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Smooth Consumption and Life Cycle Consumption Theory: Evidence from the United States and Implications for China

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Abstract This paper explores the path to achieve sustainable economic growth through the lens of Life cycle consumption theory, emphasizing the importance of smooth consumption patterns. The notion is introduced into the short-term consumption function that the marginal propensity to consume is not constant, acknowledging the variability among individuals. Meanwhile, the research considers the acceleration effect of changes in expected income on the marginal propensity to consume, thereby addressing a limitation of classical economic theory, which inadequately accounts for the influence of economic cycles on consumption behavior. The research analyzes the characteristics of autonomous consumption and wealth stock, as well as the role of smooth consumption. It identifies specific conditions for the constancy of the long-term propensity to consume, offering a framework for reconciling short-term and long-term consumption functions. The empirical analysis utilizes mixed cross-sectional data from the Consumer Expenditure Survey of the United States Bureau of Labor Statistics and the Surveys of Consumers from the University of Michigan, covering the years 2012 to 2018, and the results are supportive. The study concludes with recommendations for enhancing top-level design in pension planning and leveraging institutional advantages to elevate income expectations, thereby promoting the implementation of smooth consumption strategies.

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Introduction

In recent years, the consumption of Chinese residents has maintained a relatively stable growth level, playing an increasingly important role within the Chinese economy. According to National Data from the National Bureau of Statistics of China (2021) and the United States (U.S.) Bureau of Economic Analysis (2024), the average annual growth rates of household consumption expenditure per capita in China and the U.S., respectively, were 8.16% and 3.22% (from 2000 to 2019),[1] with both exhibiting a standard deviation of 1.69%. Within the context of a new paradigm focused on high-quality development, the function of consumption as a ballast stone for the Chinese economy and as an indicator for enhancing the well-being of people has become more prominent. The ratio of private consumption in China to that in the U.S. increased nearly fourfold, from 11.59% in 2000 to 42.35% in 2019. Obviously, there is still a huge consumption gap between China and the U.S.

However, the consumption level during a period of steady growth does not represent realization of smooth consumption as defined by the classical life cycle hypothesis (LCH). The classical LCH posits that individuals save during their working years in anticipation of retirement, subsequently utilizing these savings to sustain a stable level of consumption throughout their life cycle, thereby achieving smooth consumption.

Li et al. (2015) studied a puzzle that Chinese retirees effectively maintained smooth consumption as predicted by the LCH, while the LCH has rarely been tested in the context of other developing countries. Employing the China Urban Household Survey spanning 2002 to 2009, the study investigated households whose husbands were around 60 years of age (the retirement age for men), including two categories of households. The first group comprised households currently employed in the government, the public sector, state-owned enterprises, and collectively-owned enterprises. The second group consisted of households whose husbands had retired from these institutions, benefiting from comprehensive welfare provisions and robust pension security in that era.

Nevertheless, past and current situations do not necessarily predict future outcomes. According to the State Council of the People's Republic of China (2018), small and medium-sized enterprises (SMEs) in China constitute over 80% of the urban employment. The consumption capacity of most SME employees is crucial

[1] Due to the impact of the Coronavirus Disease 2019 (COVID-19) epidemic, the economic growth indicators of various economies were greatly affected after 2019. Therefore, data after 2019 are not referenced when discussing the main indicators of economic growth as shown herein, except for special needs.

to achieving smooth consumption throughout society. However, these employees encounter different scenarios, compared with state-owned enterprise employees. Currently, employees in SMEs are subject to reduced actual pension contribution rates, lower contribution bases and shorter contribution periods. Thus, they encounter diminished pension replacement rates, defined as the ratio of pension benefits to pre-retirement incomes.

Zheng (2018) noted that the replacement rate of basic pension insurance for urban workers in China experienced a decline from 80.5% in 1999 to 45.8% in 2010 and, according to similar calculations, stabilized at 44.2% in 2019. The Organization for Economic Co-operation and Development (OECD, 2012) advocated for a pension replacement rate of at least 70% to ensure that retirees can maintain their standard of living, with an even higher ratio recommended for low-income individuals. Currently, China's pension replacement rate remains below the 70% benchmark. The following text describes the situation in the U.S.

The World Bank (1994) proposed a three-pillar framework to achieve smooth consumption by establishing the pension planning system. This framework encompasses public pension arrangements, enterprise annuities, and personal retirement savings. On this issue, China and the U.S. are at different stages of development. The U.S. implemented a three-pillar system earlier and more completely.

In 1935, the first pillar in the U.S. was instituted through the Social Insurance Act, which covered most of the population. However, Social Security's cost, remaining higher, was projected to exceed its income in 2021. The U.S. passed a series of bills in the 1970s to create the second and third pillars, such as the 401(k) and Individual Retirement Account, providing a high coverage rate and level of protection for individuals. Following the establishment of these two pillars, there was rapid expansion in their adoption, with account balances far exceeding the Social Security taxes collected during the same timeframe.

Currently, China's pension planning system remains incomplete and confronts the challenge of insufficient funding for retirement. Primarily, public pension schemes dominate the system, exerting increasing pressure on government finances. Additionally, the coverage rate of the second pillar, comprising enterprise or occupational annuities, is notably low. Furthermore, the personal pension account system, representing the third pillar, was only established in 2024 under a new institutional framework, and personal pension planning predominantly relies on spontaneous savings accumulation and asset allocation. It is essential for China to vigorously promote comprehensive retirement financial planning that encompasses the entire life cycle of household assets to pave the way for smooth consumption in the future.

In the evolution of consumption theory, a notable issue referred to as the Consumption Puzzle emerged. Keynes (1936) proposed the absolute income hypothesis, which posits that consumption is a stable function of disposable income. According to this hypothesis, the marginal propensity to consume (MPC) is consistently lower than the average propensity to consume (APC), and the APC is characterized as a decreasing function of disposable income. In contrast, Kuznets (1942) examined empirical data from the U.S. for the period 1879–1938, and concluded that, in the long run, the MPC equals the APC. This finding implies that the long-term consumption function can be represented as a straight line originating from the origin,

thereby suggesting that Keynes's theory may not hold in the long run. The discrepancy between this theoretical inference and empirical evidence regarding short-term and long-term consumption functions is the Consumption Puzzle.

Research on the Consumption Puzzle constitutes a focused investigation by economists into the determinants of consumption, resulting in the emergence of various consumption theories and models. Duesenberry (1949) and Friedman (1957) introduced the relative income hypothesis and the permanent income hypothesis, respectively. Klein (1951) performed an empirical analysis using household data from the Federal Reserve's Surveys of Consumer Finance for the period 1948–1949. The analysis indicated that an increase in the ratio of liquid assets to income would reduce the proportion of household savings. Conversely, both an increase in the per capita income level of the household and growth in income for the current year were found to increase the savings ratio. Klein and Morgan (1951) also investigated the assumption of a non-constant marginal propensity to save, employing the aforementioned dataset for their empirical analysis. They concluded that incorporating a quadratic function of income leads to a positive second-order effect of income on the level of savings.

Modigliani and Brumberg (1954, 1980) along with Ando and Modigliani (1963) systematically proposed the classical LCH. They suggested that consumers possess the ability to engage in long-term planning, and their consumption choices depend on various factors, including current income, anticipated income, net assets, and age. This hypothesis laid the groundwork for subsequent theoretical research on consumption and financial planning for the elderly. In a comprehensive literature review, Deaton (2005) stated that the current basic view of the classical LCH cannot be challenged. It is possible that people are witnessing the transformation of this hypothesis from an empirical theory to a normative theory, from an objective statement to a principled regulation. Fernández-Villaverde and Guerrón-Quintana (2020) summarized the impact of uncertainty shocks and business cycles on macroeconomic factors, such as consumption.

Feldstein (1974, 1976) employed LCH to examine the economic impact of financial planning systems for the elderly, thereby establishing himself as a pioneer of this research paradigm. These studies explored the macroscopic effect of social insurance within the pay-as-you-go system in the U.S. Regression analysis conducted on the U.S. data for the period 1929–1971 corroborated the LCH, revealing that increases in social insurance benefits would modestly boost consumption.

