MPC Heterogeneity and the Age Profile: Evidence from China *

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Preliminary

Abstract

This paper investigates the aggregate implications of an aging population on the effectiveness of fiscal policy in China. Utilizing a nationally representative panel dataset, we estimate Chinese households' marginal propensity to consume (MPC) out of transitory income shocks and plot the age profile of MPCs. Contrary to many lifecycle models' predictions, our findings indicate that MPCs for the elderly population (aged 60+) in China tend to decrease with age due to precautionary saving motives driven by higher health risks. To quantitatively assess the effect on aggregate MPC, we construct an Aiyagari-type model incorporating a pay-as-you-go (PAYG) pension system and health shocks. Using empirical estimates, we calibrate model parameters and validate the model's predictions against observed data. Our counterfactual analyses indicate that policy changes, such as delaying the retirement age or increasing the elderly dependency ratio, result in higher average MPCs, suggesting that younger households would face greater financial constraints in these scenarios.

Keywords: aging, fiscal policy, marginal propensity to consume

JEL Codes: E62, H3, J1

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1 Introduction

With China's population aging rapidly and GDP growth slowing, the nation's economic outlook is fraught with uncertainties. Effectively stimulating the economy through fiscal policies—such as stimulus payments, transfers, rebates, and tax redistribution—becomes increasingly crucial in this demographic context. A key measure for understanding the impact of these policies is the marginal propensity to consume (MPC), which indicates the consumption response to transitory income changes and is essential for calculating fiscal multipliers within a New Keynesian framework (Jappelli and Pistaferri, 2014; Auclert et al., 2018; Spector, 2020).

Previous research has documented the heterogeneity of MPCs across households with varying wealth and liquid assets (Fagereng et al., 2021; Ampudia et al., 2018). However, there is a notable gap in the literature regarding age-related MPC variations and their aggregate implications. This study aims to fill this gap by examining the age heterogeneity of MPCs using the China Family Panel Studies (CFPS), a nationally representative longitudinal dataset.

To quantify the aggregate implications of these findings, we develop an Aiyagari-type model incorporating a pay-as-you-go pension system and health shocks. Using empirical estimates for model calibration, we perform counterfactual analyses to project the future fiscal multipliers under different demographic scenarios. Our results suggest that if the current fertility rates persist, China's aggregate fiscal multiplier could decline significantly over the next two decades.

This paper contributes to the literature by highlighting the importance of demographic factors in fiscal policy effectiveness and offering new insights into the consumption behavior of different age groups in China. The findings have important implications for policymakers aiming to design effective fiscal interventions in an aging society.

The remainder of this paper is organized as follows: Section 2 reviews the lifecycle profile of MPCs; Section 3 outlines the empirical strategy and data; Section 4 presents the model and results; Section 5 concludes.

2 Empirical Analysis

2.1 Data Sources

In this paper, we mainly use China Family Panel Studies (CFPS), a nationally representative, biennial longitudinal survey of Chinese communities, families, and individuals. Launched in 2010 by the Institute of Social Science Survey (ISSS) of Peking University, CFPS aims to collect extensive data on various socio-economic factors to support social science research in China. The CFPS dataset includes information from around 15,000 households and 50,000 individuals, covering the period from 2010 to 2020. The survey captures a wide range of variables, including but not limited to total income, consumption at the household level, demographic characteristics, health status, and education levels. The CFPS is designed to provide longitudinal data, allowing researchers to analyze changes over time and understand trends within the Chinese population. Table 1 provides summary statistics of key variables used in the analysis.

Table 1: Summary Statistics of Key Variables

Variable	**Observations**	**Mean**	**Std. Dev.**	**Description**
Urban	9,588	0.5560	0.4969	Urban residence indicator
Finc_pc	9,588	23,119.78	43,784.76	Per capita income
Fexp_pc	9,588	22,128.27	28,687.39	Per capita expenditure
Age	9,547	45.12	15.45	Age of the household head
Famsize	9,588	2.89	1.23	Number of family members
Age_avg	9,588	44.85	11.38	Average age of the household
Eduyear_avg	9,588	8.65	2.57	Average years of education
Fexp_tot	9,588	54,431.80	63,373.42	Total household expenditure
Finc_tot	9,588	60,871.37	117,848.40	Total household income

2.2 Empirical Strategy

2.2.1 Baseline Model for MPC Estimation

To estimate the aggregate level of MPC, we follow an empirical strategy grounded in the Euler equation approach, as outlined in Baker (2018) and Fisher et al. (2020). The methodology allows us to derive the MPC by regressing first-differenced changes in income and consumption.

