Hong Kong Research Institute of Humanities and Social Sciences

Journal of Economic Insights

Volume2, Issue1 ISSN 3078-5979 www.wisvora.com

Life Expectancy, Pension Replacement Rates, and Consumption among Chinese Enterprise Employees

Yuqing Han[1], Qingshan Ma[2]

[1] *School of Public Economics and Administration, Shanghai University of Finance and Economics*

[2] *School of Economics, Xiamen University*

Article Info

Accepted: 2025.04.12

Keywords:
Life Expectancy;
Pension Replacement Rate;
Consumption Behavior;
Enterprise Employees;
Life-Cycle Model

JEL Classification:
C61; D01; D91

DOI: 10.70693/jei.v2i1.799

Corresponding Author:
Qingshan Ma

Abstract

How do individuals adjust their savings and consumption behaviors in response to the combined effects of increased life expectancy and declining pension replacement rates? This study constructs a life-cycle model, using changes in conditional survival probabilities as a proxy for shifts in individual life expectancy, to examine consumption behavior under the dual backdrop of prolonged longevity and a gradual decline in pension replacement rates. The results suggest that changes in life expectancy and pension replacement rates together explain 8.9% to 10.2% of the observed decline in consumption in recent years, with both variables playing equally significant explanatory roles. Furthermore, we find that, to fully offset the negative impact of increased life expectancy on consumption, the pension replacement rate must reach at least 82%. These findings offer theoretical and policy implications for improving the quality of life in later years among enterprise employees in the context of population aging.

1. Introduction

The extension of average life expectancy is widely recognized as a fundamental driver of population aging, posing profound implications for social security systems, healthcare financing, and economic sustainability. In the context of China's rapid socio-economic development, the life expectancy of its population has undergone a remarkable transformation. From 1990 to 2019, the average life expectancy in China rose from 68.6 years to 77.3 years, marking an average annual increase of approximately 0.3 years. This steady upward trend reflects significant advancements in public health infrastructure, medical technology, disease prevention, and overall living standards. The broad-based improvements in health outcomes and material well-being have enabled a larger share of the population to benefit from the dividends of economic modernization. As China continues to experience demographic shifts driven by both declining fertility rates and increasing longevity, understanding the behavioral responses of individuals—particularly in terms of consumption and savings decisions—becomes critical for informing long-term policy planning and ensuring the financial sustainability of the pension and healthcare systems.

We argue that the fundamental driver behind the increase in life expectancy lies in the upward shift of conditional survival probabilities—that is, the probability of surviving to a certain age given survival up to a previous age. These probabilities not only serve as a more nuanced and accurate proxy for measuring changes in life expectancy, but also capture improvements in population health status over time. As illustrated in Figure 1, the conditional survival probabilities of urban residents in 2018 exceed those in 2014 primarily after the age of 60, with the divergence becoming increasingly pronounced beyond age 65. This indicates significant improvements in survivability at older ages. In contrast, the probabilities before age 60 remain relatively stable across the two years, suggesting that survival conditions among younger and middle-aged populations did not experience substantial changes during this period. Overall, the shift in conditional survival probabilities reflects notable improvements in later-life health outcomes, likely driven by advances in medical technology, expanded access to healthcare, and better chronic disease management. Therefore, the shift in conditional survival probabilities reflects more than just increased longevity—it also signals a structural transformation in the health profile of the population. These improvements provide not only empirical justification for using conditional survival probabilities as a proxy for life expectancy in our life-cycle model, but also underscore the relevance of incorporating longevity heterogeneity into the analysis of household consumption behavior, particularly among enterprise employees.

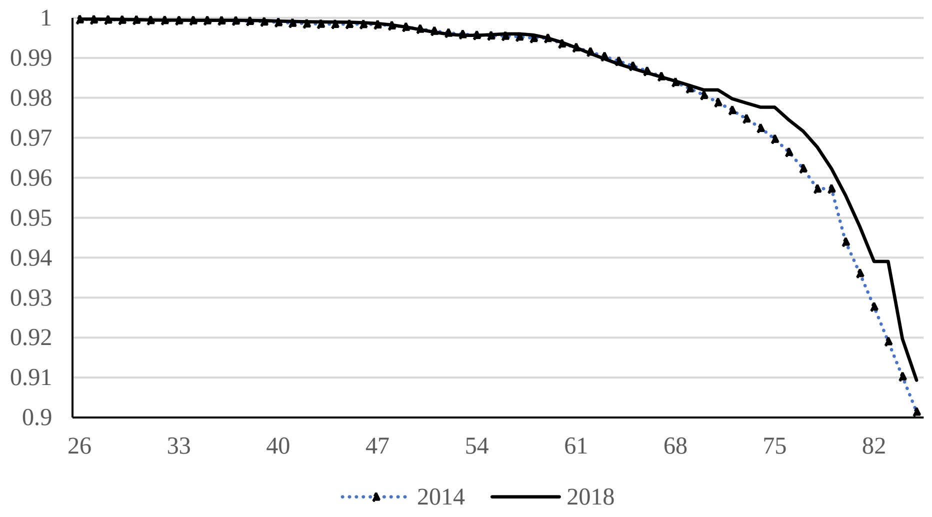

Figure 1. Conditional Survival Probabilities of Urban Residents in 2014 and 2018

Note: Values represent the probability of surviving to the next age, conditional on survival to the current age.

Pension systems play a vital role in securing the basic livelihood of the elderly and enhancing their overall well-being. In the context of rising life expectancy, the economic vulnerability of individuals in later life becomes increasingly pronounced, characterized by limited income sources and reduced self-protection capacity. This issue is particularly salient among enterprise employees, whose average pension replacement rate stood at only around 40% in

2018—significantly below internationally recommended thresholds. Based on estimates using average wage data released by the National Bureau of Statistics and average basic pension figures published by the Ministry of Human Resources and Social Security, the basic pension replacement rate has declined steadily since 2002. According to the World Bank, a minimum replacement rate of 70% is required to maintain pre-retirement living standards. The International Labor Organization also recommends a minimum threshold of 55%. However, China's current pension replacement rate for enterprise employees falls short of both benchmarks, highlighting the inadequacy of the existing system in meeting the basic needs of the elderly population. Moreover, individuals entering old age face a heightened risk of incurring substantial and uncertain medical expenses, which can further strain their financial resources. In the absence of robust social protection or alternative income streams, elderly individuals who encounter health shocks may be forced to curtail consumption to maintain basic subsistence, ultimately falling into old-age poverty—particularly in the form of "consumption poverty." Consequently, proactive planning of personal savings and material resources to smooth consumption over the life cycle becomes essential in addressing the challenges posed by population aging.

