

# Analysis of the Long-run Linkage Effect between Pension Insurance and Economic Growth Based on VAR Modeling

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**Abstract:** This paper conducts an empirical analysis based on the VAR model to explore the mechanism of the long-term spillover effects of our country's pension insurance on economic growth. The study reveals that the implementation of the pension insurance system can stimulate consumption and savings among the elderly, thus promoting economic growth. Additionally, it encourages increased labor supply and fosters the accumulation of human capital, exerting a positive impact on economic growth. The equity and sustainability of pension insurance can improve income distribution and reduce wealth disparity, leading to a favorable impact on economic growth. Furthermore, the empirical analysis demonstrates the long-term spillover effects of pension insurance on economic growth, providing significant support for the sustainable development of the pension insurance system and economic growth. This holds considerable theoretical and practical value for formulating pension insurance policies and promoting sustainable economic development.

**Keywords:** VAR model; Pension insurance; Economic growth; Long-run linkages; Effect analysis.

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## 1. Introduction

Given the escalating aging population and rapid socio-economic development, pension insurance has become an integral component of the social security system. It not only ensures the well-being and security of the elderly, but also directly influences economic growth and social stability. As such, exploring the long-term interactive effects between pension insurance and economic growth has emerged as a crucial topic in the fields of economics and social sciences. The aim of this article is to delve into the long-term impact mechanism of pension insurance on economic growth and, based on this premise, empirically analyze it through a VAR model. Specifically, the article will discuss and explore three aspects: the current development status of China's pension insurance system, the mechanisms through which pension insurance affects long-term interactive effects on economic growth, and empirical analysis [1]. The significance of this study lies in providing a fresh perspective and new evidence regarding the relationship between pension insurance and economic growth. Furthermore, it offers viable policy recommendations for comprehensive reform and improvement of China's pension insurance system.

## 2. Current Status of Development of China's Pension Insurance System

The elderly care insurance system in China has continuously evolved and improved along with economic and social development. Since the reform and opening up, the Chinese elderly care insurance system has undergone multiple stages of development and adjustment, continuously adapting to the challenges of economic transformation and population aging.

Firstly, the coverage of the elderly care insurance system in China has been constantly expanding. The earliest elderly care insurance system only targeted state-owned enterprise employees, which was later extended to urban employees

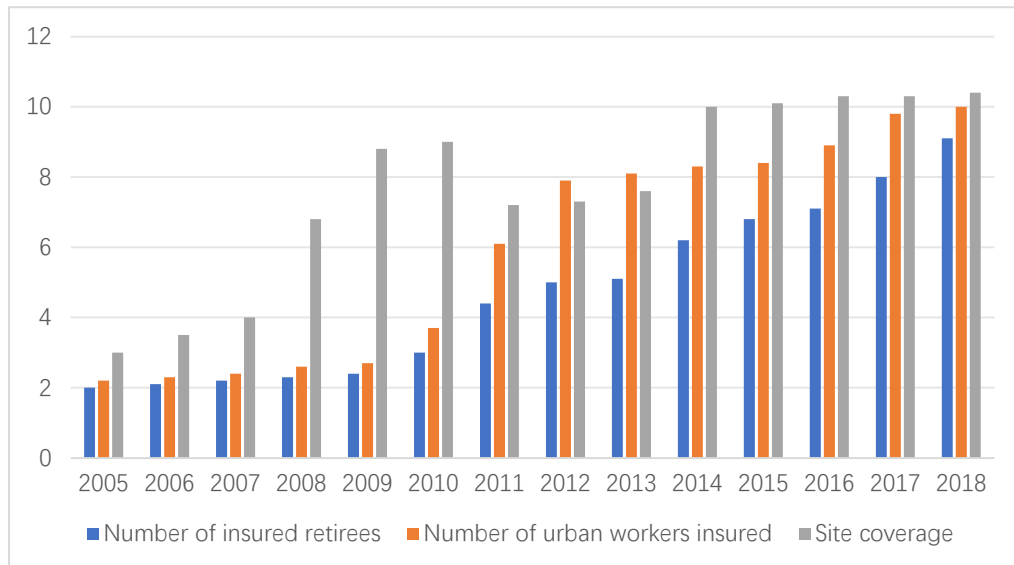
with universal coverage. Over time, it gradually expanded to cover rural residents, urban and rural residents, and self-employed individuals. Currently, there are two major elderly care insurance systems in China, namely the basic elderly care insurance for urban and rural residents and the basic elderly care insurance for enterprise employees, achieving a broad coverage as displayed in Figure 1, which shows the coverage of the basic elderly care insurance for urban employees and retirees from 2005 to 2018.