We begin with the following baseline model:

$$\Delta \ln C_{it-2} = \alpha + \beta \Delta \ln Y_{it-2} + \delta Z_{it-2} + \rho_1 \text{county}_{it-2} + \rho_2 \text{year}_{it-2} + \epsilon_i$$

where $\Delta \ln C_{i,t-2}$ represents the first-differenced consumption for household i, $\Delta \ln Y_{i,t-2}$ denotes the first-differenced income, $Z_{i,t-2}$ includes household-level control variables such as family size, education level, and urban/rural residence, county_{it-2} and year_{it-2} are fixed effects for county and year, respectively, and ϵ_i is the error term.

2.2.2 Age-group Specific MPC Estimation

To capture the age-specific effects, we extend the baseline model as follows:

$$\begin{aligned}
\Delta \ln C_{i,t-2} = \alpha &+ \beta_0 \text{Age}_{i,t-2} + \beta_1 \Delta \ln Y_{i,t-2} \\
&+ \beta_2 (\Delta \ln Y_{i,t-2} \times \text{Age}_{i,t-2}) + \delta Z_{i,t-2} \\
&+ \rho_1 \text{province}_{i,t-2} + \rho_2 \text{year}_{i,t-2} + \epsilon_i \qquad (1)
\end{aligned}$$

This specification allows us to estimate the interaction effect between income changes and age on consumption changes, providing a detailed age profile of MPCs.

2.3 Results

2.3.1 Baseline Results and The Age Profile of MPC

Table 2 displays the baseline estimation results using different model specifications.

Table 2: Baseline Estimation Results

	(1) Pooled OLS	(2) With Controls	(3) County FE	(4) Household FE
$\Delta \ln C_{it}$	0.113***	0.112***	0.106***	0.111***
	(0.0120)	(0.0117)	(0.0117)	(0.0106)
Urban		0.00714	0.0114	0.144**
		(0.0204)	(0.0269)	(0.0628)
Family Size		-0.138***	-0.146***	-0.315***
		(0.00849)	(0.00930)	(0.0137)
Avg Age		-0.00492***	-0.00399***	-0.0108***
		(0.000849)	(0.000967)	(0.00198)
Avg Years of Educ			-0.0122**	-0.0164*
			(0.00487)	(0.00956)
Constant	0.153***	0.778***	0.943***	1.686***
	(0.0101)	(0.0552)	(0.127)	(0.149)
Observations	7990	7990	7990	79905
R-squared	0.016	0.054	0.095	0.099

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1 presents the estimated age profile of MPCs using a pooled sample from CFPS data spanning 2010 to 2020. The results indicate that MPCs tend to decrease during the 20s and 40s, increase in the 30s, and stabilize after retirement age.

2.3.2 MPC by Health and Housing Status

We also investigate how MPC varies with health status. Figure 2 shows that individuals with poorer health tend to have higher MPCs, likely due to higher immediate consumption needs.

Housing status also plays a significant role in determining MPC. Figure 3 illustrates that renters typically exhibit higher MPCs compared to homeowners, reflecting the different

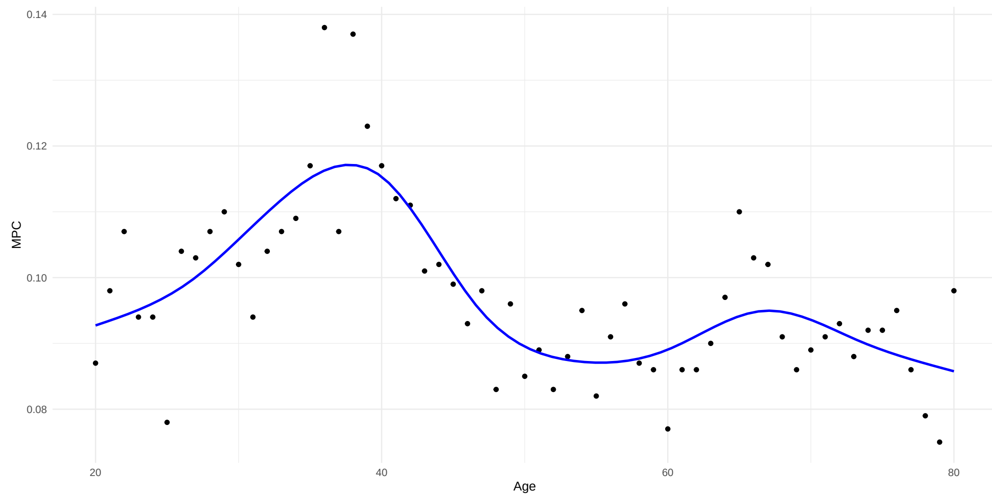

Figure 1: The Age Profile of MPC, estimated from CFPS 2010-2020.

