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ASSESSING THE IMPACT OF SOCIAL FACTORS ON THE SUSTAINABLE ECONOMIC DEVELOPMENT OF CHINA AND ITS REGIONS

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Abstract. This study examines the extent and nature of the impact of social factors on the sustainable economic development of China and its regions. Thus, based on the entropy method, the integral index of China's sustainable economic development was calculated, which became an explanatory variable in the regression analysis. The regression analysis of panel data of 30 Chinese provincial-level administrative regions covering the period from 2012 to 2021 resulted in the construction of three fixed-effect models showing the relationship between each of the socially-oriented dependent variables, as well as their totality, and sustainable economic development. The type of models was selected using the Hausman test and, to ensure reliability, an analysis of both the overall sample and its regional heterogeneity was carried out in addition to the reliability tests. According to the results of the study, one of the social factors (aging of the population) can contribute significantly to China's economic stability. At the same time, the second social factor – the growing participation of the population in pension insurance – has a negative impact on the Chinese economy. The combination of these factors does not have a significant impact on China's sustainable economic development. The study also shows that the impact of the social factors analyzed on economic sustainability differs in the eastern, central and western provinces of China. Based on the empirical results of the study, the following recommendations are proposed for China's sustainable economic development in the face of social challenges (aging of the population): to expand the use of the consumer potential of the senior population, and to develop this group as human resources; to promote the rational distribution of the factors of production among provinces by coordination of the state's regional policies. These recommendations can be used by the government to formulate a strategy for the sustainable economic development of China and its provinces. The research results will also be beneficial for businesses aiming to adapt their corporate environment to emerging realities and trends.

Keywords: sustainable economic development, state, region, social factors

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ОЦЕНКА ВЛИЯНИЯ НА УСТОЙЧИВОЕ ЭКОНОМИЧЕСКОЕ РАЗВИТИЕ КИТАЯ И ЕГО РЕГИОНОВ СОЦИАЛЬНЫХ ФАКТОРОВ

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Аннотация. В данном исследовании рассмотрены степень и характер влияния социальных факторов на устойчивое экономическое развитие Китая и его регионов. Так, на основе энтропийного метода рассчитан интегральный индекс устойчивого экономического развития Китая, который стал объясняемой переменной в регрессионном анализе. Результатом регрессионного анализа панельных данных по 30 административным районам Китая на уровне провинций за период с 2012 по 2021 год Китая стало построение трех моделей с фиксированными эффектами, показывающими связь между каждым из объясняющих показателей социальной направленности, а также по их совокупности и устойчивым экономическим развитием. Для определения выбора типа моделей был использован тест Хаусмана, а для обеспечения надежности результатов исследования был проведен анализ всей выборки и региональной неоднородности, а также тесты на надежность. По результатам исследования доказано, что один из социальных факторов (старение населения) может в значительной степени способствовать экономической устойчивости Китая. В то же время второй социальный фактор (рост участия населения в пенсионном страховании) негативно влияет на китайскую экономику. Совокупность этих факторов не оказывает существенного влияния на устойчивое экономическое развитие Китая. В исследовании также показано, что влияние на экономическую устойчивость анализируемых социальных факторов различается в восточных, центральных и западных провинциях Китая. Основываясь на эмпирических результатах исследования, предложены следующие рекомендации по устойчивому экономическому развитию Китая в условиях социальных вызовов (старения населения): расширять использование потребительского потенциала пожилого населения, развивать человеческие ресурсы пожилого возраста; содействовать рациональному распределению факторов производства в разрезе провинций посредством координации региональной политики государства. Эти рекомендации могут быть использованы правительством при формировании стратегии устойчивого экономического развития Китая и его провинций. Результаты исследования также будут полезны бизнесу для адаптации корпоративной среды к новым реалиям и трендам.

Ключевые слова: устойчивое экономическое развитие, государство, регион, социальные факторы

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Introduction

Many factors influence country's sustainable economic development, which is a goal that integrates the economic, social and environmental dimensions [25]. It aims to meet current human needs without compromising the ability of future generations to meet their own needs. The economic component of development is closely related to the social one. The influence of the economic system on the social system and vice versa has been proven by science and practice [30]. Historical social challenges over the

millennia have included water and food shortages, inequality and various other social phenomena [26, 27]. Modern aspects of social tensions include the problems of urbanization, population aging and declining birth rates. The expansion of the range of social issues requires a rethinking of economic policy in terms of sustainable development in every country [28]. However, to generate effective management decisions, it is essential to understand the relationship between specific social factors unique to a particular state and its economic system [29].