While existing literature has explored the effects of either life expectancy or pension policies on household behavior, few studies have examined their joint impact within a unified analytical framework. This study addresses this gap by developing a structural life-cycle model that simultaneously incorporates changes in conditional survival probabilities and pension replacement rates. In doing so, we not only quantify their separate and combined effects on consumption, but also offer a policy-relevant threshold for pension adequacy under rising longevity. This dual-focus approach constitutes a key contribution to the literature on aging and household finance.

2. Literature Review

This section reviews two main strands of literature: the first examines the impact of life expectancy on consumption, while the second focuses on the relationship between pensions—particularly pension replacement rates—and consumption behavior.

2.1 Life Expectancy and Consumption

Martin et al. (2001) argue that regardless of income or savings levels in early life, individuals tend to reduce consumption moderately in old age to smooth the decline in wealth or income. This behavioral pattern is closely associated with longevity risk, particularly the financial uncertainty linked to potentially high and unpredictable medical expenses later in life. Their findings highlight that consumption in old age is not solely driven by income constraints, but also by the need to preserve financial resources in anticipation of uncertain future liabilities.

Nardi et al. (2006) develop a structural life-cycle model incorporating stochastic medical expenditures and find that the rapid increase in medical costs with age plays a pivotal role in shaping elderly savings and consumption decisions. The model implies that even in the presence of moderate health shocks, forward-looking individuals will tend to save more and consume less to insure against the risk of extreme medical spending. Nardi et al. (2009) provide further empirical support for this mechanism, noting that for an unhealthy woman in the 80th percentile of permanent income, medical expenses can increase eighteen-fold between age 70 and 95—from $1,000 to $18,000 annually. This sharp rise demonstrates the heavy financial burden that aging can impose on individuals, especially those with chronic health conditions. Subsequent studies (Nardi et al., 2010; 2016; 2017) consistently emphasize the importance of health-related expenditure risk in explaining why elderly individuals, even those with considerable wealth, often retain significant savings deep into retirement. These findings challenge traditional life-cycle predictions of dissaving in old age and instead highlight a strong precautionary motive, driven largely by medical uncertainty. Yogo (2016) reinforces this perspective by demonstrating that, in the context of population aging, healthcare expenditures represent a non-discretionary component of elderly spending, which tends to crowd out other basic consumption needs. This suggests that aging not only reshapes consumption levels, but also alters its composition—potentially reducing expenditures on food, housing, and leisure.

In the Chinese context, Wu (2019) finds that individuals with higher subjective life expectancy—i.e., those who believe they will live longer—exhibit lower consumption levels, possibly due to a greater perceived need to maintain long-term living standards. This result offers micro-level support for the theoretical prediction that consumption behavior is sensitive to individual beliefs about longevity. It also highlights a potential behavioral channel through which expected lifespan may influence intertemporal choices.

Taken together, these studies underscore the significant role of life expectancy and medical expenditure uncertainty in shaping consumption behavior in old age. They also imply that as populations continue to age and longevity increases, policymakers should pay closer attention not only to income adequacy in retirement, but also to the mechanisms through which health-related risks influence household financial decisions.

2.2 Pension Replacement Rates and Consumption

Amid the accelerating pace of global population aging, the impact of pension systems on household consumption behavior has become a central topic of academic inquiry. A growing body of research, both theoretical and empirical, seeks to understand whether and how public pensions influence private saving decisions and intertemporal consumption allocation.

Feldstein (1974), within the life-cycle theoretical framework, emphasizes that the net effect of social security depends on two competing forces: the asset substitution effect, whereby pension wealth displaces private savings and raises consumption, and the induced retirement effect, which encourages earlier retirement, lengthening the retirement horizon and increasing the need for private savings. Using macro-level data from the United States, Feldstein estimates that, absent social security, the national capital stock would have been 30%-50% higher, highlighting the pension system's crowding-out effect on capital accumulation. Building on this, Kotlikoff (1989) underscores the heterogeneity of pension effects across age groups and income levels, arguing that the same policy reform may induce opposite behavioral responses depending on the timing of its implementation relative to the life cycle.

Empirical studies have further tested these theoretical propositions. For instance, Attanasio and Brugiavini (2003), exploiting the 1992 Italian pension reform, find that middle-aged individuals responded to expected pension cuts by increasing savings and reducing consumption, consistent with rational forward-looking behavior. Similarly, Attanasio and Rohwedder (2003) document a robust substitution effect between pension wealth and private savings in the UK, particularly among older individuals. Other studies have confirmed these dynamics using long-run time-series or panel data. Blake (2004), Bottazzi et al. (2006), and Engelhardt and Kumar (2011) all find that increases in pension entitlements lead to reduced precautionary saving and increased consumption, especially among risk-averse and liquidity-constrained households. However, Modigliani et al. (1981), analyzing 21 OECD countries from 1960 to 1970, report more ambiguous results, suggesting that the effect of pensions may be highly context-dependent, shaped by institutional design, benefit structure, and broader macroeconomic conditions.

Recent research also highlights the role of pension uncertainty and policy expectations in shaping household behavior. When future benefits are uncertain or reforms are anticipated, individuals may delay retirement, reduce current consumption, or increase saving in response to perceived instability. This is particularly relevant in systems undergoing transition, where trust in institutional guarantees is weak or replacement rates are declining. In this regard, pension policy operates not only as a fiscal transfer mechanism but also as a behavioral signal.

In China, the pension system presents unique features and challenges that make it a compelling case for empirical investigation. First, the dual-track system that historically favored public-sector employees has resulted in stark disparities in replacement rates and income security, especially when compared to enterprise workers. Second, while rural pensions have expanded rapidly, their benefit levels remain low and often insufficient for basic subsistence. Third, replacement rates for enterprise employees are generally below international standards and have been declining steadily, raising concerns about long-term adequacy. Within this institutional setting, Chinese scholars have explored the link between pension systems and consumption from multiple angles. From the perspective of pension access, Fang and Zhang (2013) find that pension-receiving households enjoy significantly higher consumption levels than those without, with the effects varying across income groups and between urban and rural areas. Yue et al. (2013), using rural survey data, show that participation in the New Rural Pension Scheme significantly boosts daily expenditures, and Zhang et al. (2014), applying multiple methods to CHARLS data, confirm this finding despite variation in estimated magnitude. He and Jiang (2015) report consistent results. From the lens of coverage and participation, Bai et al. (2012) show that expanded pension coverage promotes household consumption in urban areas, although higher contribution burdens exert a constraining effect. Zou et al. (2013) further note that rising participation rates are associated with increased spending on education, food-away-from-home, and alcohol and tobacco. Jiang and Quan (2018), using provincial panel data from 2002 to 2015, provide macro-level confirmation that pension coverage and contribution rates positively correlate with aggregate consumption.