Venti and Wise (2000) asserted that variations in savings choices among households can result in important disparities in wealth accumulation at retirement, even under similar total lifetime income conditions. Poterba et al. (1998) discovered that, for general 401(k) participants, the anticipated value of their 401(k) assets is likely to exceed that of their social insurance funds upon retirement. Zhao et al. (2021) revealed that personal tax-deferred pension accounts enhance the income and consumption of holders after retirement.

In examining the applicability of LCH to the Chinese context, Modigliani and Cao (2004) investigated the phenomenon of the rising Chinese saving rate, positing

that the LCH offers a crucial explanation for this trend. They argued that the transition to a market economy, coupled with the lack of a pension system and implementation of a one-child policy, contributed to the increase in savings. Furthermore, Ang (2009) found that the macroeconomic data from China supported the hypothesis of the extended LCH, which suggests that anticipated pension benefits tend to discourage household saving over the long term. Li and Zhang (2021) discovered a positive correlation between changes in housing wealth and those in household consumption, while this relationship did not extend to financial wealth. Their analysis employed various panel regression procedures containing data from 14 countries, including China. It appears that wealth, particularly housing wealth, tends to enhance household consumption rather than crowd it out. In the Chinese context, housing has emerged as a crucial store of value due to limited investment options. However, a decline in housing values may result in a corresponding decrease in consumption due to the wealth effect. To enhance consumption, China could benefit from advancing its financial development, particularly by establishing a robust pension system.

The current study explores the pathways to achieve smooth consumption through the lens of the LCH. It modifies the model to develop both short-term and long-term consumption functions, aiming to make the following four marginal, but important, contributions.

First is refinement of the classical LCH consumption function. Within the classical LCH model, labor income prior to retirement is treated as a separate variable. This study distinguishes between the nature of stock and flow, merging property income with labor income, which exhibits obvious variation across different life-cycle stages, to create a unified income flow. This approach is contrasted with the relatively stable nature of wealth stock, allowing for analyzing their respective impacts on consumption.

Second is consideration of economic cycles and career factors. The classical LCH model does not incorporate the impact of economic cycles and career factors on short-term household consumption. Acknowledging that the MPC differs among individuals at the micro level, this study introduces the non-constant assumption of the MPC to elucidate how a change in short-term income expectation can exert a multiplier effect on household consumption, mediated by variability in the MPC.

Third is incorporation of autonomous consumption. The classical LCH model does not consider autonomous consumption, focusing solely on induced consumption driven by income and wealth. This study incorporates basic living expenses as autonomous consumption, which remain a constant in the short term but evolve into a shifting factor in the long term.

Fourth is further elucidation of the Consumption Puzzle. The classical LCH model contributes to explaining the Consumption Puzzle to some extent. This study investigates the nature of autonomous consumption and wealth stock within the long-term consumption function, as well as the role of smoothing consumption. It reveals the conditions under which long-term propensity to consume becomes a constant. This facilitates a reconciliation of short-term and long-term consumption functions and further explains the Consumption Puzzle.

Furthermore, this research conducts empirical analysis to substantiate the extended model. By using micro-level data from the U.S., the corresponding empirical results provide support for the above theoretical contributions on the short-term consumption function discussion.

Theoretical Exploration

The Essence of LCH

The theoretical basis for smooth consumption is grounded in the classical LCH and its associated consumption function. From the LCH perspective, a person's life can be divided into three stages. The first is the adolescent stage, where income is lower than consumption, necessitating reliance on borrowing, such as parental support expenses. The second is the working stage, where income is higher than consumption and savings are accumulated. The third is the retirement stage, where income once again falls below consumption, leading individuals to draw upon their savings, mainly through various pensions. Individuals seek to achieve smooth consumption throughout these life stages to ensure a stable quality of life, especially in the latter two stages.

Basic Model of the LCH-based Consumption Function

Based on the consumption function under the classical LCH, at the micro level,

$$c_t^j = a_1 w_{t-1}^j + a_2 y_t^{L(j)} + a_3 y_t^{e(j)},$$

where c_t^j represents the consumption expenditure of consumer j in period t. a_1, a_2, a_3 are the proportional coefficients. w_{t-1}^j represents the wealth stock of consumer j at the beginning of period t. $y_t^{L(j)}$ represents the disposable labor income of consumer j in period t ($y_t^{L(j)} = y_t^{GL(j)} - tax_t^j$, $y_t^{GL(j)}$ is the pretax labor income of consumer j in period t, tax_t^j is the tax amount of consumer j in period t). $y_t^{e(j)} = \sum_{\tau=t+1}^{N} y_\tau^{L(j)}/(1+i)^{\tau-t}$ represents the present discounted value of consumer j's expected disposable labor income (from the first year $t+1$ after period t to year N) in period t (i represents the discount rate, and N represents the end of the working period).

Given that the average expected labor income is proportional to current labor income, i.e., $y_t^{-e(j)} = \frac{y_t^{e(j)}}{N-t} = \beta y_t^{L(j)}$, then

$$c_t^j = a_1 w_{t-1}^j + a_2 y_t^{L(j)} + a_3 y_t^{e(j)} = a_1 w_{t-1}^j + \left[a_2 + a_3(N-t)\beta\right] y_t^{L(j)}.$$

Let $\alpha_1 = a_1, \alpha_2 = a_2 + a_3(N-t)\beta$, then,

$$c_t^j = \alpha_1 w_{t-1}^j + \alpha_2 y_t^{L(j)}.$$

If the equation holds for all consumers, the macroscopic consumption function can be expressed as:

$$C_t = \alpha_1 W_{t-1} + \alpha_2 Y_t^L$$

where C_t, W_{t-1}, Y_t^L are the corresponding macroscopic consumption, wealth, and labor income variables.

When the economy is in a phase of short-term fluctuations, changes in Y^L will occur, but substantial changes in W will not occur immediately, remaining relatively stable. Corresponding to the $C - Y^L$ plane, the short-term macroscopic consumption function can be approximated as a straight line with an intercept, $\alpha_1 W$,and a slope, α_2 (i.e., the MPC of income). In general, savings increase with changes in the short-term fluctuation stage and the accumulation effect ($W'_{t-1} > W_{t-1}$) leads to a change in the shifting factor $\alpha_1 W_{t-1}$. Therefore, the short-term consumption curve shifts upward:

$$C_t = \alpha_1 W_{t-1} + \alpha_2 Y_t^L \rightarrow C'_t = \alpha_1 W'_{t-1} + \alpha_2 Y_t^L.$$

Based on the assumption of Ando and Modigliani (1963), income and wealth both grow at a steady rate in the long run, with the growth ratio, $\Delta W/\Delta Y^L$, remaining approximately constant. Therefore, it can be posited that in an economy characterized by steady growth for a long time, the long-term propensity to consume C/Y^L is a constant in the plane $C - Y^L$. This implies that the long-term consumption function can be represented as a linear relationship originating from the origin, characterized by a constant slope. The LCH reveals the fundamental principle of smooth consumption and contributes to the reconciliation of short-term and long-term consumption functions.

Modifications Based on the LCH Consumption Function

Fine-tuning (Adjusting the Definitions for Some Variables of LCH Function)

Drawing upon the qualitative difference between stock and flow, it is essential to define the flow that underpins smooth consumption, characterized by substantial fluctuations, as income throughout the entire temporal framework of the life cycle expectation, encompassing both pre-retirement and post-retirement income. This income comprises two parts with different weights: the first component includes current labor income and expected future labor income, while the second component pertains to property income. Hence, the life cycle income and expenditure diagram under the fine-tuned LCH is illustrated in Online Supplemental Appendix (OSA) Fig. 1.

The basic model is fine-tuned in the present study. At the micro level, consumption is determined by the wealth stock at the beginning of the period (i.e., at the end of the previous period), disposable income for the current period and expected income, which can be articulated as:

$$c_t^j = a_1 w_{t-1}^j + a_2 y_t^j + a_3 y_t^{e(j)} \tag{1}$$

where $y_t^j = y_t^{G(j)} - tax_t^j$ represents the disposable income of consumer j in period t (including both labor income and property income, rather than labor income only). $y_t^{e(j)} = \sum_{\tau=t+1}^{T} y_\tau^{(j)}/(1+i)^{\tau-t}$ represents the discounted value of consumer j's expected disposable income in period t, and T represents end-of-life expectancy, rather than the end of the work period. The meaning of the variable, wealth, remains unchanged.