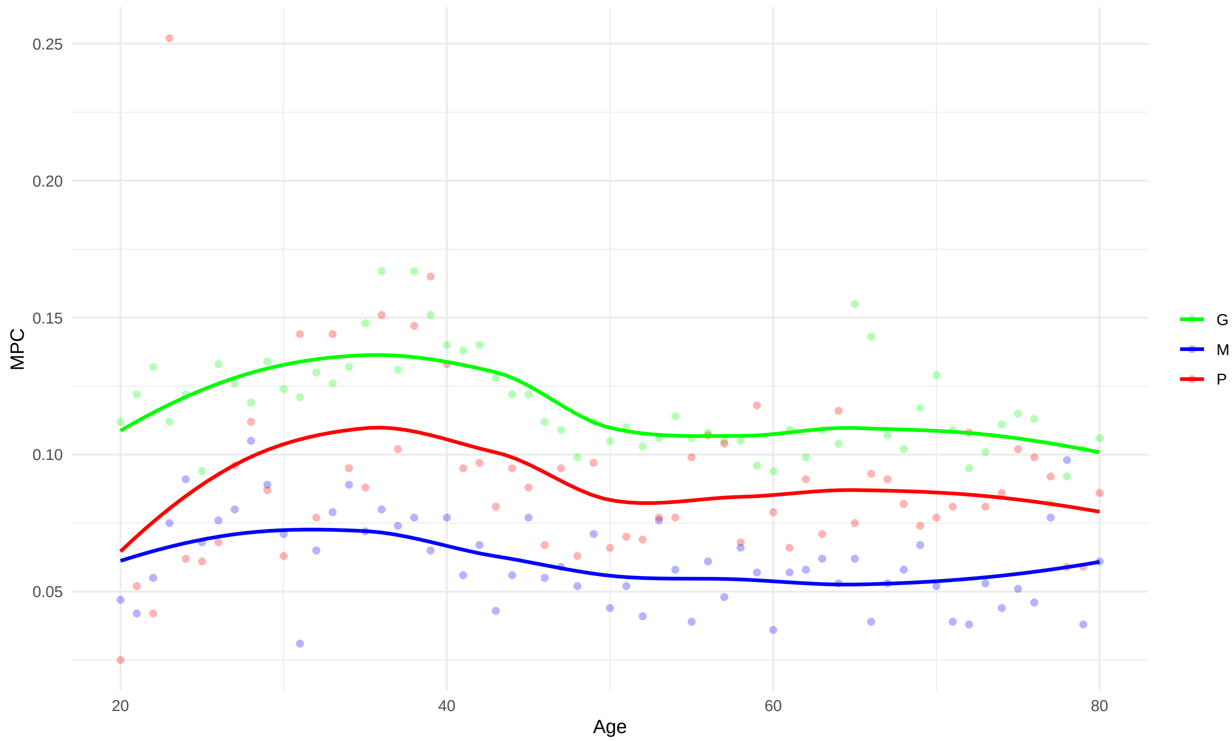

Figure 2: The Age Profile of MPC by Health Status

financial constraints and consumption patterns associated with housing tenure.