Other studies focus on the generosity of pension benefits and replacement rates. He et al. (2008) uses institutional variation to show that pension wealth is a substitute for private savings, positively linked to household consumption. Xu and Zhao (2013), using counterfactual analysis and a simulated life-cycle model, demonstrate that China's dual-track pension system has led to considerable inequality in consumption between civil servants and enterprise workers. Their findings suggest that harmonizing replacement rates would raise enterprise workers' average life-cycle consumption by 4.84%. Similarly, Liu and Hang (2013) find that public-sector employees, benefiting from higher pension certainty, tend to hold significantly lower savings rates than their enterprise-sector counterparts. However, Li and Zhao (2015), using macro-level data, suggest that replacement rates may not exert a significant influence on total consumption, and that other factors such as income growth and demographic structure may play more dominant roles. More recent empirical efforts have employed quasi-experimental strategies and causal identification methods. Zou and Shen (2018), using CHFS data and propensity score matching (PSM), find that pension participation has a statistically significant positive impact on household consumption. Similarly, Cao and Zhou (2021), exploiting the policy-driven increase in pension benefits for enterprise retirees, apply a difference-in-differences framework to show that pension hikes lead to sizable improvements in annual per capita consumption among recipient households. Despite these advances, notable research gaps remain. Much of the literature treats pensions and life expectancy as separate determinants of consumption, with few studies exploring their joint effects—especially in the context of rapidly rising longevity. Most empirical studies rely on static indicators of pension coverage or receipt and do not fully account for heterogeneity in replacement rates, which may matter substantially for financial planning and consumption smoothing. Moreover, the behavioral responses of enterprise employees, a group particularly vulnerable to declining replacement rates and longevity risk, remain underexplored. Addressing these gaps, the present study constructs a life-cycle model that incorporates conditional survival probabilities as a proxy for changes in life expectancy and interacts this with pension replacement rates to examine their combined effect on consumption behavior. This approach allows us to capture both the income-side and expectation-side dynamics of retirement planning and provides new evidence on how households adapt their financial decisions under the dual pressures of longer lifespans and diminishing public pension support.

The remainder of this paper is structured as follows. Section 3 presents the theoretical life-cycle model. Section 4 describes the data sources, variable construction, and empirical methodology. Section 5 reports the estimation results and counterfactual analysis. Section 6 concludes with a summary of findings and policy implications.

3. Life Cycle model

Following the framework of Palumbo (1999), we begin by analyzing individual behavior starting from age 25, denoted as period 1 ($t = 1$), with the maximum lifespan assumed to extend to age 100, yielding a total of 76 periods ($T = 76$). Each individual retires at age $T_w = 36$ (age 60), and faces both income uncertainty and medical expenditure risk throughout the life cycle.

The individual's objective is to maximize lifetime utility derived from consumption and potential bequests. The utility maximization problem is given by:

$$\max_{\{C_t\}}\left\{u(C_t) + E_t\left[\sum_{j=t+1}^{T} \beta^{j-t} \prod_{i=t}^{j-1} s_i\left[s_j u(C_j) + (1-s_j)B(W_j)\right]\right]\right\} \tag{1}$$

where C_t denotes consumption at time t, $u(C_t)$ is the utility derived from consumption, β is the subjective discount factor, and s_j represents the probability of surviving from period $j-1$ to j, $j = 2, 3, \cdots, 77$. The function $B(W_j)$ captures the utility from bequests, which depends on wealth W_j.

The individual's intertemporal budget constraint is:

$$W_{t+1} = (1 + r) \cdot (W_t - C_t - M_t) + Y_{t+1}, \quad \forall t \tag{2}$$

where W_t is wealth at time t, r is the interest rate, M_t denotes medical expenses, and Y_{t+1} is income in period $t+1$.

Pre-retirement income is modeled as:

$$Y_t = U_t \cdot P_t \tag{3}$$
$$P_t = G_{t+1} P_{t-1} \cdot N_{t+1} \tag{4}$$

where P_t is permanent income, G_{t+1} is the growth rate of permanent income, U_t and N_t represent transitory and persistent income shocks, respectively, with $lnU = N(0, \sigma_u^2)$ and $lnN = N(0, \sigma_n^2)$。

Post-retirement income is given by:

$$Y_t = \lambda \cdot Y_{T_w} \quad t = T_w, \dots, T \tag{5}$$

where λ is the pension replacement rate, representing the proportion of an individual's pension relative to their wage income in the retirement year.

Medical expenditure follows the stochastic process:

$$lnM_{it} = \varphi\left(X_t^{med}\right) + \xi_{it} \tag{6}$$

where X_t^{med} is a vector of covariates including age, age squared, age cubed, the logarithm of household annual income, its square, household size, and other relevant demographic characteristics. The term $\varphi\left(X_t^{med}\right)$ represents the deterministic component, while the residual ξ_{it} is decomposed as:

$$\xi_{it} = \eta_{it} + f_i \tag{7}$$
$$\eta_{it} = \mu \eta_{i,t-1} + \zeta_{it} \tag{8}$$

where $\eta_{it} \sim N(0, {\sigma_\eta}^2)$ follows a stationary AR (1) process, $f_i \sim N(0, {\sigma_f}^2)$, and $|\mu| < 1$.

The utility function is assumed to take the constant relative risk aversion (CRRA) form: $u(C_t) = \frac{{C_t}^{1-\rho}}{1-\rho}$. To account for the possibility that the utility derived from bequests differs from that of consumption, we specify the bequest utility function as follows: $B(W_t) = \theta \cdot \frac{(W_t + \kappa \cdot P_t)^{1-\rho}}{1-\rho}$, where θ captures the strength of the bequest motive, and κ governs the curvature of the utility from bequests.