Given that the average expected income of consumer j is proportional to the income of the current period, i.e., $\overline{y}_t^{e(j)} = \frac{y_t^{e(j)}}{T-t} = \beta y_t^j$, then

$$c_t^j = a_1 w_{t-1}^j + a_2 y_t^j + a_3 y_t^{e(j)} = a_1 w_{t-1}^j + \left[a_2 + a_3(T-t)\beta\right] y_t^j.$$

Let $\alpha_1 = a_1, \alpha_2 = a_2 + a_3(T-t)\beta$, then.

$$c_t^j = \alpha_1 w_{t-1}^j + \alpha_2 y_t^j.$$

If the equation is valid for all consumers, the macroscopic consumption function can be expressed as follows:

$$C_t = \alpha_1 W_{t-1} + \alpha_2 Y_t.$$

Following this fine-tuning process, the mechanism of smooth consumption and the characteristics of the LCH consumption function exhibit enhanced precision. During periods of short-term economic fluctuations, the flow Y_t, comprising both labor and property income, will change accordingly, but the stock W_{t-1} remains relatively stable and does not experience immediate changes. If this stock is approximated as the intercept term in the short run, the short-term macroscopic consumption function can be approximated as a straight line in the $C - Y$ (instead of $C - Y^L$) plane, with an intercept $\alpha_1 W$ and a slope α_2, as shown in OSA Fig. 2.

Expansion (Adding New Relevant Variables in the LCH Function)

Recognizing that the MPC differs among individuals at the micro level, this article proposes an assumption of non-constant MPC and examines the impact of fluctuations in expected income on consumption patterns via the MPC. It posits that the short-term growth rate of expected income changes affects consumption levels through the marginal consumption level. Specifically, it is supposed that the MPC is a function induced by the expected short-term income growth rate (g). Then, based on Eq. (1), $a_2 = \delta_1 + \delta_2 g$ (δ_1 and δ_2 are constant coefficients). In addition, it analyzes the role of autonomous consumption C_0, which is independent of personal endowment and is generated to maintain the basic expenses of life.

Drawing upon the foregoing analysis, the short-term macro consumption function can be expressed in the following form:

$$C_t = C_0 + a_1 W_{t-1} + a_2 Y_t + a_3 Y_t^e = C_0 + a_1 W_{t-1} + \left(\delta_1 + \delta_2 g\right) Y_t + a_3[(T-t)\beta]Y$$

$$\rightarrow C_t = C_0 + a_1 W_{t-1} + \left[\delta_1 + a_3(T-t)\beta\right] Y_t + \delta_2\left(gY_t\right).$$

Let $\alpha_1 = a_1$, $\alpha_2 = \delta_1 + a_3(T-t)\beta$, $\alpha_3 = \delta_2$, then the short-term macro consumption function becomes

$$C_t = C_0 + \alpha_1 W_{t-1} + \alpha_2 Y_t + \alpha_3(gY_t)$$

where C_t represents the consumption expenditure of the whole society in period t. $\alpha_1, \alpha_2, \alpha_3$ are proportional coefficients. W_{t-1} represents wealth at the beginning of the

current period as a stock, and there is no substantial change in the inductive consumption brought by wealth in the short term. Y_t is the disposable income of the current period, which is applicable to all stages of the life cycle, and exhibits substantial changes in the short term used as the flow Y_t. The product term gY_t represents the expected short-term change in income in a macro sense (derived from the non-constant assumption of the MPC of income), reflecting the non-linear characteristics of the impact of income on consumption in the short term. C_0 represents autonomous consumption, which is a constant in the short run, but will be transformed into a variable or a shifting factor in the long run that moves across the short-term periods. Based on this, the long-term macro consumption function showing the trend change across time periods t is as follows[2]:

$$C_t = C_{0,t} + \alpha_1 W_{t-1} + \alpha_2 Y_t. \tag{2}$$

In summary, the fundamental attributes of the consumption function within the LCH after certain modifications can be summarized as follows (Fig. 1). First, since autonomous consumption remains constant in the short term, the short-term macroscopic consumption function can be expressed as a three-dimensional surface with the intercept C_0, alongside variations in wealth and income. When short-term fluctuations are ignored, this three-dimensional surface can be simplified to a three-dimensional plane (OSA Fig. 3).

Second, the product term gY_t reflects the expected influence of the economic cycle and individual career trajectories. The second-order impact of expectations on consumption indicates that, *ceteris paribus*, variations in expected short-term income exert an accelerating effect on consumption by altering the MPC. This phenomenon is analogous to the effect of acceleration on displacement through velocity as described in classical mechanics.

Third, if short-term wealth is relatively constant, then the three-dimensional surface with an intercept C_0 can be approximated as a two-dimensional graph with the intercept term $C_0 + \alpha_1 W_{t-1}$. The slope of the short-term consumption trend line is represented as α_2. The MPC at a certain point in time may not be less than the APC. However, based on the short-term trend line, $MPC < APC$, and APC exhibits an inverse relationship with total income.

Fourth, corresponding to the long term as in Eq. (2), the inter-period variations of autonomous consumption will manifest as alterations in the shifting factor C_0 ($C_0 \rightarrow C_0'$), resulting in an overall upward shift in the consumption plane. The investigation of autonomous consumption can be categorized into short-term and long-term dimensions. In the short term, the autonomous consumption derived from the minimum living standard remains constant and constitutes a time period. Conversely, in the long term, across different time periods, the autonomous consumption varies in relation to the level of economic development.

[2] The t of this formula represents the term period (not the year) from 1 to n. For long-term, the trend line changes (short-term fluctuations are not considered). Accordingly, C_t,C_0,W_{t-1} and Y_t are variables that vary from period to period.

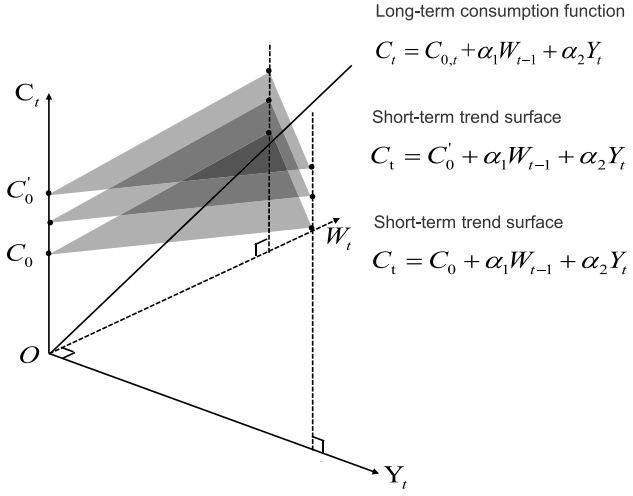

Fig. 1 Schematic diagram of the short-term and long-term consumption function under the extended LCH with time segment shift. As a shifting factor, C_0 moves up with the changes of period. If $C_0 \rightarrow C_0'$, the short-term trend surface and the short-term consumption function move up. Under the condition of steady growth, the long-term consumption function can be simplified to a straight line passing through the origin on the two-dimensional plane $C - Y$

Fifth, considering the long run and the relatively stable nature of wealth stock, the intertemporal effects of autonomous consumption and wealth accumulation induce alterations in the shifting factor within the approximate two-dimensional graph.$\left(C_0 + \alpha_1 W_{t-1} \rightarrow C_0' + \alpha_1 W_{t-1}'\right)$. This results in an upward shift in the short-term consumption trend line.