Thus, for China, the population aging is a major trend in global demographic development and an important challenge in the economic and social development. At present, Chinese society is in the transition stage from a mildly aging society to a moderately aging society [1]. In the context of actively coping with population aging, achieving sustainable economic development has become an urgent issue. The impact of population aging on the economy and society is multifaceted [2]. On the one hand, population aging reduces the effective supply of labor, affecting enterprise production and economic development, but population aging will also force enterprises to replace labor with technology, stimulate the endogenous power of innovation, thus promoting economic development. On the other hand, the increase in population aging leads to an increase in financial risks associated with formation of a pension fund, and, therefore, measures are constantly being taken to adjust the participation of the population in pension insurance. As can be seen, both the aging of the population and its participation in the pension insurance are important factors influencing the sustainable economic development of a country. Therefore, the purpose of the study is to assess the extent and nature of the impact of modern social factors on the sustainable economic development of China and its regions. Research objectives are as follows:

– identify the impact of population aging on China's sustainable economic development;

– determine the impact of population participation in pension insurance on China's sustainable economic development;

– assess the impact of a combination of two above factors on the sustainable economic development of China;

– analyze the heterogeneity of the impact of aging of the population and its participation in pension insurance on sustainable economic development in different regions of China (eastern, central and western);

– develop recommendations for improving China's national and regional economic policies, taking into account the issues of aging of the population and its participation in pension insurance.

Literature review

Recent studies on the impact of population aging on the economic stability of the state has led to a variety of conclusions, with most studies suggesting that population aging has a constraining effect on economic growth. For example, in [3] Malaysia's 1981–2019 panel data was examined, and the results showed that the increase of population aging has a negative impact on economic growth. In [4], based on Chinese provincial panel data, it was found that population aging hinders economic development, while human capital, technological innovation and social security effectively mitigate its negative impact. In [5] it was pointed out that population aging significantly reduces the level of high-quality economic development in the region and neighboring regions. However, there are also studies that have opposite findings. Some studies have shown that population aging has a promoting effect on economic growth. For example, in [6] it is argued that population aging will have a positive impact on economic development in the long run. In [7] and [8] it was confirmed that population aging promotes high-quality economic development with financial stability and human capital as mediating variables. In [9] China's Inner Mongolia Autonomous Region was taken as the research area and it was verified that population aging significantly promotes high-quality economic development in ethnic areas. This shows that there is still no consensus on the impact of population aging on sustainable economic development.

There are even fewer studies on the impact of participation of the population in pension insurance on sustainable economic development. In the current situation, China has a pronounced trend of negative

population growth and population aging, which poses significant risks to the state pension system and could lead to a serious pension crisis. Based on the current basic pension insurance premium rates, pension fund income and expenses, in [10], using mathematical and actuarial modeling, the fund balance dynamics was assessed and a series of recommendations to reduce the pressure on income and expenses of the funds was proposed. In [11] it was suggested that the downward adjustment of the enterprise pension insurance contribution rate has become an important measure to reduce the burden on enterprises, stimulate market vitality and promote long-term stable economic growth. In [12] the authors prioritized economic growth maximization and established a pension insurance equilibrium model, which concluded that the optimal contribution rate is lower than the realistic collection rate. The research [13] pointed out that a higher contribution rate of enterprise pension insurance would limit the income and benefit level of ordinary employees, which is not conducive to the accumulation of employees' human capital, resulting in a shortage of qualified professionals, difficulties in industrial upgrading, and impediments to product innovation, etc. In general, a high compulsory participation in the pension system is not conductive to the accumulation of human capital. On the contrary, it may further constrain economic growth, contribute to a shortage of pension fund accumulation, and negatively impact government revenues and expenditures. It is important to note that few studies are devoted to the relationship between population aging and its participation in pension insurance. In [14] it was found that population aging and declining fertility rate would cause an increase in pension insurance expenditures, which may trigger the payment risk of pension insurance. In [15] it was found that aging will directly or indirectly increase the pressure of urban workers' pension insurance payments. Therefore, in the face of increasing population aging, which leads to increased pension insurance payment pressure, the pension insurance participation rate will also increase.

A review of the literature has shown the relevance of the present research on the assessment of a country's sustainable economic development under the influence of interrelated factors: population aging and its participation in pension insurance. Let us formulate three hypotheses of the proposed study.