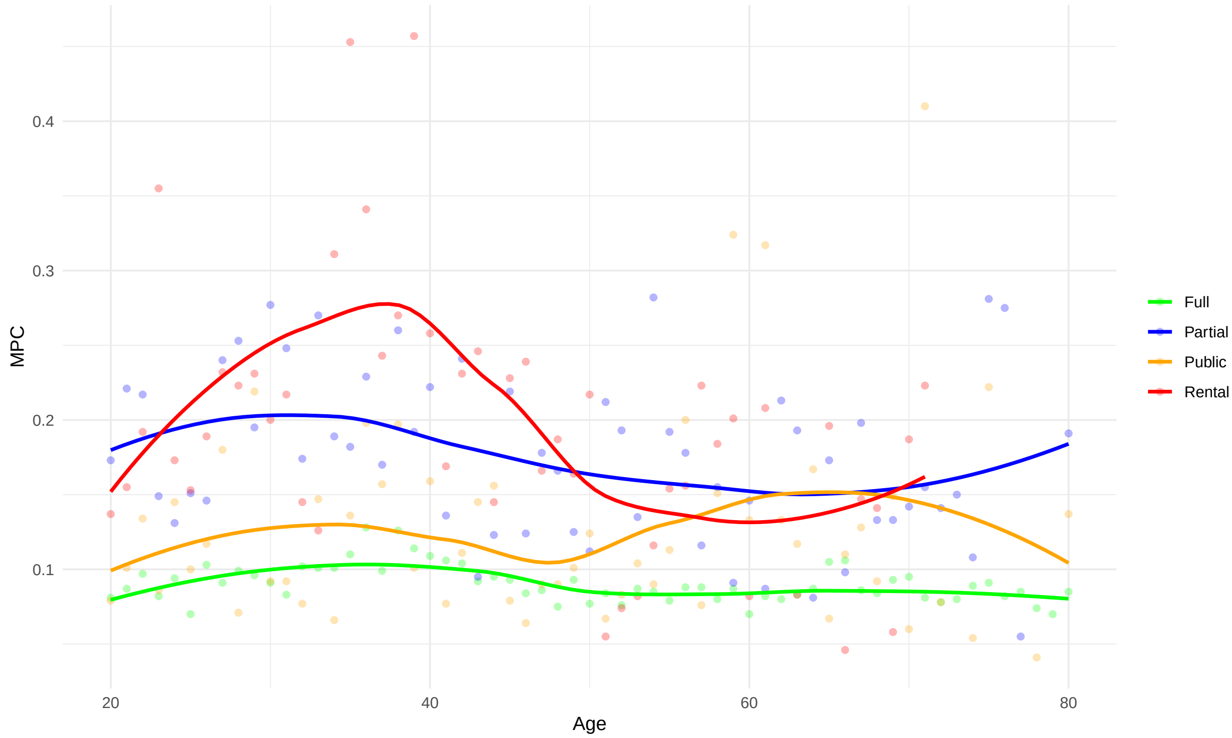

Figure 3: The Age Profile of MPC by Housing Status

3 Model

The benchmark model is an overlapping generations model with heterogeneous agents and incomplete markets. Our model period is one year. We explicitly model the working and retirement stages of the life cycle. Let j be age $\in$$\{\mathrm{j}_0, j_1, ..., j_r, ...j_d\}$, with j_r being retirement time and being the maximum possible lifespan. People start their economic life at the age of 20 and live up to the maximum age of 90. They retire at age j_r and from that time on, they face mortality risk.

3.1 Individual

The economy is populated with overlapping generations of agents whose maximum lifetime is J periods. Agents have preferences over consumption and leisure. Accordingly, the agent receives utility from consumption and leisure and maximizes expected intertemporal utility at the beginning of age 1 in period t as given by the following

$$\max \beta^{s-1}(\prod_{j=1}^{J} \phi_{t+s-1}^{j-1}) E_t[u(c_{t+s-1}^{s}, l_{t+s-1}^{s})])] \tag{2}$$

where β denotes the subjective discount factor, ϕ_j is the conditional survival rate from age $j-1$ to j, c_j is consumption, and $l_h \in [0,1]$ is the number of hours worked. Instantaneous utility $u(c,l)$ is specified as a function of consumption c and and leisure $1-l$:

$$u(c) = \frac{(c^{\gamma}(1-l)^{1-\gamma})^{\eta}}{1-\eta} \tag{3}$$

where $1/\eta$ denotes the intertemporal elasticity of substitution (IES) and γ is the share of consumption in utility.

In each period, a new generation of agents enters the economy and receives a persistent shock to income when transitioning into period t, denoted by $\eta_{j,t}$, as well as a transitory shock $v_{j,t}$. These two shock are non-linear, non-normality and age-dependent income shock estimated using method from Arellano et al. (2017) and De Nardi et al. (2019)[1]. At time t, agents of working age receive the after-tax labor income $(1-\tau_l-\tau_p)w_t exp(\eta_{j,t}v_{j,t})\kappa_j l(a,j,\eta,v)$. w_t is the equilibrium j wage at time t. τ_p is the social security payroll tax. τ_l is the labor income tax. κ_j is the common deterministic labor efficiency for agents at age j. The policy function for hours worked l_j at age j is a function of age, asset holding, persistent income shock and transitory income shock.

After the retirement age j_r, retirees receive a social security income that is partially indexed to the economic growth rate. Specifically, retirees receive the indexation rate ν of the retirement benefit of currently working agents and 1ν of their own retirement benefit. For simplicity, the retirement benefit b is the same within a group of agents with the same level of persistent income shock and of the same transitory income shock. The retirement benefits are calculated as a fraction θ of the average before-tax labor income of that group.

[1]We are going to elaborate these two shock in next section.

If agents die before the maximum age J, their savings become accidental bequests that are redistributed equally to all surviving agents.

In general, the income q_j for a given agent over his or her lifetime can be expressed as

$$q_t = \begin{cases} (1-\tau_l-\tau_p)(1+g)^{j-1} w_t exp(\eta_{j,t} v_{j,t}) \kappa_j l_j(a,j,\eta,v) & j=1,...,j_r-1 \\ (1-\nu)\bar{b}+\nu\bar{b}(1+g)^{j-j_r} & j=j_r,...,J \end{cases} \tag{4}$$

where $\bar{b}$ is the retirement benefit received by those whose retirement ages are equal to the mandatory retirement age as follows. ν is the share of Pay-As-You-Go pension scheme.

$$\bar{b} = \theta \frac{\sum_{j=1}^{j_r-1} \sum_a \sum_\eta \sum_v w_t exp(\eta_{j,t} v_{j,t}) \kappa_j l(a,j,\eta,v) \lambda(a,j,\eta,v)}{\sum_{j=j_r}^{J} \sum_a \sum_\eta \sum_v \lambda(a,j,\eta,v)} \tag{5}$$

where $\lambda(a, j, \eta, v)$ is the population distribution.