Sixth, in the long run, consistent with the assumptions posited by Ando and Modigliani (1963), it is assumed that income and wealth will grow steadily, with the growth rate (or the rate of change), $\Delta W/\Delta Y$,remaining approximately constant. This implies that the growth rates of real income and wealth both depend on the sum of population growth and the rate of increase of productivity. Furthermore, it is posited that the growth rate of autonomous consumption relative to income,$\Delta C_0/\Delta Y$, is also approximately constant. This assumption is both reasonable and intuitive, as C_0 can be seen as a reflection of a real basic standard of living, which aligns with the long-term growth of basic consumption and is almost consistent with the growth of national income. Thus, movement of the macroscopic consumption variable that evolves along the trend renders a stable long-term propensity to consume. For the long-term period of stable economic growth, the long-term propensity to consume, C/Y, remains constant, leading to a long-term consumption function that can be represented as a straight line originating from the origin, with a constant slope, i.e.,

$$C_t = C_{0,t} + \alpha_1 W_{t-1} + \alpha_2 Y_t \rightarrow (C_t/Y_t) = (C_{0,t}/Y_t) + \alpha_1 (W_{t-1}/Y_t) + \alpha_2 = Constant$$

$$\rightarrow C_t = kY_t, \text{ let } k = (C_{0,t}/Y_t) + \alpha_1 (W_{t-1}/Y_t) + \alpha_2.$$

Seventh, the constancy of the long-term propensity to consume requires sustainable long-term economic growth, which in turn relies on the realization of smooth consumption patterns within the consumption-driven economic growth framework. Historical evidence and practical conditions show that effective financial planning for the elderly is essential for achieving smooth consumption across various time domains for microscopic individuals throughout their life cycles. The macro landscape is essentially the aggregate result of the micro behaviors, and the time series is the intertemporal accumulation of the cross-section. When the concept of smooth consumption is extended to the economy, the macro-economy can truly attain sustainable growth by upholding a smooth consumption pattern within the consumption-driven model. Therefore, the steady growth of macro consumption will persist over an extended period, with the growth of autonomous consumption and wealth stock aligning with the income growth for a long period, thereby facilitating the convergence of long-term propensity to consume towards a constant. This perspective provides an additional framework for explaining the Consumption Puzzle.

Cases

This study is inspired by the work of Blanchard and Johnson (2017). In order to provide preliminary demonstrations of the expanded theoretical model, two cases are employed as follows.

Case 1: Pension Planning and the Consumption Level of the Elderly

With effective financial planning for the elderly, asset income can sufficiently cover the basic needs of personal consumption expenditure after retirement. Typically, only a small proportion of a family's post-retirement income comes from employment, with the bulk originating from asset income. As shown in Table 1, the average net asset value for the U.S. households aged 65 to 69 was $313,807 in 1991. Given the challenges associated with generating direct income from home equity, as well as the unpredictability of income from equity in other property (such as motor vehicles, rental housing, vacation homes) with social security assets calculated by discounting, the net assets total, after excluding these three categories (social security assets, home equity, and equity in other property), amounts to $115,315. Assuming a comprehensive annualized rate of return of 4%, the estimated annual return would be approximately $4,612.60.

According to data from U.S. Social Security Administration (1992), the National Data of the U.S. Bureau of Economic Analysis (2024) and the Current Population Survey (U.S Census Bureau, 2025) in the same period, the average annual social security income for individuals in the U.S. is $7,236 and the average annual expenditure of households is $41,813.69. Concurrently, the average population of families is 3.18. It can be estimated that in a household with a single elderly person aged 65 or older, pension income, which encompasses both asset income and social security income, would suffice to cover 90.11% of the elderly's consumption needs. In

Table 1 Distribution of assets among the U.S. families, Ages 65- 69, 1991

Asset Category	Average Household Value (Dollar)	Proportion in Net Asset (%)	Proportion of Families Owning (%)
Personal Financial Assets	42,018	13.39	34.50
Personal (Targeted) Retirement Assets	10,992	3.50	84.80
Employer-Provided Pension Assets	62,305	19.85	56.20
Social Security Assets	99,682	31.77	88.00
Home Equity	64,955	20.70	75.30
Equity in Other Property	33,855	10.79	81.80
Total	313,807	100.00	

The asset category, average household value and proportion of families owning are taken from Venti and Wise (1993)

cases where there are two elderly persons aged 65 or older in the household, pension income would meet 72.57% of the elderly's consumption needs. Furthermore, if a comprehensive annual interest rate of 5% is applied, this income would cover 76.96% of the elderly's consumption needs for the two elderly persons.

Based on these calculations, if a family engages in effective financial planning for the elderly, under a feasible expected rate of return, the family can meet the replacement rate threshold through investment income after retirement, thereby ensuring the stability of the level of personal consumption. At this stage, the family's wealth would mainly be composed of pension financial products and liquid assets, resulting in a stable investment portfolio and fairly low demand for the utilization of asset principals.

Case 2: Income Expectation, Consumption and Economic Growth

The short-term economic cycle has a substantial impact on household consumption through expectations. In December 2007, the onset of the U.S. subprime mortgage crisis marked a pivotal moment, as it subsequently permeated the broader financial market and the real economy in the ensuing year. This crisis engendered widespread pessimism on the macroeconomic outlook and personal employment prospects, which had a huge impact on the income expectations of the U.S. consumers.

As illustrated in Fig. 2, the average expectation of household income growth over the next year among U.S. consumers was only 1.05% in the period 2008–2009, subsequently declining to an unprecedented low range of 0.20%−0.67% in the period 2010–2013. In contrast, the figure was 2.39% in the period 2006–2007, indicating the impact of the crisis. Due to income stickiness, the impact of the crisis on income was slower than income expectations. Disposable personal income remained stable and increased slightly at the onset of the crisis. A noticeable decline in disposable personal income did not occur until the third quarter of 2008. Notably, in the first quarter of 2008, the pessimistic expectation about future income precipitated a sharp decline in personal consumption expenditure on durable goods, contributing to

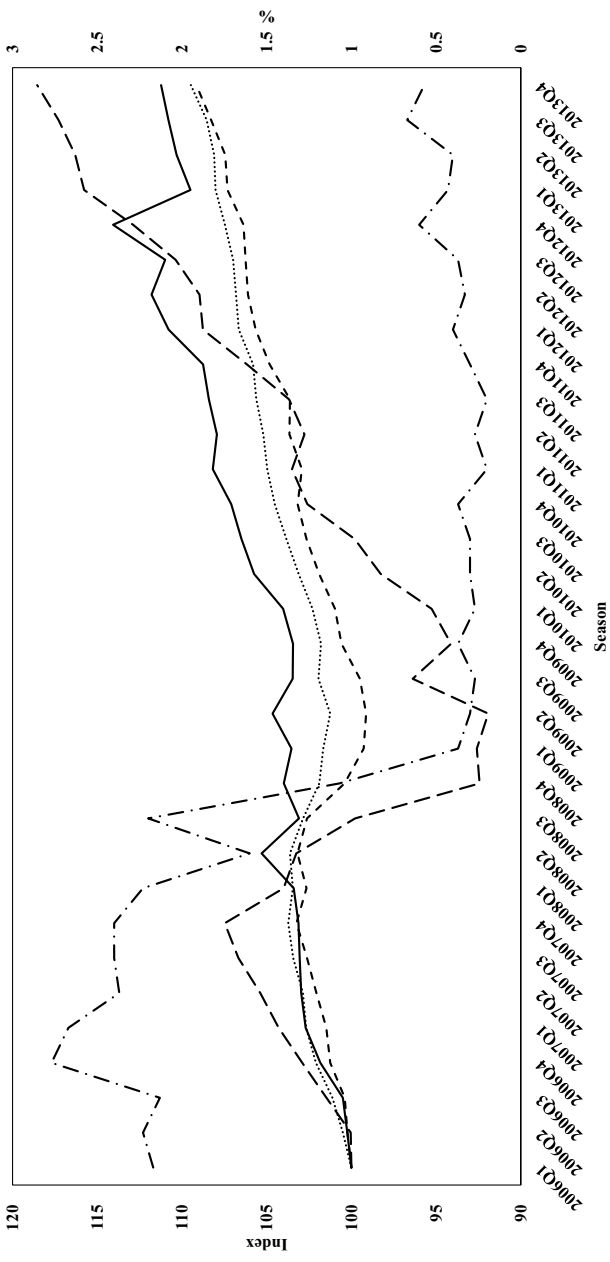

Fig. 2 Selected indicators within U.S. Economic growth and consumption, 2006–2013. For the convenience of comparison, the indexes on the left axis take the first quarter of 2006 as the base period, which is regarded as 100, while those on the right axis have no base period. Data Sources: Compiled from Federal Reserve Economic Data (Federal Reserve Bank of St. Louis, 2025) and Surveys of Consumers (University of Michigan Survey Research Center, 2020)

sluggish growth or even a contraction in overall personal consumption expenditure. When compared with the fourth quarter of 2007 and that of 2009, the disposable personal income index experienced an increase of 0.32%. However, as the expected household income change over the next year fell from 2.4% to 0.37%, the personal consumption expenditure index concurrently decreased by 1.94% during the same period. The pattern was obviously observed in the fourth quarter of 2008 versus the previous quarter.