Population aging significantly influences sustainable economic development through labor supply, human capital and consumption [16]. It reduces labor supply and increases costs, but at the same time stimulates technological innovation in businesses [17]. With an increase in life expectancy, the return on investment in education increases, which results in a higher level of education and human capital development [18]. Population ageing also increases consumer demand, particularly in the healthcare sector due to rising morbidity and medical costs, contributing to the development of the elderly care and healthcare industries. It is necessary to use the consumption potential of the elderly in the entertainment and cultural sector, promoting the development of the “silver” economy. Therefore, the first hypothesis is proposed: Population aging positively affects sustainable economic development [19].

An increase in the participation rate in pension insurance can increase the financial burden on the state and society in the context of an aging population. An increase in the participation rate leads to an increase in pension payments, which can lead to a strain on the pension system if income growth lags behind expenditure growth, which will negatively affect the economy [20]. An increase in the participation rate may also lead to earlier retirements, reducing labor supply and dampening productivity [21]. In addition, enterprises may need to raise wages to ensure that they have enough labor, which will lead to higher costs. While the pension system aims at improving social welfare and combating poverty, it could increase intergenerational inequality, with younger cohorts bearing a higher tax burden to fund pensions for the elderly [22]. Based on the above analysis, the second hypothesis is proposed: An increase in population participation in pension insurance can have a negative impact on sustainable economic development.

In recent years, the continuous intensification of population aging and the continuous adjustment of the pension insurance system, with the pension insurance participation rate continuously increasing, the negative impact of the increase in the pension insurance participation rate on sustainable economic

development may affect the impact of population aging on sustainable economic development. Based on the above analysis, the third hypothesis is proposed: An increase in the pension insurance participation rate mitigates the impact of population aging on sustainable economic development.

Methods and materials

The study is based on panel data from 30 provincial-level administrative regions in China covering the period from 2012 to 2021 and uses the regression analysis method. The result of the study was the construction of three fixed-effect models showing the impact of population aging and participation of the population in pension insurance on China's sustainable economic development.

The integral index of sustainable economic development (*sed*) is selected as the dependent variable in the model. This indicator is based on the approach in [23], according to which, a set of indicators of China's sustainable economic development was classified into five groups:

1) innovation;
2) coordination;
3) green development;
4) openness;
5) sharing.

The set of indicators is presented in Table 1.

The entropy method was used to assign weights to each indicator, and the resulting weights were used to calculate the comprehensive index of sustainable economic development for 10 provinces (cities) in China over the period 2012–2021.

The comprehensive evaluation model and specific steps of the entropy value method are as follows [31]:

(1) Indicator standardization.

Positive indicators:

$$X'_{ij} = \frac{X_{ij} - \min\left(X_{ij}\right)}{\max\left(X_{ij}\right) - \min\left(X_{ij}\right)}.$$

Negative indicators:

$$X'_{ij} = \frac{\min\left(X_{ij}\right) - X_{ij}}{\max\left(X_{ij}\right) - \min\left(X_{ij}\right)},$$

where i stands for the province ($i = 1, 2, \ldots, n$), j is the indicator ($j = 1, 2, \ldots, m$), X_{ij} is the original indicator, X'_{ij} is the standardized indicator, and $\max(X_{ij})$ and $\min(X_{ij})$ are the maximum and minimum values of the original indicator, respectively.

(2) Calculation of the proportion of the indicator accounted for by the i-th province under the j-th indicator.

$$P_{ij} = \frac{X'_{ij}}{\sum_{i=1}^{n} X'_{ij}}.$$

(3) Calculation of the information entropy e_j of the indicator.

$$e_j = -\frac{1}{\ln\left(n\right)} \sum_{i=1}^{n} P_{ij} \ln\left(P_{ij}\right).$$

Table 1. The set of sustainable economic development indicators for China [31]