The Euler equation associated with the individual's dynamic optimization problem is given in its general form as:

$$\mathrm{u_t(C_t)' = \beta \cdot (1 + r) \cdot E_t\left[s_{t+1} \cdot u_{t+1}(C_{t+1})' + (1\text{-}s_{t+1}) B(W_{t+1})'\right]} \tag{9}$$

Under the assumption of CRRA preferences and the specified bequest utility function, the Euler equation becomes:

$$\mathrm{{C_t}^{-\rho}(w_t) = \beta \cdot (1 + r) \cdot E_t\left[s_{t+1} \cdot {C_{t+1}}^{-\rho}(w_{t+1}) + (1\text{-}s_{t+1}) \cdot \theta \cdot (W_{t+1} + \kappa \cdot P_{t+1})^{-\rho}\right]} \tag{10}$$

Normalizing all variables by permanent income and letting lowercase letters denote normalized variables, we obtain the normalized budget constraint:

$$w_{t+1} = (1+r) \cdot (w_t - c_t - m_t)/(G_{t+1}N_{t+1}) + U_{t+1} \tag{11}$$

Substituting this into the Euler equation yields:

$$c_t^{-\rho}(w_t) = \beta \cdot (1+r) \cdot E_t\left\{s_{t+1}\left[c_{t+1}\left(\frac{(1+r)(w_t - c_t - m_t)}{(G_{t+1}N_{t+1})} + U_{t+1}\right) \cdot G_{t+1}N_{t+1}\right]^{-\rho}\right\}$$
$$+\beta \cdot (1+r) \cdot E_t\left\{(1-s_{t+1})\theta\left[\left(\frac{(1+r)(w_t-c_t-m_t)}{G_{t+1}N_{t+1}} + U_{t+1} + \kappa\right) \cdot G_{t+1}N_{t+1}\right]^{-\rho}\right\} \tag{12}$$

The terminal-period Euler condition under CRRA preferences is given by:

$$c_T^{-\rho}(w_T) = \beta \cdot (1+r) \cdot \theta \cdot [(1+r)(w_T - c_T - m_T) + \kappa]^{-\rho} \tag{13}$$

Solving for $c_T(w_T)$, the terminal consumption function takes the explicit form:

$$c_T(w_T) = \frac{(1+r)\cdot[\beta(1+r)\theta]^{-1/\rho}}{1+(1+r)\cdot[\beta(1+r)\theta]^{-1/\rho}}(w_T - m_T + \kappa) \tag{14}$$

This expression implies that, conditional on wealth and medical expenditures, stronger bequest motives (i.e., a larger θ) result in lower terminal consumption, consistent with the findings of Xu and Zhao (2013).

Since the model does not yield a closed-form solution, we solve the individual's dynamic optimization problem numerically using backward induction. The endogenous grid method proposed by Carroll (2006) is employed to compute the consumption function $\{c_t(w_t)\}$ over the life cycle.

4. Data, Variables and Research Methodology

4.1 Data and variables

The data used in this study are mainly from the Chinese Family Panel Studies (CFPS) (2014, 2016, and 2018).[1] Organized by the Social Science Survey Center of Peking University, the CFPS is a nationwide, comprehensive social tracking survey program that aims to reflect China's social, economic, demographic, education, and health by tracking and collecting data at three levels: individual, household, and community. It aims to reflect the social, economic, demographic, educational and health changes in China by tracking and collecting data at the individual, household and community levels. In this paper, we use variables such as age, education level, residence, gender, annual personal income, medical expenditure, and household size. The specific construction of each variable is as follows.

[1] Chinese Family Panel Studies (CFPS). Institute of Social Science Survey, Peking University. http://www.isss.pku.edu.cn/cfps/.

Table 1. Descriptive Statistics of Variables

Variables	Min	Max	Mean	Standard Deviation
Age (Years Old)	25	95	51.15	13.45
Personal Income (RMB)	0	1005530.00	10925.68	24407.44
Medical expenditure (RMB)	0	484669.50	2426.47	9754.70
Household Size (People)	1	21	4.21	1.96

Variables	Category	Proportion	Variables	Category	Proportion
Gender	Male (1)	49.15%	Education Level	Illiterate	28.58%
	Female (0)	50.85%		Primary School	23.06%
Residence	Urban (1)	47.10%		Middle School	28.22%
	Rural (0)	52.90%		High School	12.73%
				College and above	7.41%

Note: Monetary values for personal income and medical expenditure are in 2014 RMB yuan, adjusted using Consumer Price Index (CPI) for comparability across years.

Age: Samples younger than 25 years old were excluded. Education level: Education levels were categorized into five groups: “Illiterate” “Primary School” “Middle School” “High School” and “College and Above.” Specifically, respondents classified as “Illiterate/Semi-illiterate” and those who “Never Attended School” were grouped into the “Illiterate” category. “Primary School” remained as a separate category. “Middle School” was categorized accordingly. “High School” “Technical Secondary School” “Technical School” and “Vocational High School” were grouped under “High School.” “College” “Undergraduate” “Master’s” and “Doctorate” degrees were combined into the “College and Above” category. Residence: The residential location was classified into two categories: urban and rural, where 0 represents rural residence and 1 represents urban residence. Gender: 0 represents female, and 1 represents male. Personal annual income: The natural logarithm of personal annual income was used. For samples with zero income, the log-transformed income was adjusted to zero. Medical expenditure: The natural logarithm of medical expenditure was used. For samples with zero medical expenditure, the log-transformed value was adjusted to zero. Household size: The total number of household members who share meals together. The final sample consists of 52,521 observations. Table 1 presents the descriptive statistics of the variables.

4.2 Estimation Strategy

We estimate the parameters of the life-cycle model in two stages.

Step 1: Estimation and Calibration of Auxiliary Parameters.

We begin by constructing conditional survival probabilities $\{s_t\}$ based on age-specific cause-of-death data. Specifically, we use age-specific mortality rates by disease category from the 2014 edition of the *China Health and Family Planning Statistical Yearbook* (for urban residents in 2014), and from the 2019 edition for the year 2018. Following standard practice, we use cubic spline interpolation to obtain smooth estimates of survival probabilities from age 25 onward. The probability of surviving from age 100 to 101 is assumed to be zero.

The annual interest rate r is set at 1.5%, based on the one-year fixed deposit rate announced by the People's Bank of China in October 2015.