The agent receives transfers tr_t from the government. tr is the accidential bequest as follows.

$$tr_{t+1} = \frac{\sum_{j=1}^{J} (1-\phi_j) \sum_a \sum_\eta \sum_v a'(a,j,\eta,v) \lambda_t(a,j,\eta,v)}{\sum_{j=1}^{J} \sum_a \sum_\eta \sum_v \lambda_{t+1}(a,j,\eta,v)} \tag{6}$$

The budget constraint faced by an agent at age j can be written as

$$c_j + a_{j+1} = q_j + [1 + (1-\tau_k)(r-\delta)](a_j + tr) \tag{7}$$

where r is the interest rate. a_{j+1} is the assets saved for old age $j+1$ at age j. Since agents are not allowed to borrow, $a_{j+1} \geq 0$. Agents are born with no assets $a_1 = 0$. Agents have no altruistic motivation to leave bequests, so at the maximum age, $a_{J+1} = 0$.

3.2 Firm

Goods market is competitive. The representative firm is constant returns to scale with no adjustment costs. The total technological changes at period t is denoted by A_t. The firm chooses labor, capital to maximize a Cobb-Douglas production function $Y_t = A_t K_t^\alpha L_t^{1-\alpha}$.

Where α is the capital-labor elasticity, K_t and L_t are the effective capital and labor input at time t, and $A_t = A_0(1 + g_t)^t$. g_t is the exogenous growth rate of the TFP. This model assumes that this technology is own by a large number of profit-maximizing, competitive firms.

The capital K follows the law of motion

$$K_{t+1} = (1 - \delta)K_t + I_t \tag{8}$$

where I_t denotes capital investment. δ is the constant depreciation rate. The first order conditions that determine net real return to capital and real wage are as follows,

$$r_t = \alpha A_t K_t^{\alpha-1} L_t^{1-\alpha} - \delta \tag{9}$$

$$w_t = (1 - \alpha)A_t K_t^{\alpha} L_t^{-\alpha} \tag{10}$$

3.3 Government and Social Security

The government levies income taxes τ_t^l and τ_t^k on labor and capital income and taxes on consumption τ_t^c. In addition, the government confiscates all accidental bequests Beq_t. It pays aggregate transfers Tr_t, provides a certain level of total public expenditures G_t. In each period, the government budget is financed by issuing government debt:

$$Tr_t + G_t = Tax_t + Beq_t \tag{11}$$

where taxes Tax_t are given by

$$Tax_t = \tau_t^l A_t L_t w_t + \tau_t^k (r_t - \delta)K_t \tag{12}$$

The government provides pay-as-you-go pensions to the retirees which it finances with the contributions of the workers. Let PB_t denote aggregate pension payments. The social security budget is assumed to balance:

$$PB_t = \tau_t^p A_t L_t w_t \tag{13}$$

3.4 Competitive Equilibrium

Definition: A competitive equilibrium for a given set of policy arrangements θ is a collection of individual policy rules for consumption $C(a, j, \eta, v)$, saving $S(a, j, \eta, v)$, and labor supply $L(a, j, \eta, v)$ of agents who were born at time t with the relative prices of labor and capital r, w at time t , the population measure (a, j, η, v), and accidental bequests Tr at time t, such that at time $t + J$,

1. The individual decision rules solve the individual's optimization problem.
2. The aggregate factor inputs are generated by the agents' decision rules:

$$\bar{L}_t = \sum_{j=1}^{j_r-1} \sum_a \sum_\eta \sum_v \kappa_j l(a, j, \eta, v) \lambda(a, j, \eta, v) \tag{14}$$

Aggregate capital $\bar{K}_t$ is equal to the sum of the individual wealth levels:

$$\bar{K}_t = \sum_{j=1}^{J} \sum_a \sum_\eta \sum_v S(a, j, \eta, v) \lambda(a, j, \eta, v)(1 + g)^{J-j} \tag{15}$$

3. The relative prices r, w solve a firm's profit maximization problem by satisfying the firm's first order condition.

4. Given the relative price r, w, government policy θ, and a lump-sum transfer tr, the individual policy rules C_j, S_j, L_j solve the individual's problem.