Dimension	Norm	Unit	Indicator properties	Weights
Innovation (0.4305)	Science and technology expenditures as a share of fiscal expenditures	%	+	0.0676
	R&D staff full-time equivalent	man-year	+	0.1213
	Technology market turnover/GDP	%	+	0.1406
	Number of domestic three kinds of patent applications authorized for 10000 people	item	+	0.1010
Coordination (0.1204)	GDP per capita by region as % of national GDP per capita	%	+	0.0520
	Ratio of annual per capita disposable income of urban and rural residents	–	–	0.0121
	Share of added value of tertiary sector in GDP	%	+	0.0246
	Share of local fiscal expenditure on culture, sports and media in fiscal expenditure	%	+	0.0317
Green (0.0474)	Non-hazardous treatment rate of domestic waste	%	+	0.0042
	Greening coverage in built-up areas	%	+	0.0120
	Electricity consumption per unit of GDP	kWh/$	–	0.0070
	Share of environmental protection expenditure in fiscal expenditure	%	+	0.0242
Openness (0.2440)	Total exports and imports of goods/regional GDP	%	+	0.0779
	Number of foreign-invested enterprises	classifier for households	+	0.1461
Sharing (0.1777)	Urban registered unemployment	%	–	0.0195
	Public library holdings per capita	classifier for volumes of books	+	0.0658
	Teacher-student ratio in general colleges	%	+	0.0314
	Physicians per 10,000 people	man	+	0.0278
	Share of social security expenditure in local general public budget expenditure	%	+	0.0332

(4) Calculation of the information redundancy of the j-th indicator d_j.

$$d_j = 1 - e_j.$$

(5) Calculation of the weight of each indicator w_j.

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j}.$$

(6) Determination of the integrated indicator of sustainable economic development (sed_i), which is then used as the basis for subsequent regression analysis.

$$sed_i = \sum_{j=1}^{m} w_j \times X'_{ij}.$$

The following two indicators were selected as **dependent variables** for the regression analysis:

1) population aging as an indicator calculated as a percentage of the population aged 65 years and over;

2) rate of participation in the pension insurance, which is an indicator calculated as a percentage of the population covered by the basic pension insurance.

Control variables were also identified:

1) level of human capital, measured by the average number of students enrolled in higher education institutions per 100000 inhabitants;

2) employment rate, measured as the ratio of employment at the end of the year to the total population of each province and city;

3) urban population density, expressed as the ratio of the urban population to the urban area;

4) level of government support (gov), measured by the share of budget expenditure in GDP.

The regression models are as follows:

$$sed_{it} = \alpha_0 + \alpha_1 aging_{it} + \alpha_2 control_{it} + \mu_i + \sigma_t + \varepsilon_{it}; \quad (1)$$

$$sed_{it} = \beta_0 + \beta_1 pension_{it} + \beta_2 control_{it} + \mu_i + \delta_t + \varepsilon_{it}; \quad (2)$$

$$sed_{it} = \nu_0 + \nu_1 aging_{it} + \nu_2 pension_{it} + \nu_3 \left(aging \times pension\right) + \nu_4 control_{it} + \mu_i + \delta_t + \varepsilon_{it}. \quad (3)$$

In (1) the direct impact of population aging on sustainable economic development is analyzed, while (2) focuses on the direct impact of population participation in pension insurance on sustainable economic development.

To construct (3), based on (1) and (2), the coefficient of interaction between the two factors under consideration was incorporated to investigate the deterrent effect of population participation in pension insurance. In the equation i is a province (or an autonomous region, or a municipality directly subordinated to the central government), t is the year, *sed* is an integral indicator of sustainable economic development, *aging* is an indicator of population aging, *pension* is the coefficient of participation of the population in pension insurance, *aging*×*pension* is an indicator of the relationship between population aging and the coefficient of the population participation in pension insurance, *control* is **the control variables**: human capital (human), the level of employment in relation to the employer (employ), and the level of employment in relation to the employee (employee), the coefficient of population participation in pension insurance (pension), population density (density), and the level of government support (gov); μ_i is a fixed effect for a region, δ_t is a fixed effect for a year, and e_{it} is a random disturbance.

Results and discussion

To solve the problem of selecting a fixed effect model and a random effect model for testing, the Hausman test was used. It showed P = 0.000, which indicates that the original hypothesis of using a random effect model is rejected [24]. Therefore, in this study, a fixed effect model was selected for the regression analysis.

Table 2 shows the regression results for the entire sample. The first column shows the results of regression analysis of the influence of population aging factor on sustainable economic development, and the coefficient of population aging here is positive and provides a contribution to sustainable economic development at the level of 1%, which confirms the first hypothesis. If we analyze the reason for this, it may be that population aging will increase the demand of the elderly for pension and health care and other goods and services. This will lead to the modernization of pension, health care and other industries, thus forming a new point of economic growth, which will have a positive impact on the sustainable development of the economy. This will have a positive impact on the sustainable economic development.