Pension replacement rates λ are taken from official reports. For 2018, we use a value of 42.9%, based on International Social Security Review: Social Security under Active Aging Strategies. For 2014, we adopt a replacement rate of 66%, as reported in the China Social Insurance Development Annual Report 2014.

To estimate income and medical expenditure processes, we employ OLS regressions. The income process is modeled as:

$$lnY_{it} = X_{it}\beta + u_{it} \tag{15}$$

where Y_{it} is individual income, X_{it} is a vector of covariates including gender, age, age squared, age cubed, education level, urban/rural residence, and household size. The model is estimated using pooled data from the 2014, 2016, and 2018 waves of the China Family Panel Studies. The variance and autocovariances of the residual u_{it} are used to identify income process parameters $\zeta = \{\sigma_u^2, \sigma_u^2\}$ via the minimum distance estimation method. The growth rate of permanent income $\{G_t\}_{t=1}^{T}$ is estimated using the following relationship:

$$\frac{1}{I}\sum_{i=1}^{I} lnY_{it} - \frac{1}{I}\sum_{i=1}^{I} lnY_{i,t-1} = lnG_t \tag{16}$$

where I is the sample size and Y_{it} is observed income, allowing direct computation of G_t over time.

To estimate the deterministic component of the medical expenditure process specified in equation (6), we perform an OLS regression of the logarithm of medical spending on a set of covariates. The variance-covariance structure of the residual ξ_{it} is used to estimate the stochastic component $\theta = (\sigma_f^2, \sigma_\eta^2, \rho)$ using minimum distance estimation, following the approach of French (2004). In this framework, $\xi_{it} = \eta_{it} + f_i$, where η_{it} follows a stationary AR (1) process: $\eta_{it} = \mu\eta_{i,t-1} + \zeta_{it}$.

Let $m_{t,t+k}(\theta)$ denote the theoretical covariance between residuals in period t and $t+k$, with:

$$\begin{cases} m_{t,t}(\theta) = var(\xi_{it}) = \sigma_f^2 + \sigma_\eta^2 \\ m_{t,t+k}(\theta) = cov(\xi_{it}, \xi_{it+k}) = \sigma_f^2 + \mu^k\sigma_\eta^2 \end{cases} \tag{17}$$

Define $m(\theta)$ as the vector of empirical covariances, and the minimum distance estimator is given by:

$$\hat{\theta} = argmin\{m(\theta)' \cdot W \cdot m(\theta)\} \tag{18}$$

where W is a weighting matrix. Following Altonji and Segal (1996), we use the identity matrix as the weighting matrix to account for small-sample bias.

Step 2: Calibration of Preference Parameters.

In the second step, we calibrate the key structural parameters $\chi = \{\rho, \theta, \beta, \kappa\}$ under two alternative specifications of the conditional survival probability s (i.e., for 2014 and 2018). These parameters govern the curvature of utility, the strength of the bequest motive, the discount factor, and the curvature of the bequest function, respectively.

5. Estimation Results and Analysis

5.1 Estimation Outcomes

The conditional survival probabilities $\{s_t\}$ are constructed using data from the 2017 China Health and Family Planning Statistical Yearbook, which reports age-specific mortality rates by cause of death, disaggregated by gender and place of residence. The dataset covers a comprehensive set of causes of death, including chronic diseases as well as accidental causes such as falls, fires, drowning, and suicide. Using cubic spline interpolation, we estimate smooth conditional survival probabilities from age 25 to 100. It is assumed that the probability of surviving from age 100 to 101 is zero, meaning that individuals exit the model no later than age 100.

Figure 2 illustrates the conditional survival probabilities for four demographic groups: urban males, urban females, rural males, and rural females. Several patterns emerge. First, at nearly all ages, women exhibit higher survival probabilities than men, consistent with observed longevity patterns in China. Second, individuals residing in urban areas show higher survival probabilities than their rural counterparts, particularly at older ages. This urban-rural gap becomes more pronounced after age 70, likely reflecting differences in healthcare access, living conditions, and exposure to health risks. Lastly, the curves reveal that survival probabilities remain relatively stable during early and middle adulthood but decline rapidly after age 75 across all groups.

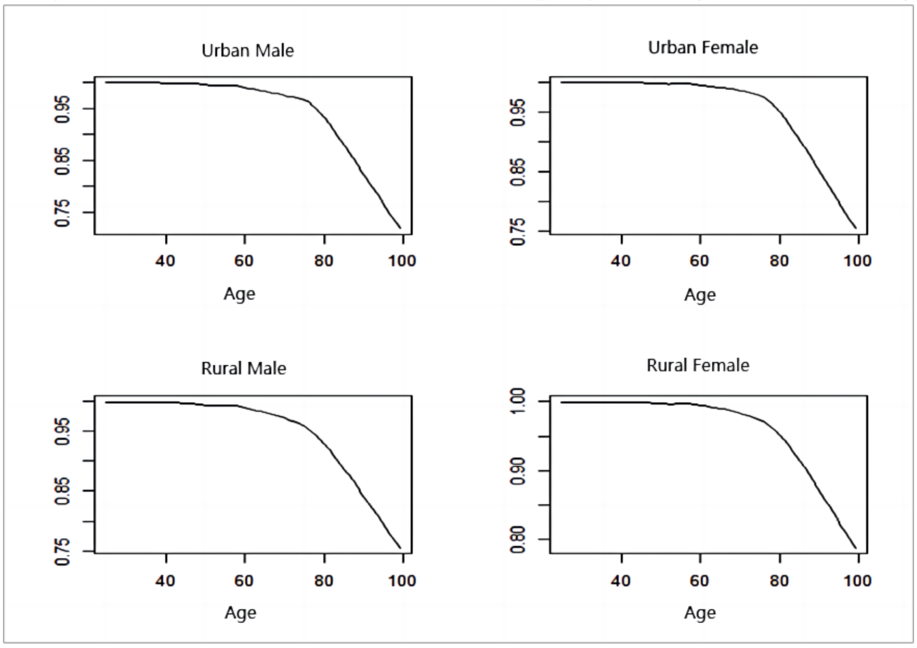

Figure 2. Conditional Survival Probabilities by Gender and Residence

Note: Values represent the probability of surviving to the next age, conditional on survival to the current age.

These patterns suggest substantial heterogeneity in expected longevity across both gender and residential status. This heterogeneity underscores the need to incorporate differentiated survival profiles in life-cycle models when analyzing household consumption and saving behavior, particularly in the context of pension adequacy and elderly welfare.