5. The commodity market clears:

$$\sum_{j=1}^{J} \sum_a \sum_\eta \sum_v \lambda_j (C_j + S_j)(1 + g)^{J-j} = Y + (1 - \delta) \sum_{j=1}^{J} \sum_a \sum_\eta \sum_v \lambda_j S_{j-1}(1 + g)^{J-j} \tag{16}$$

6. The population measure is updated through

$$\lambda(a', j+1, \eta', v') = \sum_{j=1}^{J} \sum_{a} \sum_{\eta} \sum_{v} \Pi(\eta', \eta)\Pi(v', v)\phi_j \lambda_j(a, j, \eta, v) \tag{17}$$

7. The social security system is self-financing:

$$\tau_p = \frac{\sum_{j=j_r}^{J} \sum_a \sum_\eta \sum_v \lambda(a, j, \eta, v)[(1-\nu)\bar{b}(1+g)^{J-j} + \nu \bar{b}(1+g)^{J-j_r}]}{w(1+g)^{J-1}L} \tag{18}$$

8. The lump-sum distribution of accidental bequests is determined by

$$Tr_t = \sum_{j=1}^{J} \sum_{a} \sum_{\eta} \sum_{v} (1-\phi_{j+1}) S(a, j, \eta, v)\lambda(a, j, \eta, v)(1+g)^{J-j} \tag{19}$$

4 Estimation

We use a nonlinear model of earning process as introduced in Arellano et al. (2017), taking advantage of the panel structure of the CFPS survey data. We start by describing the canonical linear decomposition model in macroeconomics, and proceed to present the nonlinear model.

4.1 The Canonical Earnings Process

For a cohort of household labeled by ID $i = 1, 2, \ldots N$ and age of the household head $t = 1, 2, \ldots, T$. Let y_{it} denote the logarithm of residual labor earnings of household i at age t controlling for household characteristics. We decompose of y_{it} is as follows:

$$y_{it} = \eta_{it} + \epsilon_{it},\ i = 1, \ldots, N,\ t = 1, \ldots T \tag{20}$$

Where the distribution of η and ϵ are absolutely continuous. The first term, η_{it}, represent the *persistent* component of earnings, and is assumed to follow a first order Markov process.

The second term, η_{it}, denotes the transitory component, which is uncorrelated over time, and is independent of η_{is} for all s. The key difference between the two is that a shock to the persistent component generates long-lasting effects to the household's current and future earnings, while shocks to the transitory component have only a temporary impact and do not significantly affect the household's long-term earnings.

The canonical model used in macroeconomics is described by:

$$\eta_{i,t} = \rho\eta_{i,t-1} + \xi_{it} \tag{21}$$

$$\eta_{i1} \sim N(0, \sigma_{\eta_1}), \quad \xi_{it} \sim N(0, \sigma_\xi), \epsilon_{it} \sim N(0, \sigma_\epsilon) \tag{22}$$

Where η_{it} is an AR(1) process with independent Gaussian innovations ξ_{it} with constant variance σ_ξ. The transitory component ϵ_{it} follows a normal distribution with zero mean.

De Nardi et al. (2019) describe three types of restrictions in the canonical model of earning process.

1. The autoregressive coefficient ρ measures the persistence of the η component, and is assumed to be constant and independent of age. This would imply that the second and higher order moments for the conditional distributions of both the transitory and persistence component are both age-independent, a finding that contradicts empirical evidence.

2. The shocks are assumed to be normally distributed, which are at odds with negative skewness and high kurtosis of earning changes found by Guvenen et al. (2021) using administrative panel data, as well as De Nardi et al. (2019) using individual pre-tax earnings in PSID.

3. The linearity assumption of the persistent component η_{it} implies additive separability of the conditional expectation $\rho\eta_{i,t-1}$ and an independent innovation term ξ_{it}. Under this assumption, deviations from the conditional expectation are solely determined

by the current innovation, implying that all conditional centered second and higher moments should be independent of previous realizations of the persistent component. However, the observed dependence of these moments on previous earnings realizations contradicts this implication.

Motivated by the evidence above, we choose to estimate a more general non-parametric earnings process proposed by Arellano et al. (2017), which allows for age-dependency, non-linearity and non-normality, as described in the section below.

4.2 A Nonlinear Model of Earnings Process

We proceed in the following three steps to estimate the nonlinear earnings process, similar to De Nardi et al. (2019). Namely, we first perform a quantile-based panel data estimation introduced by Arellano et al. (2017), which provides estimated quantile functions of both persistent and transitory components. Second, we use the quantile functions to simulate large numbers of earnings histories. Finally, we use simulated data to generate two discrete Markov-chain approximations for both persistent and transitory components, which we then use in our structural model.