The magnitude of the alteration in consumption expenditure far surpassed the variation in income, reflecting the drag of pessimistic income expectations on consumption. Consequently, this situation led to a drag on the gross domestic product (GDP) from consumption. Specifically, in 2008 and 2009, the pulling rates of personal consumption expenditure on the U.S. GDP were recorded at −0.14% and −0.85%, respectively. The lack of consumption led to a severe recession in the overall U.S. economy during the crisis and the continued fragility of the subsequent recovery.

Data Sources and Descriptive Statistics

Building upon the theoretical analysis and corresponding model, the analysis now focuses on the micro-empirical study using the household as the primary unit of analysis. The data employed were sourced from the Consumer Expenditure Survey (CES) database of the U.S. Bureau of Labor Statistics (BLS) (2020) and the Surveys of Consumers database (University of Michigan Survey Research Center, 2020).

To expand the sample size and analyze a period characterized by stable autonomous consumption, this study utilized data from the households surveyed by the CES between 2012 and 2018. (henceforth referred to as the "sample period" and the "sample") Throughout this period, economic conditions in the U.S. exhibited relative stability. To mitigate the interference of seasonal factors, this research focuses exclusively on 23,798 households that provided the survey data for the full year, thereby establishing effective sample points. These data points were subsequently integrated into a mixed cross-sectional dataset with various factors.

For the time factor, this study used the quarterly time code to record when the data were provided by the households. The sample values range from 20122 to 20181, where the initial four digits denote the year and the final digit represents the serial number of the quarter, resulting in a total of 24 values. Throughout the sample period, each time code corresponds on average to 992 sample points, and the time distribution of these sample points is relatively uniform.

For age, this study used the age of the household respondent at the first interview, ranging from 16 to 88. Since the current standard retirement age in the U.S. is about 66 years old, this research categorized families with an age parameter of 66 years or older as post-retirement families, while those below this threshold were classified as pre-retirement families, thereby creating two subsamples. The analysis yielded a total of 17,432 sample points for the pre-retirement group and 6,366 sample points for the post-retirement group.

For the consumption factor, this study utilized one-year expenditure data commencing from the quarter corresponding to the household time code (encompassing a total of four quarters, hereinafter referred to as the "reporting period" for each household) to represent annual consumption.[3] The average consumption expenditure of each household during the sample period was $37,093.72.

Regarding the income factor, this study selected the annual income in the reporting period. In instances where households did not report income data, the CES utilized the imputation method to generate estimates for the missing information. Income encompasses both pre-tax and after-tax income. Throughout the sample period, the average pre-tax income for households was $71,771.3, while the average after-tax income was $65,232.74.

For the wealth factor, this study selected the asset levels reported in the initial quarter of each reporting period. Total assets included the total value of financial assets, personal pension insurance accounts, consumer durables, and real estate. Net assets were calculated as the cumulative net values of various asset categories (if the Liabilities of a certain type of consumer durable or real estate exceeded their corresponding assets, the net value was adjusted to 0).[4] During the sample period, the average net worth of households was $210,993.6, while the average value of total assets was $267,057.1.

For the short-term expected income change factor, this study selected the product of each household's current after-tax income and the corresponding expected income growth rate. The Surveys of Consumers database (University of Michigan Survey Research Center, 2020) divides the population into high-, middle-, and low-income groups, analyzing their expectations for the growth rate of household income in the next year. Correspondingly, households in the CES are classified into three groups according to the weighted quantile levels of their pre-tax income within the country, which are matched with the annual average of the expected income growth rate for the same reporting period, thereby generating the product term. The expected income growth rate tended to be higher for the higher-income group compared to that of the lower-income group. Summary statistics are presented in Table 2.

As shown in Fig. 3, the fluctuations in household income and consumption in the U.S. largely align with the essence of the LCH, with consumption changes occurring at a more gradual pace compared to income changes. In the U.S., the average annual consumption for pre-retired households was $39,979.95, while the average annual after-tax income was $73,060.52, and the average annual salary income was $69,147.16. For the post-retirement households, the average annual consumption was $29,190.35, the average annual after-tax income was $43,797.97, the average salary income was $14,343.36, and the average annual pension income was $26,190.81. Therefore, in the short run, the APC is 56.86% overall, with 54.72% for pre-retirement households and 66.64% for post-retirement ones, which is higher than pre-retirement. The income substitution rate, defined as post-retirement income divided by pre-retirement income, was

[3] Due to limited space, the specific items included in the variables pertaining to consumption, income and wealth were omitted.

[4] This adjustment was implemented to mitigate the influence of outlier data on the statistical outcomes.

Table 2 Statistical characteristics of the selected data

Variable	Symbol	N	Mean	Std	Min	Max
Annual household consumption	*CONSUMPTION*	23,798	37,093.72	223.55	358.33	1,499,617.00
Annual after-tax income	*NET-INCOME*	23,798	65,232.74	380.16	−290,578.00	609,757.20
Value of total assets	*TOTAL-ASSET*	23,798	267,057.10	2,968.35	0.00	11,441,314.00
Value of net assets	*NET-ASSET*	23,798	210,993.60	2,811.34	0.00	11,441,314.00
Expected change in income over the next year	*EXPECTED-INCOME*	23,798	1,212.05	9.58	−5,317.47	14,329.29
Household mortgage balance	*HOUSEHOLD-LOAN*	23,798	54,453.52	660.66	0.00	1,122,090.00
Whether quarter time code equals 20122	*TIME1*	23,798	0.05	0.001	0	1
Whether quarter time code equals 20181	*TIME24*	23,798	0.04	0.001	0	1

Data Sources: compiled from CES (Bureau of Labor Statistics, 2020) and the Surveys of Consumers (University of Michigan Survey Research Center, 2020). Due to limited space, the statistical characteristics of some dummy variables (*TIME2*, *TIME3*, …, *TIME23*) are not listed

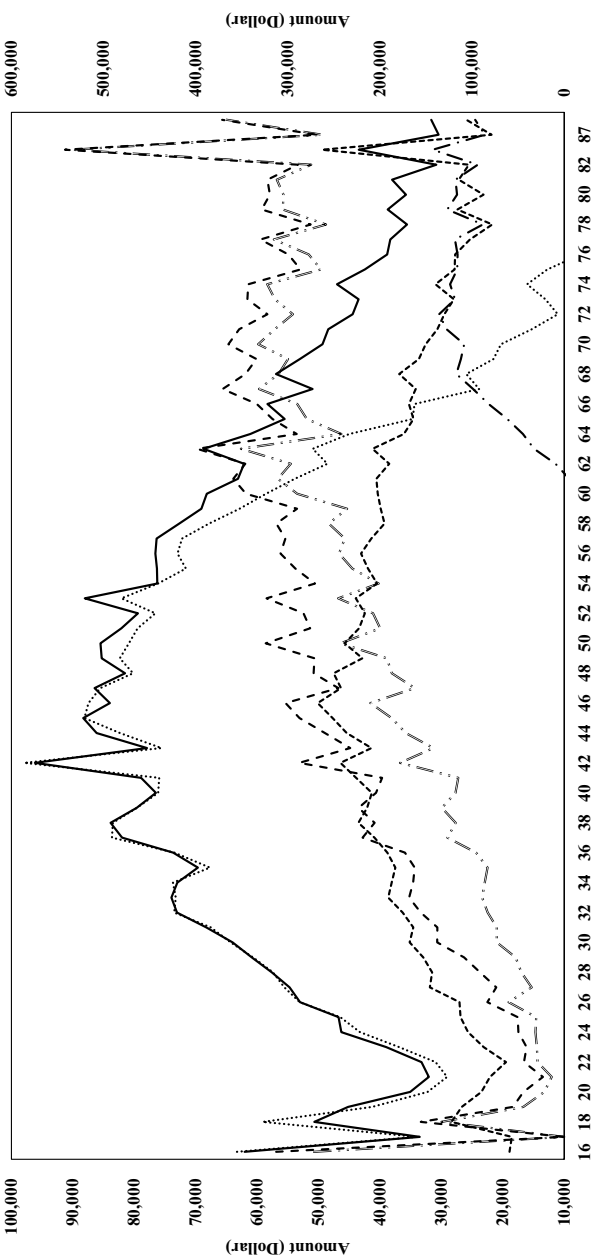

Fig. 3 Average income, asset and average consumption curves of households of different age groups in the U.S., 2012–2018. Data Source: Compiled from the CES (Bureau of Labor Statistics, 2020)

