficiency.

5. Conclusion

Since the reform and opening up, China's economy has been growing steadily and rapidly. This is thanks to abundant and cheap labor. However, as China gradually becomes an aging society, the "demographic dividend" is slowly disappearing. The aging population has become one of the main obstacles to China's economic growth. Population ageing also creates an urgent need to change the nature of economic growth. As the main means of government intervention in the economy, fiscal policy plays an important role in promoting private investment, stimulating domestic consumption and improving citizens' living standards. In the process of China's economic development, the government's fiscal policy has always been driven by reality, adapted to the changes in the international and domestic economic environment, and made an indelible contribution to China's economic growth. Fiscal policy is an important economic lever for governments to address the problem of aging. The consumer market for the elderly is a special market that requires the active intervention of the government and the assistance and support of the whole society.

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Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Conflicts of Interest

These are no potential competing interests in our paper. And all authors have seen the manuscript and approved to submit to your journal. We confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

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