We assume the persistent component η_{it} follows a general Markov process, without specifying the exact dependent structure of η. We use $Q(\eta_{i,t-1}, \tau)$ to denote the τth conditional quantile of η_{it} given $\eta_{i,t-1}$, for each $\tau \in (0, 1)$. In particular, Equation (21) is replaced by

$$\eta_{it} = Q_t(\eta_{i,t-1}, u_{it}), \quad (u_{it}|\eta_{i,t-1}, \eta_{i,t-2}, \dots) \sim \text{Uniform}(0, 1), \quad t = 2, \dots, T \tag{23}$$

Note that the conditional quantile functions Q_t can be age specific. We do not restrict the form of conditional distribution of η_{it} given $\eta_{i,t-1}$, allowing for more general forms of conditional heteroscedasticity. The persistence of $\eta_{i,t-1}$ is introduced as

$$\rho_t(\eta_{i,t-1}, \tau) = \frac{\partial Q_t(\eta_{i,t-1}, \tau)}{\partial \eta} \tag{24}$$

which measures the persistence of $\eta_{i,t-1}$ when hit by a shock with percentile τ. In the canonical model in Equation (21) where the persistent component follows an AR(1) process, $\rho_t(\eta_{i,t-1}, \tau) = \rho$. In the general model, the persistence is allowed to depend on both the past values of $\eta_{i,t-1}$ and the rank of the new shock τ. For the transitory component ϵ_t, we drop assume it has zero mean and is independent over time and of η_{is} for all s. The marginal distribution of ϵ_{it} is allowed to be age specific.

4.3 Results

The results for the estimated earning process is summarized below in Fig 4. We then discretize the calibrated persistent and income processes following (De Nardi et al., 2019), and use the calibrated shocks in the main model. Figure 5 compares the model-generated MPC profile and data.

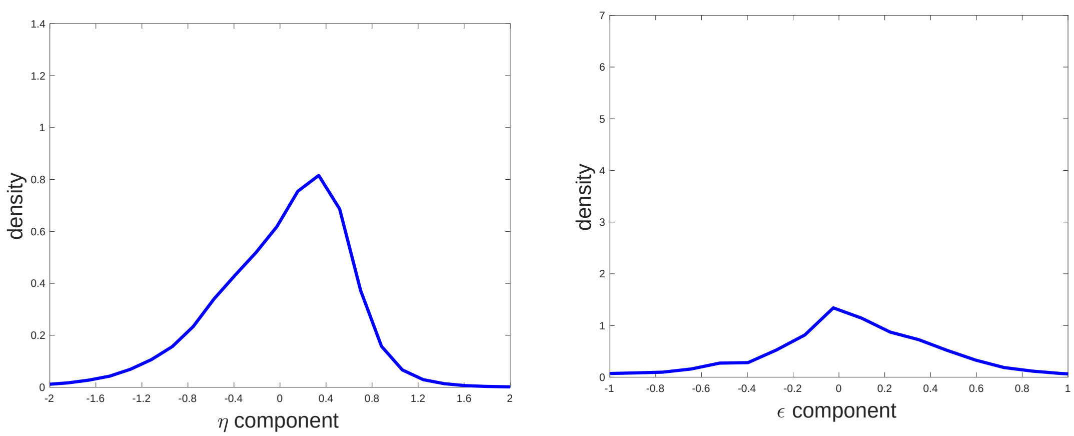

Figure 4: The estimated distribution of persistent (left) and transitory (right) component of income.

We also consider two counterfactual cases compared with the benchmark model, summarize in Figure 6. The first case correspond to a policy that delays the legally required retirement age by 5 years, and second case suppose the elderly dependency ratio increases from 30.54% in 2010 to a hypothetical value of 74.25%. Interestingly, we find that in both counterfactual scenarios, average MPC are both higher than the baseline model, suggesting

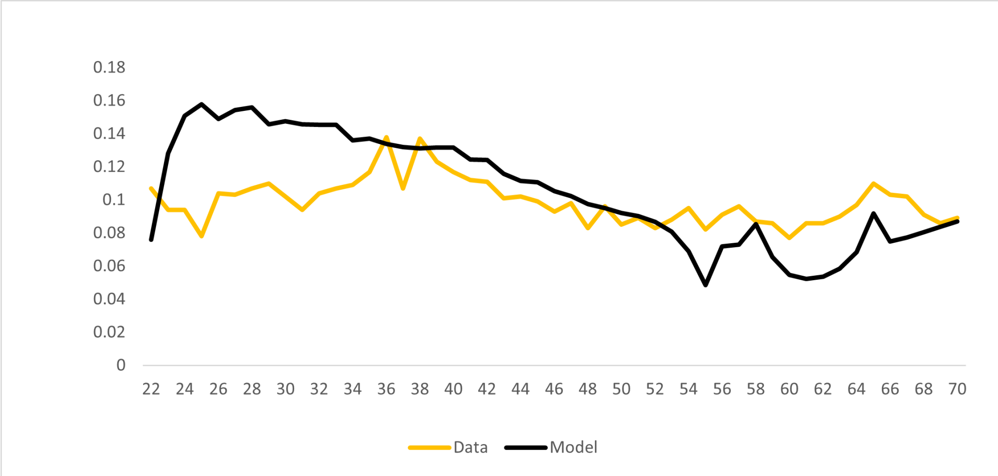

Figure 5: Calibrated Age Profile o MPC compared with Data

a situation where the young are increasingly financially constrained and thus having higher MPCs than the current economy.