59.95%, whereas the consumption substitution rate, defined as post-retirement consumption divided by pre-retirement consumption, was 73.01%, which is close to the OECD standard. Pension insurance constituted 59.80% of post-retirement income, while wage income decreased rapidly from 94.64% of pre-retirement income to 32.75% of the post-retirement income. In addition to pension income, variations in asset levels also explain the factors that contribute to the stability of consumption following retirement. From ages 21 to 63, both average net assets and average total assets exhibit a clear upward trend, while after the age of 63, household wealth begins to decline gradually. The income and principal derived from long-term wealth accumulation play a crucial role in supporting consumption after retirement.

Regression Analysis and Robustness Test

Regression Analysis of the Basic Model

Based on the discussion about consumption theory, three short-term consumption models were constructed accordingly, employing the least squares method with heteroscedasticity correction for statistical inference. Model 1 incorporates a constant term and after-tax income, positing that consumption is a stable function of disposable income, thereby validating the Keynes consumption model. Model 2 builds upon the role of disposable income and initial wealth within the LCH to verify the basic LCH consumption model, introducing autonomous consumption. Based on Model 2, Model 3 considers the effect of changes in expected short-term income to affirm the extended LCH consumption model. Based on the three models, the samples were divided into two age subsets. Subset 1 refers to the pre-retirement family, forming Models 1.1, 2.1, 3.1, while Subset 2 refers to the post-retirement family, forming Models 1.2, 2.2, 3.2, and so on. Additionally, the time dummy variables were incorporated into the estimation formula of each model to eliminate the influence of temporal factors on the estimation parameter.

$$\begin{aligned}\text{Model 1 } CONSUMPTION = {} & \alpha_0 + \beta_1 \times NET - INCOME + \varphi_1 \times TIME1 \\ & + \varphi_2 \times TIME2 + \cdots + \varphi_{23} \times TIME23 + \varepsilon,\end{aligned}$$

$$\begin{aligned}\text{Model 2 } CONSUMPTION = {} & \alpha_0 + \beta_1 \times NET - INCOME + \beta_2 \times NET - ASSET \\ & + \varphi_1 \times TIME1 + \varphi_2 \times TIME2 + \cdots + \varphi_{23} \times TIME23 + \varepsilon,\end{aligned}$$

$$\begin{aligned}\text{Model 3 } CONSUMPTION = {} & \alpha_0 + \beta_1 \times NET - INCOME + \beta_2 \times NET - ASSET \\ & + \beta_3 \times EXPECTED - INCOME + \varphi_1 \times TIME1 \\ & + \varphi_2 \times TIME2 + \cdots + \varphi_{23} \times TIME23 + \varepsilon.\end{aligned}$$

As shown in Tables 2 and 3, the variable *CONSUMPTION* denotes the household's annual consumption, while *NET-INCOME* signifies the household's total after-tax income. Additionally, *NET-ASSET* refers to the net assets of the household at the beginning of the period. The variable *EXPECTED-INCOME* indicates the expected change in income over the next year. Furthermore, *TIME1* serves as a time

Table 3 Least squares estimation results of mixed cross-section data

	Whole sample	Subset 1: pre-retirement	Subset 2: post-retirement	Whole sample	Subset 1: pre-retirement	Subset 2: post-retirement	Whole sample	Subset 1: pre-retirement	Subset 2: post-retirement
Independent variable	*Model1*	*Model1.1*	*Model1.2*	*Model2*	*Model2.1*	*Model2.2*	*Model3*	*Model3.1*	*Model3.2*
NET-INCOME	0.335***	0.332***	0.340***	0.299***	0.281***	0.300***	0.172***	0.147***	0.234***
	(0.00739)	(0.00834)	(0.0178)	(0.00632)	(0.00811)	(0.0171)	(0.0218)	(0.0260)	(0.0397)
NET-ASSET				0.0156***	0.0211***	0.0105***	0.0156***	0.0210***	0.0105***
				(0.00203)	(0.00346)	(0.00128)	(0.00202)	(0.00344)	(0.00128)
EXPECTED-INCOME							5.391***	5.712***	2.799*
							(0.847)	(0.966)	(1.524)
_cons	16,628***	16,565***	17,107***	15,618***	16,574***	15,823***	14,773***	15,171***	15,909***
	(981.4)	(1,200)	(1,728)	(995.5)	(1,178)	(1,689)	(1,004)	(1,189)	(1,693)
n	23,798	17,432	6,366	23,798	17,432	6,366	23,798	17,432	6,366
R^2	0.330	0.324	0.290	0.365	0.367	0.326	0.369	0.371	0.327

Due to limited space, the estimated coefficients of dummy variables (*TIME1, TIME2, …, TIME23*) of above models are not listed. Similar treatment will be applied in the following text. The table presents the results of an OLS regression testing. *** $p<0.01$, indicating extremely strong evidence against the null hypothesis. ** $p<0.05$, showing very strong evidence against the null hypothesis. * $p<0.10$, suggesting some evidence against the null hypothesis. Standard errors are in parentheses. Data Sources: Compiled from CES (Bureau of Labor Statistics, 2020) and the Surveys of Consumers (University of Michigan Survey Research Center, 2020)

dummy variable that identifies whether the time code corresponds to 20122, assigning a value of 1 if this condition is met and 0 otherwise. Similarly, *TIME2* assesses whether the time code is 20123, and this pattern continues, with *TIME23* evaluating whether the time code is 20174.

In this study, a constant term representing autonomous consumption was incorporated into each model. The constant terms in Models 1, 2 and 3 represent autonomous consumption with progressively constrained financing sources. Specifically, in Model 3, the only assets or sources of capital available for autonomous consumption are government guarantees, charitable aid, and loans. The regression outcomes in Table 3 indicate that the constant terms for Models 1, 2 and 3 across the whole sample are $16,628, $15,618, and $14,773, respectively. This suggests that autonomous consumption, as measured by the econometric model, decreases as sources of consumption funding become more restricted. According to the Poverty Thresholds data of the U.S. Census Bureau (2024), the average household poverty line, considering the average household size, is $17,792. The autonomous consumption levels of households calculated in this analysis range from $14,773 to $17,107. The policy is characterized by its universal and welfare-oriented nature, indicating that the level of autonomous consumption for households should be marginally below the poverty line for the U.S. households, which is in line with reality. Comprehensive analysis of the various models and variables is provided as follows (Table 3).

First, the three regression outcomes of Model 1 presented in Table 3 are examined. The coefficient for after-tax income is significant (*NET-INCOME,* $p < 0.01$). According to the Keynes consumption model, consumption is posited to be a stable function of income. On average, the MPC is 33.5%. Specifically, the pre-retirement MPC is 33.2%, which is marginally lower than the post-retirement MPC of 34.0%. This discrepancy can be attributed to the generally lower income levels after retirement. Normally pre-retirement households save more for retirement, resulting in reduced consumption levels. The opposite is true for households after retirement, which is also consistent with the general rule. As mentioned in the descriptive statistics, the overall APC of the U.S. households is 56.86%. In particular, the APC before retirement is 54.72%, while the APC after retirement rises to 66.64%. The marginal propensity to consume is estimated to be lower than the APC, which is in line with the basic principles of the Keynes consumption model.