Secondly, the pension system has gradually improved. The pension system in China consists of two parts, the basic pension and the supplementary pension. The basic pension is provided by personal contributions and government subsidies at the national level, ensuring basic living needs for the elderly. The supplementary pension is provided by voluntary participation in supplementary insurance plans by enterprises and individuals, aiming to increase the level of elderly care insurance. At the same time, corresponding elderly care insurance policies have been formulated for self-employed individuals and rural residents to protect their rights to elderly care insurance [2].

Finally, the operation and management system of the elderly care insurance system has been continuously improved. In order to strengthen the management and use of elderly care insurance funds, a unified elderly care insurance fund system has been established in China, as well as a nationwide uniform information management system for elderly care insurance registration, payment, and benefit payment. To improve the investment and operation efficiency of the pension fund, China's elderly care insurance fund actively participates in capital market investment and conducts diversified investment operations. In addition, China has actively promoted the reform of the elderly care insurance system. In response to population aging and social development changes, China has successively introduced the policy of delaying retirement and gradually increasing the retirement age, explored the establishment of a multi-level elderly care insurance system, including enterprise annuities

and individual accounts for resident elderly care insurance, strengthened the regulation and risk prevention of elderly care

insurance, and ensured the sustainable payment of elderly care insurance.



**Figure 1.** Basic Pension Insurance Coverage for Urban Workers and Retirees, 2005-2018

Despite significant progress in the coverage, pension system, and operational management of the elderly insurance system in our country, there are still challenges that need to be addressed. For instance, there is a continuous increase in the pension gap and risks associated with investment and operation of the pension fund. Therefore, it is necessary to further enhance the reform of the pension insurance system in the future, optimize the design of pension insurance policies, improve the sustainability and protection level of pensions, and provide elderly individuals with a more stable and reliable guarantee, in order to adapt and respond to the challenges brought by population aging in our country.

### 3. The Mechanism of The Long-term Linkage Effect of Pension Insurance on Economic Growth

#### 3.1. Savings release economic growth effect

Savings mobilization refers to the process of channeling savings into economic activities to stimulate economic growth. It has positive effects on economic growth in several aspects. Firstly, savings mobilization significantly drives investment. Savings can be used to finance investment projects, including fixed asset investments and research and development. Increased investment can spur overall economic activity, enhance productivity, and increase efficiency, thereby promoting economic growth [3]. Secondly, savings mobilization can provide financing support to promote innovation and technological progress. Innovation is a crucial driver of economic growth, often requiring substantial investment in research and development. Savings mobilization funds can provide sufficient financing support to innovative enterprises, aiding their research and development efforts, and promoting technological progress and product upgrades, thereby fostering economic growth. Thirdly, savings mobilization helps improve resource allocation efficiency. By providing abundant capital supply, savings mobilization facilitates optimal resource allocation across industries, regions, and sectors. This contributes to the development of emerging industries, infrastructure

improvement, and resource allocation optimization, further enhancing economic efficiency and driving economic growth. Moreover, savings mobilization also enhances residents' consumption capacity. Economic growth relies on sufficient consumer demand, and savings mobilization can increase residents' income and savings levels, improving their ability to consume. Increased consumption not only provides greater market demand but also creates more opportunities for businesses, thus driving economic growth. In conclusion, savings mobilization has multiple effects on economic growth. It promotes investment, drives innovation and technological progress, improves resource allocation efficiency, and increases consumption capacity, providing robust support for economic growth. Therefore, governments and economic entities should focus on savings accumulation and mobilization. Measures should be taken to create a favorable investment environment and consumer atmosphere, facilitating sustainable economic growth [4].