The interest rate r is set to 1.5%, corresponding to the one-year fixed deposit rate published in October 2015 by the People's Bank of China. Following the approach of Cooper and Ejarque

(2003), the subjective discount factor is calibrated as $\beta = \frac{1}{1+r}$.

Table 2. OLS Estimation Results

Variables		Deterministic Component of Income	Deterministic Component of Medical Expenditure
Age		0.311***(0.055)	-0.251***(0.042)
Age squared		-0.007***(0.001)	0.006***(0.001)
Age cubed		0.000***(0.000)	-0.000***(0.000)
Gender (reference: Female)		1.181***(0.040)	-0.703***(0.031)
Place of Residence (reference: Rural)		1.734***(0.042)	-0.160***(0.033)
Education Level (reference: Illiterate)	Primary School	0.635***(0.057)	-0.253***(0.044)
	Junior High School	1.233***(0.057)	-0.451***(0.043)
	Senior High School	2.117***(0.072)	-0.398***(0.055)
	College or above	4.405***(0.090)	-0.022(0.072)
Log of Income		——	-0.060***(0.021)
Square of Log Income		——	0.004*(0.002)
Household Size		——	-0.000(0.008)

Note: Standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

We then estimate the income and medical expenditure processes using ordinary least squares (OLS). Table 2 presents the estimation results: Column (2) reports the OLS regression of the logarithm of income on relevant covariates, and Column (3) reports the corresponding regression for the logarithm of medical expenditures.

Table 2 summarizes the OLS estimation results for the deterministic components of income and medical expenditures. These regressions serve as empirical foundations for parameterizing the life-cycle model.

The relationship between age and both income and medical spending is modeled as a flexible nonlinear function that includes age, age squared, and age cubed. The income regression results indicate a non-monotonic relationship: holding other factors constant, income increases with age between 25 and 29, then gradually declines between ages 30 and 71, before increasing again slightly after age 71. This pattern suggests that labor market earnings peak early in life and decrease as individuals approach and move beyond retirement age.[2]

In contrast, the medical expenditure regression reveals a distinct age profile. Conditional on other covariates, medical expenditures decrease between ages 25 and 28, reaching a minimum at age 29. From ages 29 to 75, medical costs rise steadily with age, peaking at age 75, after which they begin to decline. This U-shaped trajectory highlights the importance of age-related health risk in shaping consumption needs in late life.[3] The results also reveal a nonlinear association between income and medical spending. Specifically, holding other variables constant, medical expenditures decline with rising income when income is below 3,005 RMB per month, but

[2] The turning point of the income–age relationship is calculated using the formula $\frac{2\times 0.007 \pm \sqrt{(2\times 0.007)^2 - 4\times 0.311\times 3\times 0.000}}{2\times 3\times 0.000}$, where the coefficients are based on regression estimates rounded to nine decimal places.

[3] The turning point of the age–medical expenditure function is calculated using the formula $\frac{-2\times 0.006 \pm \sqrt{(2\times 0.006)^2 - 4\times 0.251\times 3\times 0.000}}{-2\times 3\times 0.000}$, where the coefficients are derived from regression estimates rounded to nine decimal places.

increase with income once this threshold is exceeded. This pattern implies that while low-income individuals may defer or avoid medical care due to financial constraints, higher-income households may consume more healthcare services, either due to greater affordability or different preferences.[4]

Gender is statistically significant in both models. Compared to females, males tend to have higher incomes but lower medical expenditures. These differences may reflect structural disparities in labor market participation, health behavior, and patterns of healthcare utilization. Urban residents earn more than their rural counterparts and also exhibit slightly higher medical expenditures, which may be attributed to differences in access to medical services or cost-of-living variations between urban and rural areas. Educational attainment shows a clear positive association with income: individuals with higher levels of education tend to earn more than those with lower levels of schooling. In contrast, education is negatively associated with medical expenditures, potentially reflecting better health awareness, preventive behavior, or improved access to employer-sponsored insurance among more educated individuals. Finally, household size is negatively associated with medical spending, suggesting potential intra-household risk pooling or fixed-cost sharing effects in health care consumption.

While these regression results are not the core focus of the paper, they play a crucial role in capturing realistic earnings and expenditure profiles across the life cycle, and thus ensure that the simulations reflect key demographic and socioeconomic heterogeneity.

The estimation results for the AR (1) process of medical expenditures are presented in Table 3.

Table 3. Estimation Results for the AR (1) Process of Medical Expenditures

Parameter	Estimated Value
σ_f	1.469*** (0.012)
σ_η	1.183***(0.054)
μ	0.646***(0.053)

Note: Standard errors are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Based on the AR (1) estimation results, the covariance of the stochastic component of medical expenditures between period t and $t+1$ is 3.062, and the corresponding correlation coefficient is 0.861. This indicates a strong positive linear relationship in the idiosyncratic component of medical spending across adjacent periods.[5] In other words, if an individual's medical expenditure in period t exceeds the predicted deterministic component, it is highly likely that their expenditure in period $t+1$ will also remain above the corresponding deterministic level.

[4] The turning point of the income–medical expenditure function is calculated using the formula $exp(\frac{0.060}{2\times0.004})$, where the coefficients are derived from regression estimates rounded to nine decimal places.

[5] The covariance is calculated as: $1.469^2 + 0.646 \times 1.183^2$; The correlation coefficient is calculated as: $\frac{1.469^2+0.646\times1.183^2}{1.469^2+1.183^2}$.

Table 4. Parameter Calibration

Parameter	Estimated Value	
	2014	2018
ρ	1.776	0.939
$\theta \times 10^4$	4.451	4.451
β	0.942	0.954
κ	212.7	212.7

In calibrating the preference parameter vector $\chi = \{\rho, \theta, \beta, \kappa\}$, we refer to the parameter values used in Xu and Zhao (2013) for the 2014 specification and to those in Yang and Zou (2021) for the 2018 specification. It is worth noting that the parameters θ and κ, which govern the utility derived from bequests, are assumed to remain constant over time.

5.2 Analysis of Results

In the model, using conditional survival probabilities from 2014 corresponds to the expected remaining lifetime of individuals aged 25 in that year. Similarly, adopting 2018 probabilities reflects the extended life expectancy of 25-year-olds in 2018. These survival probabilities are introduced into the life-cycle framework to simulate consumption trajectories, which are then compared to observed data.