Table 2. Full sample regression results

Variables	(1)	(2)	(3)
aging	0.011***		0.011***
pension		-0.005***	-0.003***
aging×pension			0.000
human	0.021**	0.113***	0.058***
employ	0.007**	0.008**	0.008**
density	0.000***	0.000***	0.000***
gov	0.000	0.001	0.000
constant	-0.717**	-0.707*	-0.749**
observations	300	300	300
R^2	0.584	0.515	0.617
Province NF	YES	YES	YES
Year NF	YES	YES	YES

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Column (2) shows the results of the regression analysis of the effect of the pension insurance participation rate on economic sustainability. It is negative and has a significance of 1%, which means that a higher pension insurance participation rate has a significant negative effect on economic sustainability, and the second hypothesis is confirmed. Column (3) shows the results of the regression analysis of the relationship between population aging and pension insurance participation rate, and it has no significant effect on economic sustainability. The third hypothesis remains untested, likely because the design and implementation of the pension insurance system were based on the reality of population aging. As a result, the influence of population participation in pension contributions on sustainable development cannot be effectively measured, as the system inherently accounts for the effects of population aging.

As can be seen from Table 2, the regression analysis results of the intercept terms in Equations (1–3) are all significant at the 10% level, and this research selected panel data of 30 provincial administrative regions in China from 2012 to 2021, thus generating 300 observations, and all of them have R^2 greater than 0.5, which indicates that the model has a strong explanatory power. Fixed effects for province and year were done in the regression model.

Next, a heterogeneity test was performed. China occupies a vast geographical area, and the level of population aging may vary in different regions, and the impact of population aging on high-quality economic development may also differ. Therefore, for the purpose of this study, China is divided into three regions based on factors such as geographic location, natural environment, level of economic development and cultural differences: eastern, central and western regions.

The eastern region, which has earlier economic development, may face more serious problems of aging, and its population aging and pension insurance participation may be different from that of other regions. While the central and western regions may be less developed economically than the eastern one, they have unique advantages in terms of resources, labor force and market potential, but they age differently because of differences in population flows and fertility rates. This research further explores the correlation between population aging, pension insurance participation rate and sustainable economic development from the perspective of regional heterogeneity (see Table 3).

In the study, the regions of China are divided into three groups:

1) the eastern region, including Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan;

2) the central region, including Shanxi, Jilin, Heilongjiang, Henan, Hubei, Hunan, Anhui, and Jiangxi;

3) the western region, including Inner Mongolia, Chongqing, Sichuan, Guangxi, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.

Table 3. Regression results based on regional heterogeneity analysis

	Eastern region			Central Region			Western region		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
aging	0.011***		0.014***	0.001		-0.009*	0.010***		0.001
pension		-0.014***	-0.007***		-0.002**	-0.005***		-0.001*	-0.003**
aging×pension			0.000			0.000			0.000
human	0.024	0.135***	0.120***	0.077***	0.100***	0.062***	0.009	0.054***	0.013*
employ	0.015	-0.002	0.007	0.019***	0.019***	0.016***	0.002	0.002	0.005*
density	0.000***	0.000***	0.000***	0.000**	0.000**	0.000	0.000	0.000	0.000
gov	-0.000	0.001	0.001	-0.002**	-0.002**	0.000	-0.000	-0.000	-0.000
constant	-1.389	0.411	-0.639	-1.833***	-1.828***	-1.431***	-0.227	-0.086	-0.378
observations	110	110	110	80	80	80	110	110	110
R^2	0.615	0.588	0.700	0.802	0.813	0.843	0.733	0.593	0.747
Province NF	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year NF	YES	YES	YES	YES	YES	YES	YES	YES	YES

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Columns (1) and (7) show that population aging has a significant positive effect on sustainable economic development in the eastern and western regions, which has a significance level of 1%. In contrast, column (4) shows that in the central region, population aging has no significant effect on sustainable economic development, and the central region shows weaker results than the eastern and western regions. The reason for this difference may be that the labor supply structure and industrial structure of the central region need to be improved. In order to fully realize the positive effects of population aging on sustainable economic development, the central region should further improve the allocative efficiency and optimize the industrial structure.