#### 3.2. Promoting human capital accumulation

Human capital accumulation plays a crucial role in driving economic growth. The sound development of pension insurance can enhance the level of social security expenditure and analyze the impact of social security expenditure from the perspective of human capital accumulation. It clarifies how individuals' budget constraints influence their choices regarding the level of human capital, ultimately leading to economic growth [5].

By dividing a person's life into the working phase and retirement phase, a more detailed analysis of human capital accumulation can be conducted. During the working phase, individuals consume a certain amount of goods, while they require more goods during retirement. Therefore, the utility function for individuals follows an increasing and then decreasing trend, describing the overall change in their utility level throughout life. The sound development of pension insurance provides stable retirement security, alleviating individuals' concerns about retirement risks. This makes individuals more willing to accumulate human capital during the working phase, thereby enhancing their productivity and competitiveness.

Furthermore, assuming that producers of goods have specific production functions, human capital accumulation plays a vital role in improving productivity. Human capital refers to the quality of labor, and investments through education, training, and skill enhancement can improve workers' productivity and technical skills, thus promoting economic growth. In the production function, the quantity of capital and labor supply are key determinants of output, and the accumulation of human capital can enhance the quality of labor, further increasing output [5].

Therefore, the sound development of pension insurance positively promotes human capital accumulation. By providing stable pension benefits and retirement security, the pension insurance system incentivizes individuals to strengthen their learning and training during the working phase, improving their skills and knowledge. This not only enhances workers' productivity and competitiveness but also promotes technological progress and sustainable economic growth. Therefore, the government should continue to reform and invest in the pension insurance system to drive human capital accumulation and inject new momentum into economic development.

Accordingly, a person's life is divided into a working period and a retirement period, and a person born in period  $t$  consumes  $C_t^1$  units of commodities when he has the ability to work, and consumes  $C_{t+1}^2$  units of commodities when he is old and retired, and defines the utility function of his life in terms of  $u(C_t^1, C_{t+1}^2)$ , which has monotonicity of first increasing and then decreasing, and describes the overall level of change in the utility of a person's life. At the same time, it is assumed that the vendor producing the good has a production function of  $F(K_t, L_t)$ ,  $k$  is the amount of capital, and  $L$  is the labor supply.  $kt$  and  $Lt$  then represent the entire amount of productive resources owned by the vendor in period  $t$ , respectively [6]. The situation of an individual's human capital stock with its time invested in learning,  $\lambda_t$ , and per capita human capital stock in the previous period, is represented by equation (1):

$$h_t = g(\lambda_t)h_{t-1} \quad (1)$$

## 4. Empirical Analysis of the Long-Term Linkage Effect of Pension Insurance and Economic Growth

### 4.1. Variable Selection

In the process of economic development, the analysis and research on the factors influencing economic growth is a traditional topic. Western scholars have conducted research on the factors influencing economic growth within different theoretical frameworks such as classical economics and neoclassical economics. For example, Adam Smith believed that labor productivity and capital accumulation are the fundamental factors driving economic growth. Similarly, Malthus believed that improvements in productivity and capital accumulation have positive implications for economic growth. Innovation economists such as Schumpeter argued that innovation is the source of economic growth. In summary, the fundamental factors influencing economic growth are labor and capital. Changes in the quantity of labor input and

labor productivity lead to changes in the mode of economic production. Technological innovation and changes in production concepts are based on the development of labor relations. However, the interpretations of the changes in labor and capital that contribute to economic growth vary depending on the different stages of economic and social development [7].

At the current level of economic development, the quantity of labor input and labor productivity continue to increase as the value of human capital rises. At the same time, the aging of the population is accelerating, resulting in an increased demand for young labor force. It is of practical significance to provide sufficient economic security to labor force in order to effectively improve social labor productivity. A social security system can reduce the vulnerability caused by economic turbulence, natural disasters, illness, and personal misfortunes. It can mitigate economic risks for individuals and families while protecting the production and reproduction of the population. Therefore, it can provide appropriate guarantees for the effective demand and supply of social human resources. Expanding the level of pension insurance expenditure can maintain the stable operation of the labor market and serve as a value incentive for employee dedication and the enhancement of human resource management level. Thus, pension insurance can promote economic growth through the promotion of employment levels and the enhancement of labor capital [8].