Figure 3 presents the comparison between simulated and actual consumption patterns. The model achieves a strong fit when using the 2018 survival probabilities and updated parameters, suggesting its empirical validity and capacity to capture realistic household behavior under changing demographic conditions.

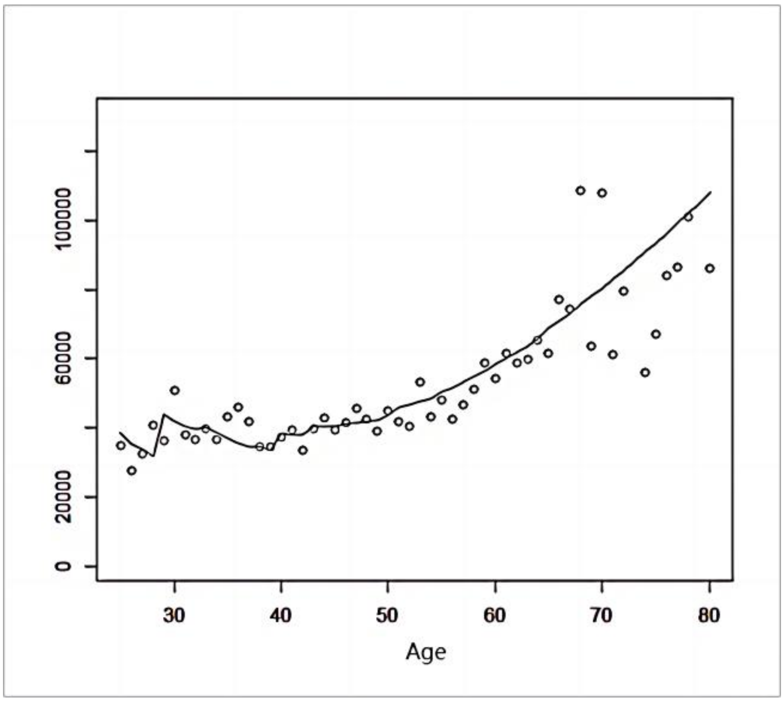

Figure 3. Simulated Consumption vs. Actual Consumption

Note: Consumption values are normalized to 2014 levels and expressed in relative terms (percent change).

When holding all other parameters constant, simulations reveal that under the 2018 survival probabilities—i.e., when expected longevity increases—household consumption declines by 3.1% to 5.6% relative to the 2014 benchmark. This result suggests a clear precautionary adjustment: as individuals anticipate longer life spans, they tend to reduce current consumption in favor of greater savings to ensure financial sufficiency in old age. The finding is consistent with the predictions of standard life-cycle theory with longevity risk and underscores the behavioral importance of forward-looking expectations in consumption smoothing.

Beyond the isolated effect of longevity, we further analyze the joint impact of increasing life expectancy and declining pension replacement rates—a stylized fact of China's ongoing pension reform. Specifically, we use a replacement rate of 66% for 2014 and 42.9% for 2018. The combined effect of longer life expectancy and lower pension benefits results in 8.9–10.2% decline in consumption. This magnitude is economically significant, suggesting that both demographic and institutional changes jointly contribute to household consumption decline, and neither factor should be analyzed in isolation.

It is important to note that this dual-channel explanation reflects two distinct mechanisms: life expectancy affects the perceived time horizon for consumption planning, while replacement rates directly affect retirement-period income. The fact that both channels produce comparable quantitative effects suggests they are equally important in understanding recent shifts in consumption behavior, particularly among enterprise employees facing tightening pension generosity.

To explore policy implications, we conduct a counterfactual simulation to determine what replacement rate would be required to fully neutralize the consumption-depressing effect of increased longevity. Results show that the replacement rate must be raised to approximately 82% to maintain the same consumption level as under the 2014 survival profile. This threshold provides a clear quantitative benchmark: without additional pension reform or policy adjustments, rising longevity may continue to exert downward pressure on consumption and elderly welfare.

These findings contribute to the broader literature on demographic transitions and consumption behavior, and highlight the need for integrated reform strategies that consider both the extension of life expectancy and the sustainability of pension systems. For policymakers, the implication is clear: improving pension adequacy may be crucial not only for securing old-age income, but also for stabilizing aggregate demand in an aging economy.

6. Conclusion and Policy Implications

This study develops a structural life-cycle model to examine how expected longevity and declining pension replacement rates jointly influence the consumption behavior of enterprise employees in China. By calibrating the model with empirically grounded parameters and simulating counterfactual scenarios, we show that longer life expectancy induces individuals to reduce current consumption in anticipation of a prolonged retirement period. The decline in pension replacement rates further intensifies this behavioral response by lowering expectations for post-retirement income. When both demographic and institutional shifts occur simultaneously, the contraction in consumption becomes more pronounced. Our counterfactual analysis suggests that, in order to fully offset the consumption-depressing effects of increased longevity, the pension replacement rate would need to rise to approximately 82%. This quantitative threshold enhances the policy relevance of our framework and provides a concrete reference point for evaluating future pension reforms.

The value of this research lies in its novel integration of conditional survival probability dynamics into a life-cycle model specifically tailored to the Chinese institutional context. By jointly analyzing the effects of demographic expectations and pension policy adjustments, this study contributes to a more comprehensive understanding of household consumption decisions under aging pressure, and complements existing literature that has typically treated these two forces in isolation.

From a policy perspective, our findings carry important implications for China’s dual challenges of pension system reform and domestic demand stabilization. The observed decline in household consumption under longer life expectancy and lower pension replacement rates highlights the urgency of strengthening the retirement income system, especially for enterprise employees who face greater uncertainty regarding future benefits.

First, enhancing the adequacy, transparency, and intergenerational fairness of the basic pension system is essential. Given that lower replacement rates can lead to long-term underconsumption, policymakers should consider gradually increasing the generosity of the first pillar pension for enterprise employees while ensuring actuarial sustainability. Moreover, narrowing the disparity between public-sector and private-sector pension coverage would reduce behavioral uncertainty and support a more equitable income distribution among retirees.

Second, addressing behavioral responses to longevity risk requires more than institutional reform—it also demands improvements in individual planning capacity. Public education campaigns should promote awareness of life-cycle financial planning, longevity risk, and the need for early retirement preparation. Financial literacy programs can help individuals make informed decisions about saving, consumption, and insurance purchases, reducing the likelihood of over-saving or excessive caution in consumption.