Second, the three regression outcomes of Model 2 are examined (Table 3). The coefficients for after-tax income and net assets are both significant (*NET-INCOME, NET-ASSET,* $p < 0.01$). Compared to the Keynes consumption model, the classicial LCH points out that both income and wealth influence consumption. According to the LCH, the MPC from income averages 29.9%, while the MPC from net assets is 1.56%. Notably, after retirement, the MPC from net assets is 1.05%, which is lower than the 2.11% before retirement. This suggests that pre-retirement asset accumulation, especially among the elderly, is more conducive to promoting current consumption. Conversely, after retirement, the impact of changes in asset accumulation on consumption diminishes post-retirement.

Third, the three regression outcomes of Model 3 are examined (Table 3). The coefficients for after-tax income and net assets are significant (*NET-INCOME, NET-ASSET,* $p < 0.01$), while the coefficients for expected short-term income change are

significant for both the post-retirement sample (*EXPECTED-INCOME, $p < 0.10$*) and for the other two samples (*EXPECTED-INCOME, $p < 0.01$*). According to the expanded LCH consumption model, the effect of expected income on the MPC and hence on consumption is separated from the contribution of income to consumption. The average MPC for after-tax income is 17.2%, for net assets it is 1.56%, and for short-term expected changes in income, it is 5.391. This indicates that if the short-term expected income increases by $1, *ceteris paribus*, the current consumption would increase by $5.391, reflecting the second-order effect of income on consumption.[5] This means households attach great importance to short-term future income expectations, which reflect economic and career prospects, when making consumption decisions. Furthermore, changes in expected income exert a multiplier effect on consumption by altering the MPC. The drag on consumption caused by pessimistic income expectations following the outbreak of the U.S. subprime mortgage crisis exemplifies this acceleration effect. The MPC for pre-retirement households is lower than that for post-retirement households (14.7% compared to 23.4%), and a similar trend is observed in the APC (54.7% versus 66.6%). This discrepancy may be attributed to the enhanced expectations of income stability due to adequate social security. After retirement, households increase their after-tax income, yet their consumption levels rise even more, facilitating the achievement of smooth consumption in the life-cycle sense.

It is worth noting that the regression outcomes of Model 3 indicate that the short-term expected income change is the product of the current after-tax income multiplied by the expected income growth rate. This relationship inevitably results in some degree of multicollinearity between the two variables. Nevertheless, the regression analysis presented demonstrates that the coefficients for both after-tax income and short-term expected income change are significant (*NET-INCOME, EXPECTED-INCOME, $p < 0.01$ or $p < 0.10$*) and align with the economic implications of the theoretical model. In this case, the presence of a certain degree of multicollinearity does not affect the interpretation of the model.

Robustness Test

This article employs three methods to test the robustness of the regression outcomes of Model 3: altering the sample size, replacing the explanatory variables, and incorporating additional explanatory variables. In summary, the estimates derived from Model 3 demonstrate a high degree of robustness.

First, observing Fig. 3, the variables of income, consumption, and assets fluctuated more smoothly and continuously between the ages of 22 and 82. Therefore, for the robustness test, the samples aged 16–21 (comprising 199 sample points) and 83–88 (comprising 1102 sample points) were excluded from the overall dataset. This

[5] In the analysis of the short-term consumption function, $C_t = C_0 + \alpha_1 W_{t-1} + \alpha_2 Y_t + \alpha_3 (g Y_t)$. It means that the effect of expected income on consumption can be separated from the effect of income on consumption. According to the results of the empirical analysis, taking model 2 and model 3 as examples, $\beta_1 = 0.299$ for model 2, $\beta_2 = 0.172$ for model 3, and $\beta_3 = 5.391$. In fact, the value range of g during the sample period is about 0–3%. Therefore, the value range of $\beta_1 + \beta_3 g$ of model 3 is about 0.172–0.334, which is consistent with the estimation result of β_1 of model 2.

adjustment resulted in a total sample size of 22,497, with the pre-retirement subsample comprising 17,233 sample points, and the post-retirement subsample consisting of 5,264. With all other conditions held constant, a regression analysis of Model 3 was conducted, yielding the results presented in Table 4. The fundamental estimations of the parameters for Model 3 remain largely unchanged, thereby affirming the validity of the aforementioned conclusions.

Second, given that both total assets and net assets serve as indicators of household wealth to some extent, *TOTAL-ASSET,* instead of *NET-ASSET*, was employed as the corresponding explanatory variable, all other conditions being equal, as in Model 3–1. In this context, *TOTAL-ASSET* represents the total household assets at the beginning of the reporting period, while the interpretations of the other variables remains consistent.

$$\begin{aligned}\text{Model } 3-1\ CONSUMPTION = {} & \alpha_0 + \beta_1 \times NET-INCOME + \beta_4 \times TOTAL-ASSET \\ & + \beta_3 \times EXPECTED-INCOME + \varphi_1 \times TIME1 \\ & + \varphi_2 \times TIME2 + \cdots + \varphi_{23} \times TIME23 + \varepsilon.\end{aligned}$$

As indicated in Table 5, based on Model 3–1, there is no obvious alteration in the estimated parameters or the significance levels pertaining to after-tax income and expected income growth. Notably, the coefficient for total assets is significant (*TOTAL-ASSET, $p<0.01$*) across the full sample and the two subsamples. The MPCs for the full sample, the pre-retirement sample, and the post-retirement sample were recorded at 1.79%, 2.36%, and 1.17%, respectively. These figures are marginally higher than the MPCs associated with net assets, which were 1.56%, 2.10% and 1.05% for the three samples. This suggests that the influence

Table 4 Robustness Test 1: Least squares estimation results after narrowing the sample range

	Whole sample	Subset 1: pre-retirement	Subset 2: post-retirement
Independent variable	*Model 3*	*Model 3.1*	*Model 3.2*
NET-INCOME	0.165***	0.144***	0.226***
	(0.0225)	(0.0262)	(0.0423)
NET-ASSET	0.0164***	0.0209***	0.0113***
	(0.00218)	(0.00344)	(0.00147)
EXPECTED-INCOME	5.487***	5.790***	2.771*
	(0.865)	(0.973)	(1.610)
_cons	14,850***	15,147***	16,012***
	(1,024)	(1,191)	(1,807)
n	22,497	17,233	5,264
R^2	0.368	0.370	0.337

Due to limited space, the estimated coefficients of dummy variables (*TIME1, TIME2, …, TIME23*) of the above models are not listed. The table presents the results of an OLS regression testing. *** $p<0.01$, indicating extremely strong evidence against the null hypothesis. ** $p<0.05$, showing very strong evidence against the null hypothesis. * $p<0.10$, suggesting some evidence against the null hypothesis. Standard errors are in parentheses. Data Sources: Compiled from CES (Bureau of Labor Statistics, 2020) and Surveys of Consumers (University of Michigan Survey Research Center, 2020)

Table 5 Robustness Test 2: Least squares estimation results after replacing the independent variable of net asset value with total asset value

	Whole sample	Subset 1: Pre-retirement	Subset 2: Post-retirement
Independent variable	*Model 3–1*	*Model 3–1.1*	*Model 3–1.2*
NET-INCOME	0.159***	0.132***	0.226***
	(0.0217)	(0.0260)	(0.0388)
TOTAL-ASSET	0.0179***	0.0236***	0.0117***
	(0.00193)	(0.00311)	(0.00134)
EXPECTED-INCOME	5.085***	5.260***	2.703*
	(0.827)	(0.940)	(1.494)
α_0	14,545***	15,021***	15,652***
	(993.4)	(1,182)	(1,682)
n	23,798	17,432	6,366
R^2	0.382	0.387	0.336

Due to limited space, the estimated coefficients of dummy variables (TIME1, TIME2, …, TIME23) of above models are not listed. The table presents the results of an OLS regression testing. *** $p<0.01$, indicating extremely strong evidence against the null hypothesis. ** $p<0.05$, showing very strong evidence against the null hypothesis. * $p<0.10$, suggesting some evidence against the null hypothesis. Standard errors are in parentheses. Data Sources: compiled from CES (Bureau of Labor Statistics, 2020) and Surveys of Consumers (University of Michigan Survey Research Center, 2020)

of variations in total assets on consumption is greater than that of changes in net assets. The gap between the MPC for total assets and that for net assets is 0.23%, 0.26%, and 0.12%, respectively, which may serve as an approximate representation of the impact of household debt on consumption. Furthermore, there appears to be a heightened propensity to take on debt for pre-retirement consumption.