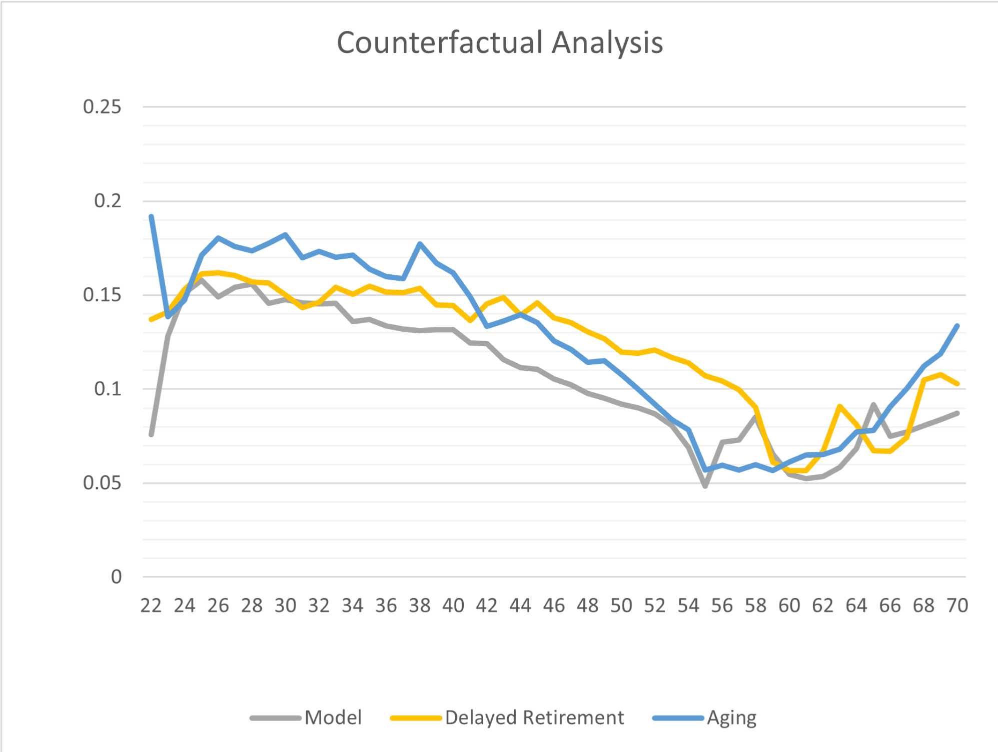

Figure 6: Calibrated Age Profile o MPC compared with Data

5 Conclusions

This study investigates the heterogeneity of marginal propensities to consume (MPC) across different age groups in China, providing new insights into the aggregate implications of an aging population on the effectiveness of fiscal policy. Our findings reveal a complex age profile of MPCs that deviates from traditional lifecycle model predictions, particularly a decline in MPC among the elderly due to increased precautionary saving driven by heightened health risks. These observations highlight the intricate dynamics of consumer behavior within an aging society.

Utilizing rigorous empirical analysis based on data from the China Family Panel Studies (CFPS) and advanced econometric models, this paper elucidates the differential impacts of age on MPC, underscoring the vital role of demographic factors in economic forecasting and policy formulation. The results indicate that MPCs tend to decrease during the 20s and 40s, increase in the 30s, and stabilize after retirement age, suggesting a nuanced relationship between age and consumption responses to income changes.

Additionally, our counterfactual analysis projects a significant decline in aggregate fiscal multipliers in the future, influenced by persistent low fertility rates. This potential decrease in fiscal multipliers underscores the necessity for policymakers to consider demographic trends when designing fiscal interventions. The analysis suggests that if current fertility rates persist, China's aggregate fiscal multiplier could diminish substantially over the next two decades, carrying profound implications for the nation's economic policy.

This study contributes to the literature by addressing a notable gap regarding the interplay between aging, consumption, and fiscal policy. It provides actionable insights for policymakers aiming to stimulate economic activity in an aging population. The findings emphasize the importance of developing adaptive policy frameworks that effectively respond to the economic challenges posed by demographic transitions in China.

In summary, this research underscores the necessity for ongoing investigation into the interactions between demographics and aggregate consumption behaviors. It advocates for the development of policies that can adapt to the evolving demographic landscape, ensuring effective fiscal interventions that sustain economic growth and stability in an aging society.

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