Columns (2) and (5) show that in the eastern and central regions, the pension insurance participation rate has a negative effect on the sustainable economic development and the significance level is 1% and 5%, respectively. Column (8) shows that the effect of pension insurance participation rate on the sustainable economic development of the western region is negative and the significance level is 10%. The reason may be that the western region is less industrially developed, its economic foundation is weaker, the pension insurance participation rate is theoretically lower, and the impact on the sustainable economic development is not significant.

The next step was to test the robustness of the models. For this purpose, the leave-out method of for the robustness test was used in order to ensure the stability of the test results. Beijing, Shanghai, Tianjin and Chongqing, as municipalities directly under the central government, may differ significantly from other provinces (autonomous regions) in terms of economic development, the degree and speed of population aging and social burden, and thus the impacts of population aging on sustainable economic development may also be different. Therefore, a regression analysis is conducted on the sample data excluding the four municipalities mentioned above. From the regression analysis results, it can be seen that the impact of population aging on sustainable economic development is significantly positive at the 1% level, and the impact of pension insurance participation rate on sustainable economic development

is still negative. This is generally consistent with the regression analysis results on the full sample, indicating that the previous argument is valid.

Conclusion

Based on panel data for Chinese provinces for 2012–2021, regression modeling was conducted to assess the impact of two social factors (population aging and population participation in pension insurance) on sustainable economic development, and the following results were obtained:

1) population aging has a positive impact on the sustainable economic development of China and its regions;

2) a higher rate of pension insurance participation will have a negative impact on sustainable economic development;

3) relationship between pension insurance participation and population aging has no significant effect on sustainable economic development due to the perfection of the pension insurance system;

4) positive effect of population aging on sustainable economic development is more significant in western and eastern regions of China.

5) negative effect of pension insurance participation rate on sustainable economic development is more significant in eastern and central regions of China.

Based on the above mentioned results, the following conclusions are made:

1. To leverage the positive effects of population aging, efforts can be focused on activating the elderly consumer market – particularly in the health care sector – and developing a "silver" economy to meet the diversified needs of the elderly and promote the growth of related industries [25]. At the same time, policies can be adopted to gradually postpone retirement, optimize the allocation of human resources, and use the rich experience of older workers to improve the quality of the workforce. Government support is also needed to develop a quality elderly care industry.

2. It is necessary to adjust the mechanism of population participation in pension insurance to mitigate the negative impact on the economy. In order to reduce the burden of pension payments, it is necessary to optimize the management of pension insurance funds, increase efficiency, and balance insurance premium rates and benefit payment conditions, taking into account an increase in the retirement age and the increase in working hours. The government should support a multi-level elderly care insurance system to diversify risks and reduce the burden on the basic pension. In order to improve public awareness of pension insurance, it is necessary for the media and education to play a more active role in raising public awareness in this issue.

3. It is necessary to promote the rational allocation of production factors in order to achieve coordinated regional development. Particular attention should be paid to the allocation of resources and cooperation between regions, the introduction of advanced technologies, and the elimination of shortcomings in economic development. At the same time, it is important to assess the characteristics of population aging and the level of pension provision in different regions, make use of the comparative advantages of regions, and develop demographic and pension insurance policies that take into account regional characteristics, so as to promote the sustainable economic development of China's regions.

Future research directions

Future research will focus on how the positive effect of population aging on economic development can be fully realized through policy innovation and market activation. It is necessary to review and optimize the pension insurance system to adapt to demographic changes and ensure its sustainability. It is also necessary to explore strategies for inter-regional resource allocation and industrial cooperation in order to promote coordinated and sustainable economic development on a national level.

REFERENCES

1. Yuan R. (2021) *Pension Sustainability in China: Fragmented Administration and Population Aging*, 1st ed. London: Routledge. DOI: https://doi.org/10.4324/9781003182696

2. Wang L., Liang J., Wang B. (2024) Population aging and sustainable economic development: An analysis based on the role of green finance. *Finance Research Letters*, 70, art. no. 106239. DOI: https://doi.org/10.1016/j.frl.2024.106239

3. Mohd S.N.A., Ishak A.A., Selvaratnam D.P. (2021) Aging population's impact on economic growth in Malaysia from 1981 to 2019: Evidence from an autoregressive distributed lag approach. *Frontiers in Public Health*, 9, art. no. 731554. https://doi.org/10.3389/fpubh.2021.731554

4. 宋佳莹, 高传胜, 马嘉蕾 (2022) 人口老龄化对经济发展影响的机理与测度[J]. 江西社会科学, 42 (12), 35–46. Song J., Gao C., Ma J. (2022) Mechanism and measurement of the impact of population aging on economic development. *Jiangxi Social Science*, 42 (12), 35–46.