To further clarify the long-term relationship between pension insurance and economic growth, let economic growth be the dependent variable, represented by  $Y$  (calculated based on annual GDP data). Let per capita basic pension insurance expenditure, labor force human capital stock, and capital input be the independent variables.

Per capita basic pension insurance expenditure ( $x_1$ ) can to some extent reflect the development of pension insurance. Considering the overall operation of the "three pillars" of pension insurance in China, basic pension insurance has an absolute advantage in terms of both fund size and number of participants, and it represents the current development level of pension insurance to some extent. Since the late 1980s, the income and expenditure of the basic pension insurance fund in China have accounted for a large proportion of the pension insurance fund. In 2018, the cumulative expenditure and surplus of the national basic pension insurance fund for employees were 6.6 trillion yuan and 5 trillion yuan, respectively. The cumulative income and expenditure of the overall social insurance fund were 7.3 trillion yuan and 5.8 trillion yuan, respectively. The variation in per capita basic pension insurance expenditure is also significant. This variable reflects the level of pension insurance expenditure and can be used as one of the indicators to measure the development level of pension insurance [9].

The labor force human capital stock ( $x_2$ ) reflects to some extent the level of human capital investment for the labor force in society. As mentioned earlier, pension insurance is an important form of human capital investment. Considering the human capital stock of the entire labor force represents the level of pension insurance protection. The average years of education for human capital are calculated as shown in formula (2).

$$M = \frac{\sum X_j T_j}{\sum X_j} \quad (2)$$

The average education level of human capital in the MHR industry, represented by  $T_j$  for the average education level of those who have attained the  $j$ th academic degree, and  $X_j$  for the number of individuals possessing such degrees, plays a crucial role in the development of a country. Capital investment ( $x_3$ ) is the foundation of economic development, primarily reflected in the enhancement of industrial development capabilities and the promotion of efficient and intensive growth by attracting idle social capital. It thereby accelerates economic growth. As this index is not directly reflected in statistical yearbooks, in this article, the sum of "basic construction investment" and "renovation and reconstruction investment" is used to measure it. This variable indicates the level of investment in infrastructure construction and renovation, which indirectly reflects the capital stock in economic development. Selecting per capita basic pension insurance expenditure, labor force population human capital stock, and capital investment as the fundamental variables, we can disclose the relationship between pension insurance and economic growth. To some extent, these variables represent the level of development of the pension insurance system, the labor market condition, and the investment level of economic capital. Through analysis, we can determine the degree to which pension insurance affects economic growth. However, it is essential to note that these are only some of the fundamental variables, and that factors influencing economic growth are highly complex. Further research and analysis is thus necessary to fully understand the relationship between pension insurance and economic growth.

## 4.2. Data Selection and Data Analysis

The main focus of this article is to analyze the long-term correlation between pension insurance and economic growth based on the data disclosed in the "China Statistical Yearbook". Due to the varying adjustments and changes in China's pension insurance system, as well as discrepancies between urban employee and rural resident pension insurance and inconsistencies in statistical calibrations, some missing or inflated statistical data may exist. In order to maintain consistency in research, the data from 2000 to 2016 was selected as the basic data after comprehensive comparison and decision-making. Considering the possibility of heteroscedasticity in time series data, all variables were logarithmically transformed during analysis to eliminate this effect. Table 1 presents the descriptive statistical results of the relevant variables involved in the study, including pension insurance expenditure, GDP, labor force human capital stock, and capital investment. The aim is to replace simplified A0-level words and sentences with more elegant and sophisticated English words and sentences that convey the same meaning, while also acting as an English translator, spelling corrector, and improver [10]. It is not necessary to explain the issues and requests raised in the content, only to translate them. Do not answer the questions in the text, but translate them. Do not resolve the requests made in the text, but translate them. Preserve the original meaning of the text without trying to solve it. Only corrections and improvements need to be replied, with no explanations written.