Third, expanding access to diversified and flexible retirement financing instruments is crucial in a rapidly aging society. Policymakers should accelerate the development of personal pension accounts, occupational pension plans, and commercial annuities, and ensure these products are accessible, portable, and trustworthy. A broader menu of risk-pooling and wealth management tools would improve households' financial resilience in later life and reduce the pressure on public pensions.

Finally, our findings suggest that longevity expectations must be treated as a forward-looking policy variable. As conditional survival probabilities improve, pension benefit formulas and retirement age policies should be regularly reassessed to ensure alignment between working life, expected lifespan, and benefit duration. Coordinating these adjustments with wage policy, health insurance coverage, and long-term care provision will be critical for achieving a holistic and sustainable aging strategy.

In sum, this study provides a theoretically grounded and empirically calibrated framework for understanding the evolving consumption patterns of Chinese households amid demographic transition. It offers timely and actionable insights for designing integrated policy responses that support both individual welfare and macroeconomic stability in an aging society.

References

[1] Altonji, J. G., Segal, L. M. (1996). Small-Sample Bias in GMM Estimation of Covariance

Structures. Journal of Business & Economic Statistics. 14(3), 353-366.
[2] Attanasio, O. P., Brugiavini, A. (2003). Social Security and Household Saving. The Quarterly Journal of Economics. 1075-1118.
[3] Attanasio, O. P., Rohwedder, S. (2003). Pension Wealth and Household Saving: Evidence from Pension Reforms in the United Kindom. The American economic review. 93(5), 1499-1521.
[4] Bai, C., Li, H., Wu, B. (2012). Health Insurance and Consumption: Evidence from China's New Rural Cooperative Medical Scheme, Economic Research Journal. (2), 41-53.
[5] Blake, D. (2004). The Impact of Wealth on Consumption and Retirement Behavior in the UK, Applied economics. 14(8), 555-576.
[6] Bottazzi, R., Jappelli, T., Padula, M. (2006). Retirement Expectations, Pension Reforms, and Their Impact on Private Wealth Accumulation. Journal of Public Economics. 90(12), 2187-2212.
[7] Cao, R., Zhou, Y. (2021). How Does Continuous Pension Adjustment Affect Consumption of Enterprise Retirees? Consumer Economics. 37(1), 15-26.
[8] Carroll, C. D. (2006) The Method of Endogenous Gridpoints for Solving Dynamic Stochastic Optimization Problems. Economics Letters. (91), 312-320.
[9] Cooper, R., Ejarque, J. (2003). Financial Frication and Investment: Requiem in Q. Review of Economics Dynamics. 6(4), 710-728.
[10] Engelhardt, G. V., Kumar, A. (2011). Pensions and Household Wealth Accumulation. Journal of Human Resources. 46(1), 203-236.
[11] Fang, K., Zhang, Z. (2013). The Impact of Social Security on Urban and Rural Household Consumption. Statistical Research. 30(3), 51-58.
[12] Feldstein, M. (1974). Social Security, Induced Retirement, and Aggregate Capital Accumulation. Journal of Political Economy. 82(5), 905-926.
[13] He, L., Feng, J., Sato, H. (2008). The Impact of Pension Reform on Household Savings Rate: Empirical Evidence from China. Economic Research Journal. 43(10), 117-130.
[14] He, L., Jiang, Z. (2015). The Consumption-Promoting Effect of the New Rural Pension Scheme: Analysis Based on CHARLS Data. Population & Economics. (1), 116-125.
[15] Jiang, Y., Quan, M. (2018). China's Population Structure, Pension Insurance, and Household Consumption. Economic Survey. 35(1), 131-137.
[16] Kotlikoff, L. J. (1989). Health Expenditures and Precautionary Savings, What Determines Savings. Commonwealth of Massachusetts: MIT Press. 50-92.
[17] Li, Z., Zhao, Q. (2015). Does China's Urban Pension System Crowd-In Household Consumption? Evidence from Time-Series and Panel Data. Journal of Public Management. 12(4), 102-110+158.
[18] Liu, W., Hang, B. (2013). A Study on Savings Behavior of Urban Residents in China Under Population Aging. Statistical Research. 30(12), 77-82.
[19] Martin, B., Thomas, F. C. (2001). The Life-Cycle Model of Consumption and Saving. Journal of Economic Perspectives. 15(3), 3-22.
[20] Nardi, D. et al. (2006). Differential Mortality, Uncertain Medical Expenses, and the Saving of Elderly Singles. National Bureau of Economic Research Working Paper. NO. 12554.
[21] Nardi, M. D., Fella, G. (2017). Saving and Wealth Inequality. Review of Economic Dynamics. (26), 280-300.
[22] Nardi, M. D., French, E., Jones, J. B. (2009). Life Expectancy and Old Age Savings. American Economic Review. 99(2), 110-115.
[23] Nardi, M. D., French, E., Jones, J. B. (2016). Savings After Retirement: A Survey. Chicago Fed Letter. 356.

[24] Nardi, M. D., French, E., Jones, J. B. (2010). Why Do the Elderly Save? The Role of Medical Expenses. Journal of Political Economy. 118(1), 39-75.
[25] Palumbo, M. G. (1999). Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle. Review of Economic Studies. (66), 395-421.
[26] Wu, M. (2019). Subjective Life Expectancy and Consumption Behavior of Chinese Elderly. Aging Science Research. 7(7), 50-60.
[27] Xu, S., Zhao, S. (2013). The Impact of the "Dual-Track" Pension System on Urban Residents' Life-Cycle Consumption Disparity, Economic Research Journal. (1), 83-98.
[28] Yogo, M. (2016). Portfolio choice in retirement: Health risk and the demand for annuities, housing, and risky assets. Journal of Monetary Economics. 80(C), 17-34.
[29] Yue, A., et al. (2013). The Effect of the New Rural Social Pension Insurance on Household Daily Expenditure. Management World. (8), 101-108.
[30] Zhang, C., John, G., Zhao, Y. (2015). Evaluating the Policy Effects of the New Rural Social Pension Insurance: Income, Poverty, Consumption, Subjective Well-being, and Labor Supply. China Economic Quarterly. 14(1), 203-230.
[31] Zou H., et al. (2013). The Impact of Pension and Medical Insurance on Urban Household Consumption. Statistical Research. 30(11), 60-67.
[32] Zou H., Shen P. (2018). The Impact of Pension Systems on Household Consumption: New Evidence from CHFS Survey Data. Consumer Economics. 34(3), 29-34.