5. Zhang C., Li R. (2022) Population aging, digital economy, and high-quality economic development. *Economic Survey*, 39 (05), art. no. 03.

6. Pham T.N., Vo D.H. (2021) Aging population and economic growth in developing countries: A quantile regression approach. *Emerging Markets Finance and Trade*, 57 (1), 108–122. DOI: https://doi.org/10.1080/1540496X.2019.1698418

7. 曹聪灵, 肖国安, 徐邵蕊, 周小渝 (2022) 人口老龄化对经济高质量发展的影响要要要基于财政可持续视角[J]. 财经理论与实践, 43 (01), 114–122.Cao C., Xiao G., Xu S., Zhou X. (2022) The Impact of Population Aging on the High-Quality Development of Economy Based on the Perspective of Financial Sustainability. *Finance and Economics Theory and Practice*, 43 (01), 114–122. DOI: https://doi.org/10.16339/j.cnki.hdxbcjb.2022.01.015

8. 刘成坤, 林明裕 (2020) 人口老龄化尧人力资本积累与经济高质量发展[J]. 经济问题探索, 2020 (07), 168–179. Liu C., Lin M. (2020) Population Aging and Human Capital Accumulation and Economic Quality Development. *Exploration of Economic Issues*, 2020 (07), 168–179.

9. 闫海春 (2020) 促进还是抑制? 人口老龄化对经济高质量发展的影响要要要基于内蒙古自治区的实证研究[J]. 湖北民族大学学报 (哲学社会科学版), 38 (2), 60–67. Yan H. (2020) Promoting or inhibiting? The Impact of Population Aging on High-Quality Economic Development Based on Empirical Research in Inner Mongolia Autonomous Region. *Journal of Hubei University for Nationalities* (*Philosophy and Social Science Edition*), 38 (2), 60–67. DOI: https://doi.org/10.13501/j.cnki.42-1328/c.2020.02.006

10. 路锦非 (2016) 合理降低我国城镇职工基本养老保险缴费率的研究—基于制度赡养率的测算. 公共管理学报, 2016 (1), 128–140, 159. Lu J. (2016) Research on Reasonably Reducing the Basic Pension Insurance Contribution Rate for Urban Workers in China–Based on the Measurement of System Maintenance Rate. *Journal of Public Management*, 2016 (1), 128–140, 159. DOI: https://doi.org/10.16149/j.cnki.23-1523.2016.01.012

11. Yang H., Tang X., Fan W. (2024) Reducing contribution rate, population policy adjustment and economic growth. *Systems Engineering – Theory & Practice*, 44 (6), 1731–1748. DOI: https://doi.org/10.12011/SETP2023-0292

12. 李含伟, 汪泓, 王亦奇 (2011) 养老保险最优缴费比率研究[J]. 系统管理学报, 20(2), 175–179. Li H.W., Wang H., Wang Y.Q. (2011) Research on optimal pension financing ratio. *Journal of Systems & Management*, 20 (2), 175–179.

13. 李时宇 (2010) 从现收现付制转轨为基金积累制的收益研究 – 隐性债务下世代交叠 – 般均衡模型的理论分析及模拟[J]. 财经研究, 36 (8), 111–121. Li S.Y. (2010) Returns analysis from PAYGO system to fund accumulation system: Theoretical analysis and simulation of overlapping generation model with implicit debt. *Journal of Finance and Economics*, 36(8), 111–121.

14. Sun R. (2023) Research on the Payment Risk Measurement of the Basic Endowment Insurance Fund for Urban Employees. *Journal of Jiangxi University of Finance and Economics*, 0 (1), 65–75.

15. 李小林, 张源, 赵永亚 (2020) 人口老龄化尧城镇化与城镇职工养老保险支付能力[J]. 金融评论, 12 (01), 94–114, 125–126. Li X., Zhang Y., Zhao Y. (2020) Population Aging, Urbanization and Payment Capacity of Urban Employees' Pension Insurance. *Financial Review/Discussion*, 12 (01), 94–114, 125–126.

