Over-Consumption in Behavioral Models and the Role of Social Security

Hyeon Park

May 24, 2022

1 Introduction

This paper introduces a class of behavioral models of consumption-saving for decision makers who have non-standard preferences which may allow over-consumption. I propose a unified model specification incorporating the three known behavioral models to describe over-consumption among the young agents: (i) Quasi-hyperbolic discounting, (ii) Temptation and commitment, and (iii) Reference-dependence with loss aversion. With the universal form of the preference, this paper investigates the effect of Social Security on consumer welfare through intergenerational redistribution when the consumers have the tendency of over-consumption.

Some argue that when individuals are prone to over-consume early in life, Social Security can help these individuals smooth out their consumption stream over their lifecycle. Social Security is often justified by its role of curtailing consumption among young individuals when it is used as a saving device for those who are not able to control themselves to save enough for their old age. This paper explores the effect of Social Security on saving behaviors and consumer welfare under different social security systems, for which I utilize the partially funded social security income in Park (2017), where different social security plans are specified via different degrees of fundedness. A social security system is represented by its degree of payroll portion, i.e. funded intensity, invested for future social security income for the current young, while the unfunded portion to be transferred for the current old. Under the inter-temporal budget constraint with partial intergenerational transfers, this paper analyzes the effects of social security on savings, consumption, and capital accumulation for an OLG production economy when an economy moves from a less funded system to a more funded one.

Much review had been done on Hyperbolic/Q-hyperbolic decision making, alongside applications such as Social Security (Schwarz and Sheshinski, 2007; Imrohoroglu, Imrohoroglu, and Joines, 2003). In the world of Hyperbolic or Q-hyperbolic discounting, the equivalence in the annuity aspect of Social Security, established in Sheshinski and Weiss (1981), between a funded pension system and an unfunded one such as optimal PAYG can be broken.

Avoiding the time-inconsistency problem of the hyperbolic discounting models, Gul and Pesendorfer (2001, 2004) present a commitment preference to deter decision makers' temptation to over-consume. A device of self-control is assigned to enforce the commitment, which sets the utility of a long-term commitment against the short-term cost of self-control. Moreover, as in Kumru and Thanopoulos (2008), Social Security can serve as a direct form of self-control, reducing the temptation cost for the decision makers who experience the welfare loss under the unfunded social security system.

The consumption model of reference dependence with loss aversion is relatively new, such as the expectation-based reference dependence in Koszegi and Rabin (2009) in which the decision makers deviate from the standard optimization rule for personal well-being based on the expectation, while the outcome is still rationally consistent, thus an equilibrium. Based on this equilibrium approach, Pagel (2017) and Park (2016) analyze consumption and saving behavior for those whose preferences are reference-dependent. In the two-period model of consumption and saving, the consumer's utility depends not only on his actual consumption, but also on comparison to his belief about optimal consumption which is formed from the information regarding future income flow. The standard consumer is, in fact, loss averse with respect to this belief, i.e. the reference point. When the consumer's loss aversion is low, a higher consumption point at the first period than the standard one confers a higher overall intertemporal utility because the consumer cares more about contemporaneous gain utility than about prospective loss utility. Thus, over-consumption early in life is rationalized. Park (2017), by focusing on the third possibility of modeling over-consumption, introduces a model of loss aversion into the intertemporal of choice under Social Security and analyses the general equilibrium effect.

In this paper, I first demonstrate that the three models are closely related to each other, under the intertemporal choice setting, in terms of the key mechanism that conveys over-consumption. In fact, the three forms can be embedded into the integrated preference I propose here. Then I present the optimization procedure to derive the intertemporal allocation by the decision makers who are known to over-consume when young. The next is to solve for general equilibrium and derive the long run steady states based on the law of motion in capital accumulation. I perform a numerical exercise to derive steady state consumption and savings under several schemes for a pension system, such as {zero funded, half funded, fully funded}. This exercise provides direct result regarding the intergenerational distribution and capital accumulation when an economy evolves from a less funded system to a more funded one.

2 The model and main findings

Young individuals born at t have the preference and maximize their lifetime utility by choosing consumption $\{c_t,\ c_{t+1}\}$, saving S_{t+1} and bequest b_{t+1} in an OLG economy in which the population grows at a rate n. These agents may intend to over-consume when they are young. The representative time $t-$cohort has the following preference:

$$U(c_t, b_{t+1}, c_{t+1} \mid \widehat{c}_t, \widehat{b}_{t+1}, \widehat{c}_{t+1}) = \tag{1}$$

$$u(c_t) + \zeta_1(u(c_t) - u(\widehat{c}_t)) + \beta[v(c_{t+1}, b_{t+1}) + \zeta_2(v(c_{t+1}, b_{t+1}) - v(\widehat{c}_{t+1}, \widehat{b}_{t+1}))] \tag{2}$$