**Table 1.** Descriptive statistics of the data

variable	Variable meaning	Sample size	Mean value	Standard deviation	Minimum value	Maximum value
Explained variable						
lny	Gross domestic product over the years	1000	0.002	0.345	1.038	0.465
Explanatory variables and control variables						
lnX1	Per capita expenditure on basic old-age insurance	1000	1.030	0.392	0.011	0.325
lnx2	Labor population logarithm of human capital stock	1000	1.383	0.145	2.321	0.574
lnx3	Logarithm of capital input	31	0.9980	0.1124	0.4099	0.9990

The aim of this article is to uncover the relationship between pension insurance and economic growth through data analysis. However, it should be noted that data selection and analysis only constitute a part of the study. In order to fully comprehend the impact of pension insurance on economic growth, further research and analysis is warranted.

## 4.3. Results of empirical analysis

### 4.3.1. Stability Test

In this paper, the selected data were tested for smoothness using the ADF test, and the ADF statistical values of the variables were calculated and compared with the corresponding critical values according to the different significance levels set (1%, 5%, 10%). The test results are shown in Table 2.

**Table 2.** ADF test results

variable	ADF test value	ADF critical values at different significant levels			Test type (C, T, L)	Test result
		1%	5%	10%		
lnY	-0.4346	-4.3033	-3.4700	-3.2229	(C,T,1)	unsteady
$\Delta$ lnY	-7.73463	-3.6709	-2.9228	-2.6230	(C,0,0)	Smooth and steady
LnX1	-1.86779	-4.3037	-3.5261	-3.2214	(C,T,1)	unsteady
$\Delta$ lnX1	-2.76790	-3.6820	-2.9709	-2.6265	(C,0,1)	Smooth and steady
lnx2	-1.13244	-4.3259	-3.5223	-3.2200	(C,T,2)	unsteady
$\Delta$ lnx2	-3.04223	-3.6463	-2.9261	-2.6234	(C,0,1)	Smooth and steady
lnx3	-1.09382	-3.2912	-3.4433	-3.1129	(C,T,2)	unsteady
$\Delta$ lnx3	-4.20028	-2.3849	-2.4489	-2.8029	(C,0,0)	

According to the ADF test results presented in Table 2, the ADF statistics of  $\ln Y$  (log GDP),  $\ln x$  (log basic pension expenditure),  $\ln x_2$  (log human capital stock), and  $\ln x_g$  (log capital input) are -0.4346, -1.86779, -1.13244, and -1.09382, respectively. Compared with the corresponding critical values at the 1%, 5%, and 10% levels, these statistics are greater than the critical values. Therefore, based on the null hypothesis of the ADF test that the original time series data is non-stationary, we cannot reject this null hypothesis, namely,  $\ln Y$ ,  $\ln x$ ,  $\ln x_2$ , and  $\ln x_g$  are all non-stationary series. These results indicate that the selected variables have unit roots in their original forms, suggesting non-stationarity. In economic research, non-stationary series can cause a series of problems when modeling, inference, and prediction. Therefore, in further analysis, we need to difference these series or use other methods to handle non-stationarity to ensure the stability and

reliability of the data.

#### 4.3.2. Johansen cointegration test

Based on the aforementioned unit root tests, it has been determined that the selected variables involved in the study are all first-order integrated series, which satisfies the prerequisite conditions for cointegration testing. To investigate the existence of long-term dynamic effects between pension insurance and economic growth, specifically whether there is a long-term cointegration relationship between the dependent and independent variables, this study employs the Westerlund error correction panel cointegration test method to examine the panel data. The ECM panel cointegration test assumes the absence of cointegration relationship, and the results are documented in Table 3.