16. Bazzana D. (2020) Ageing population and pension system sustainability: reforms and redistributive implications. *Economia Politica*, 37, 971–992. DOI: https://doi.org/10.1007/s40888-020-00183-8

17. Zuo X., Peng X., Yang X., Adams P., Wang M. (2023) Pension Module and Its Application – Population Ageing and the Impacts of Retirement Age Extension on the Economy and Pension System in

China. In: *CHINAGEM – A Dynamic General Equilibrium Model of China: Theory, Data and Applications*, 147–179. DOI: https://doi.org/10.1007/978-981-99-1850-8_10

18. Gao M., Jiang F., Wang J., Wu B. (2024) Population ageing and income inequality in rural China: an 18-year analysis. *Humanities and Social Sciences Communications*, 11, art. no. 1605. DOI: https://doi.org/10.1057/s41599-024-04110-1

19. Futagami K., Nakajima T. (2001) Population aging and economic growth. *Journal of Macroeconomics*, 23 (1), 31–44. DOI: https://doi.org/10.1016/S0164-0704(01)00153-7

20. 华颖, 郑功成 (2020) 中国养老保险制度:效果评估与政策建议. 山东社会科学, 2020 (4), 66–74. Hua Y., Zheng K.C. (2020) China's Pension Insurance System: Effectiveness Assessment and Policy Recommendations. *Shandong Social Sciences*. 2020 (4), 66–74. DOI: https://doi.org/10.14112/j.cnki.37-1053/c.2020.04.010

21. Liu Z., Zhou C., Zheng X. (2019) Impact of the Basic Pension Program on Labor Supply and Retirement Decisions: An Empirical Analysis Based on the China Health and Retirement Longitudinal Study. *Economic Research Journal*, 54 (6), 151–167.

22. Devriendt W., Heylen F., Jacobs A. (2023) Coping with demographic change: macroeconomic performance and welfare inequality effects of public pension reform. *Journal of Pension Economics & Finance*, 22 (3), 425–449. DOI: https://doi.org/10.1017/s1474747222000051

23. 丁晨辉, 田泽, 宋晓明, 王威 (2022) 新发展理念下中国区域经济高质量发展研究要要要水平测度尧时空分异与动态演变[J]. 技术经济与管理研究, 12, 3–9. Ding, Chenhui, Tianze, Song, Xiaoming & Wang, Wei (2022) Research on high-quality development of China's regional economy under the new development concept--level measurement, spatio-temporal differentiation and dynamic evolution. *Research on Technical Economics and Management*, 12, 3–9.

24. Wang Q., Li C., Hu C. (2016) Bootstrap Hausman test for individual effects in partially linear panel data models. *Journal of Beijing University of Chemical Technology* (*Natural Science Edition*), 43(1), 122–127. DOI: https://doi.org/10.13543/j.bhxbzr.2016.01.020

25. Zhang J. (2024) Analysis on the Internal Mechanism and Optimization Path of Silver Haired Economy Development under the Background of Population Aging. *Aging Research*, 11 (2), 325–331. DOI: https://doi.org/10.12677/ar.2024.112047

26. Raju A., Marisetty V.B. (2025) Community activism, Social ties and ESG campaign success. *Finance Research Letters*, 73, art. no. 106607. DOI: https://doi.org/10.1016/j.frl.2024.106607

27. Dianov S., Koroleva L., Pokrovskaia N., Victorova N., Zaytsev A. (2022) The influence of taxation on income inequality: Analysis of the practice in the EU countries. *Sustainability*, 14 (15), art. no. 9066. DOI: https://doi.org/10.3390/su14159066

28. Babkin A., Shkarupeta E., Tashenova L., Malevskaia-Malevich E., Shchegoleva T. (2023) Framework for assessing the sustainability of ESG performance in industrial cluster ecosystems in a circular economy. *Journal of Open Innovation: Technology, Market, and Complexity*, 9 (2), art. no. 100071. DOI: https://doi.org/10.1016/j.joitmc.2023.100071

29. Rytova E., Gutman S., Sousa C. (2021) Regional inclusive development: An assessment of Russian regions. *Sustainability*, 13 (11), art. no. 5773. DOI: https://doi.org/10.3390/su13115773

30. Bai X., Li X., Jia R., Liu Y. (2019) A distributionally robust credibilistic optimization method for the economic-environmental-energy-social sustainability problem. *Information Sciences*, 501, 1–18. DOI: https://doi.org/10.1016/j.ins.2019.05.031

31. Luy L., Guzikova L.A. (2025) Exploring the sustainable development of China's regional economy. *The EUrASEANs: journal on global socio-economic dynamics*, 1 (50), 36–43.

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