Third, drawing from an analysis of microdata from the Chinese Family Panel Studies, Hang and Yan (2020) posited that the overall housing credit scale is positively correlated with household short-term consumption. Given the important role that real estate assets play in the proportion of household assets in the U.S., the explanatory variable of real estate loan balance can be incorporated into Model 3, with other conditions being equal, thereby forming Model 3–2. In this context, *HOUSEHOLD-LOAN* represents the household mortgage balance at the beginning of the reporting period, while the meanings of the other variables remain unchanged.

$$\begin{aligned}\text{Model } 3-2\ CONSUMPTION = {} & \alpha_0 + \beta_1 \times NET-INCOME + \beta_2 \times NET \\ & - ASSET + \beta_3 \times EXPECTED-INCOME \\ & + \beta_5 \times HOUSEHOLD-LOAN + \varphi_1 \times TIME1 \\ & + \varphi_2 \times TIME2 + \cdots + \varphi_{23} \times TIME23 + \varepsilon.\end{aligned}$$

As illustrated in Model 3–2, Table 6, the coefficient for the short-term expected income change is no longer significant in the post-retirement sample (*EXPECTED-INCOME, $p>0.10$*). However, the estimated parameters and significance levels of the other primary explanatory variables remain largely unchanged. The newly

Table 6 Robustness Test 3: Least squares estimation results after adding the independent variable of mortgage balance

	Whole sample	Subset 1: Pre-retirement	Subset 2: Post-retirement
Independent variable	*Model 3–2*	*Model 3–2.1*	*Model 3–2.2*
NET-INCOME	0.143***	0.121***	0.209***
	(0.0212)	(0.0254)	(0.0360)
NET-ASSET	0.0159***	0.0207***	0.0109***
	(0.00201)	(0.00345)	(0.00127)
EXPECTED-INCOME	4.477***	4.815***	2.263
	(0.835)	(0.958)	(1.424)
HOUSEHOLD-LOAN	0.0636***	0.0590***	0.0814***
	(0.00366)	(0.00417)	(0.00912)
_cons	14,536***	14,806***	15,199***
	(982.0)	(1,160)	(1,643)
n	23,798	17,432	6,366
R^2	0.397	0.397	0.362

Due to limited space, the estimated coefficients of dummy variables (TIME1, TIME2, …, TIME23) of above models are not listed. The table presents the results of an OLS regression testing. *** $p<0.01$, indicating extremely strong evidence against the null hypothesis. ** $p<0.05$, showing very strong evidence against the null hypothesis. * $p<0.10$, suggesting some evidence against the null hypothesis. Standard errors are in parentheses. Data Sources: compiled from CES (Bureau of Labor Statistics, 2020) and Surveys of Consumers (University of Michigan Survey Research Center, 2020)

incorporated variable, *HOUSEHOLD-LOAN*, demonstrates significance across all samples (*HOUSEHOLD-LOAN, $p<0.01$*), which basically aligns with the findings of previous research.

Unresolved Issues and Directions for Future Research

The absence of an expectation indicator in statistical data forced this study to construct an expected income change variable derived from the U.S. household data by employing two different datasets. However, this approach introduced a degree of multicollinearity with the income variable, resulting in certain inaccuracies in the regression results. A similar issue is prevalent in Chinese survey data, where statistics concerning household wealth and expectations have been developed recently, resulting in numerous imperfections in the data. Therefore, this study was unable to utilize Chinese household surveys directly. Future efforts to accurately measure household expected income may benefit from a more complete indicator system and enhanced survey methods. Additionally, employing micro data to study the impact of income expectations on household consumption is likely to yield worthwhile advancements. Furthermore, research on long-term variations in autonomous consumption across different economies will contribute to the enhancement of social welfare policies and economic decision-making, especially in safeguarding the interests of the lowest-income group. Nonetheless, existing micro statistical data still

exhibit deficiencies in accurate calculation of long-term autonomous consumption, and further exploration in this area will be pursued in the future.

Conclusion

Within the theme of promoting high-quality development, facilitation of smooth consumption holds considerable importance for the stability and sustainable development of the national economy. This article undertook a theoretical exploration and empirical analysis from the perspective of LCH, aiming to exploring ways to achieve smooth consumption.

This paper made theoretical modifications to the classical LCH. The first modification involved recognizing the distinct natures of stock and flow variables, combining property income and labor income to form disposable income applicable throughout the entire life cycle, and treating the wealth stock at the beginning of the period as a separate variable. The second modification acknowledges the variability of MPC among individuals at the micro level, introducing a non-constant assumption of the MPC of income. This adjustment facilitates consideration of the impact of changes in expected income on consumption through the MPC, thereby addressing the insufficiency of the basic LCH model, which fails to reflect short-term economic cycles and career expectations. The third modification investigates the nature of autonomous consumption within basic consumption theory, positing that it remains a constant in the short run but transforms into a shifting factor represented as in the long run. The fourth modification analyzes the nature of growth concerning autonomous consumption and wealth stock across time periods, demonstrating that the constancy of long-term propensity to consume arises from the pursuit of smooth consumption, when consumption is the main driving force of economic growth.

This article employs U.S. micro-household data to perform regression analysis on three short-term consumption models, with the aim of validating the consumption function formed after fine-tuning and expansion. The model parameters reflect variations in the U.S. family consumption before and after retirement, as well as the factors influencing these changes. This analysis serves as a basis for further investigation into the transmission mechanism of retirement financial planning on smooth consumption. The findings indicate that over a relatively brief period of about five years, the autonomous consumption of the U.S. families remained basically stable, with the average level slightly below the poverty threshold during the same period. Additionally, the MPC in relation to current after-tax income, wealth stock, and short-term expected income changes was found to be positive. Notably, the short-term expected income changes exert a multiplier impact on consumption by influencing the MPC, thereby showing an acceleration effect. Furthermore, a comparative analysis reveals that the MPC of current after-tax income is lower prior to retirement than it is afterward, while the MPC of wealth stock and short-term expected income change is higher before retirement compared after. A series of robustness tests were subsequently conducted, yielding consistent analysis results, which reinforces the reliability of the conclusion herein.

Discussion

The theoretical exploration and empirical analysis presented in this paper show that, when supported by a sound pension financial arrangement, an individual's income can be effectively allocated across different temporal domains. This allocation facilitates the establishment of a reliable source of retirement income, thereby enabling smooth consumption in the sense of the life cycle. Consequently, this approach enhances the overall consumption capacity of society, ultimately contributing to sustainable economic growth. This analysis yields several insights.

First, it is imperative to strengthen the design of overarching mechanisms by establishing a market-determined pension financial planning system. This includes expediting the construction of the second and third pillars of pension systems, thereby providing residents with greater options and tax incentives. Such measures would allow for allocating scattered individual savings to strategic and targeted investment for retirement, thereby improving the level of pension security.

Second, it is essential to implement institutional guarantees and leverage policy guidance to stabilize residents'expectations regarding future income. This stability is crucial for maintaining confidence in long-term economic growth and the steady growth of pension accounts, while also addressing concerns related to pension security.

Authors Contributions X. Ge was in charge of designing the full framework, writing the original draft, supervising and project administration. P. Zhang was in charge of reviewing & editing, visualization, validation and funding acquisition. J. Li was in charge of designing the theoretical framework, and writing the original draft. Y. Zhao was in charge of methodology, investigation, formal analysis, and data curation.

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Data Availability The data that support the study findings are available from the U.S. Bureau of Labor Statistics at https://www.bls.gov/cex/pumd_data.htm, and the University of Michigan Survey Research Center at https://data.sca.isr.umich.edu/charts.php?demographic=income, reference number 2008–2017 Interview(zip), and Expected Household Income Change During the Next Year (Last 50 Years, Excel), which are public domain resources.

Declarations

Competing interests The authors declare that they have no conflicts of interest.

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