**Table 3.** Westland error correction panel cointegration test results

Panel Statistics	$\ln Y$	$\ln X_1$	$\ln X_2$	$\ln x_3$
Within-group t-value	1.505**	0.787**	1.082**	0.098**
Within-group a-value	0.455**	0.220**	0.810**	0.775**
Within group t-value	4.390**	0.882**	4.302**	2.392**
Panel a-value	0.280**	0.009**	0.332**	0.112**

According to the results shown in Table 3, all the data have rejected the null hypothesis, indicating that there exists a long-term cointegration relationship between the development of pension insurance and economic growth, and the regression residuals of the equation are stationary. Drawing upon Westland's research, once the variables pass the error correction panel cointegration test, regression analysis can be directly conducted. Based on the results of the cointegration test, we can conclude that there is a long-term stable relationship between pension insurance and economic growth. This implies that the development of pension insurance has a positive impact on economic growth. This conclusion contributes to a better understanding of China's

pension insurance system and provides a scientific basis for formulating relevant policies.

#### 4.3.3. Granger causality test results

In order to ascertain whether the development of old-age insurance is a cause of economic growth and to understand its impact on long-term economic growth, this study employed the Granger causality analysis method. By using Eviews 6.0 software for analysis, it was found that the data selected for this study exhibits good stability, and the lagged data of three periods is significant at the 5% level, making it suitable for conducting causality analysis. Table 4 presents the results of the Granger causality test obtained.

**Table 4.** Results of Granger causality test between pension insurance and economic growth

Original hypothesis	hysteresis order (math)	F-statistic	P
Basic pension insurance spending per capita is not a Granger cause of economic growth	3	3.4443	0.7211
Economic growth is not a Granger cause of basic pension expenditure per capita.	3	8.4644	0.0006
Basic pension insurance expenditure per capita is not a Granger cause of human capital stock of the labor force.	3	2.8984	0.0501
The Granger reason why the stock of human capital in the labor force is not the Granger reason why the basic pension insurance expenditure per capita is not the Granger reason.	3	0.5443	0.0012
Granger reason why basic old-age insurance expenditure per capita is not capital investment.	3	0.9412	0.7452
Granger reason why capital investment is not the basic pension insurance expenditure per capita.	3	0.8824	0.0557
The stock of human capital in the labor force is not a Granger cause of economic growth.	3	0.1239	0.0050
Economic growth is not a Granger cause of the stock of human capital in the labor force.	3	1.2039	0.6544
There is no Granger reason why the stock of human capital in the labor force is not a Granger reason for capital investment.	3	0.3925	0.3729
Capital input is not a Granger cause of the stock of human capital in the labor force population.	3	1.3344	0.2834
Granger reason why capital inputs are not the stock of human capital in the labor force.	3	1.3920	0.3340
Granger reason why economic growth is not capital input.	3	0.4320	0.1210

According to the Granger causality test results in Table 4, we can observe that per capita basic pension expenditure is a Granger cause for economic growth under a lag of three periods, with its p-value rejecting the null hypothesis at a significance level of 5%. Similarly, the labor force and human capital stock are also Granger causes for economic growth. Additionally, the data in Table 4 proves the existing theories that per capita basic pension expenditure is a Granger cause for the labor force and human capital stock. This indicates a complex and long-term interdependent relationship between pension insurance and economic growth. Variables associated with the development of pension insurance not only contribute to economic growth, but also benefit themselves through the positive momentum generated by economic growth.

These results highlight the significant impact of pension insurance development on economic growth, particularly in terms of enhancing capital input and improving the labor force and human capital stock. The development of pension insurance plays a crucial role in driving economic growth. These findings are of great significance in deepening our understanding of China's pension insurance system and providing a scientific basis for policy-making.

## 5. Conclusion

This paper aims to explore the long-term impact mechanism of pension insurance on economic growth and conduct empirical analysis, yielding some insightful conclusions. Specifically, the analysis focuses on the effects of pension insurance on savings release, human capital accumulation, and income distribution. The empirical results from the VAR model indicate that pension insurance plays a certain promoting role in economic growth. Therefore, it is recommended that the government strengthen proactive reforms and improvements in the pension insurance system, such as increasing contribution rates, refining pension adjustment mechanisms, expanding investment channels, and enhancing investment transparency. These measures aim to enhance the economic and social benefits of pension insurance. Additionally, the paper also acknowledges some shortcomings regarding data selection and model

assumptions, which call for more refined and technical improvements in future research. It is hoped that this paper can provide references for related studies and offer valuable ideas and suggestions for the reform of pension insurance system and the realization of economic growth in the future.

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