The integrated preference represents each of the aforementioned three models by specifying two parameters $\zeta_1 \geqslant 0$, $\zeta_2 \geqslant 0$ corresponding to each of the three models. Each young agent is endowed with e_t units of labor measured in efficiency and they earn labor income of $w_t e_t$ given the market determined wage rate w_t. The intertemporal budget constraint is

$$c_{1t} + S_{1t+1} = (1 - \tau_t) w_t e_t + b_t \tag{3}$$

$$c_{2t+1} + (1+n)b_{t+1} = (1+r_{t+1})S_{1t+1} + T_{t+1} \tag{4}$$

in which $c_{1t} \geqslant 0$, $c_{2t+1} \geqslant 0$, and $b_{t+1} \geqslant 0$. The alternative choice set also satisfies feasibility condition[1] and $b_t \geqslant 0$ is given. The social security income is given by

$$T_{t+1} = \pi(1+r_{t+1})\tau_t w_t e_t + (1-\pi)(1+n)\tau_{t+1}w_{t+1}e_{t+1} \tag{5}$$

in which $\pi \in [0,1]$ is the intensity of fundedness with τ_t the payroll-tax rate, so that only the portion $\pi\tau_t$ is invested for the future benefit of *current young*, and the remaining portion $(1-\pi)\tau_t$ to be transferred to the *current old*. Therefore, $\pi = 0$ represents a PAYG system, while $\pi = 1$ represents a fully-funded.

2.1 Optimization and allocation

I assume CRRA utility specification, so that

$$u(c_t) = \frac{c_{1t}^{1-\gamma}}{1-\gamma} \qquad \text{and} \qquad v(c_{t+1}, b_{t+1}) = \frac{c_{2t+1}^{1-\gamma}}{1-\gamma} + g\frac{b_{t+1}^{1-\gamma}}{1-\gamma} \tag{6}$$

Then the optimality condition implies

$$(1+\zeta_1)c_{1t}^{-\gamma} = \beta(1+r_{t+1})(1+\zeta_2)c_{2t+1}^{-\gamma} \tag{7}$$

and

$$(1+n)(1+\zeta_1)b_t^{-\gamma} = g\beta(1+r_{t+1})(1+\zeta_2)b_{t+1}^{-\gamma} \tag{8}$$

From the FOC together with the constraints, I obtain the consistent consumption, bequest, and saving:

$$c_{1t} = \frac{(1-\tau_t+\pi\tau_t)w_t e_t + (1-\pi)(1+n)\tau_{t+1}\frac{w_{t+1}e_{t+1}}{(1+r_{t+1})}}{1+\frac{\Phi_{t+1}^{1/\gamma}}{1+r_{t+1}}} \tag{9}$$

$$c_{2t+1} = \Phi_{t+1}^{1/\gamma}\left(\frac{(1\text{-}\tau_t+\pi\tau_t)w_t e_t + (1\text{-}\pi)(1{+}n)\tau_{t+1}\frac{w_{t+1}e_{t+1}}{(1+r_{t+1})}}{1+\frac{\Phi_{t+1}^{1/\gamma}}{1+r_{t+1}}}\right) \tag{10}$$

$$b_{t+1} = \frac{g}{1+n}^{1/\gamma}\Phi_{t+1}^{1/\gamma}\left(\frac{(1\text{-}\tau_t+\pi\tau_t)w_t e_t + (1\text{-}\pi)(1{+}n)\tau_{t+1}\frac{w_{t+1}e_{t+1}}{(1+r_{t+1})}}{1+\frac{\Phi_{t+1}^{1/\gamma}}{1+r_{t+1}}}\right) \tag{11}$$

[1]

$$\begin{gathered}\widehat{c}_{1t} + S_{1t+1} = (1-\tau_t)w_t e_t + b_t \\ \widehat{c}_{2t+1} + (1+n)\widehat{b}_{t+1} = (1+r_{t+1})S_{1t+1} + T_{t+1} \\ \text{with } \widehat{c}_{1t} \geqslant 0, \widehat{c}_{2t+1} \geqslant 0, \widehat{b}_{t+1} \geqslant 0.\end{gathered}$$

$$S_{t+1} = \frac{\Phi_{t+1}^{1/\gamma}(1-\tau_t)\frac{w_t e_t}{1+r_{t+1}} - \pi\tau_t w_t e_t - \frac{(1-\pi)(1+n)\tau_{t+1}w_{t+1}e_{t+1}}{1+r_{t+1}}}{1+\frac{\Phi_{t+1}^{1/\gamma}}{1+r_{t+1}}} \tag{12}$$

with $\Phi_{t+1} = \beta(1+r_{t+1})\frac{1+\zeta_2}{1+\zeta_1}$.

2.2 Transition toward a more funded system

I analyze the change in policy variables (consumption, savings) with respect to the fundedness intensity to provide an implication regarding what would happen to the variables when an economy moves toward a more funded system. For simplicity I explore this under the assumption that the interest rates and wage rates are given. The partial derivative of consumption c_{1t} with respect to π is[2]

$$\frac{\partial c_{1t}}{\partial \pi} = \frac{\tau_t w_t e_t - (1+n)\tau_{t+1}\frac{w_{t+1}e_{t+1}}{(1+r_{t+1})}}{1+\frac{\Phi_{t+1}^{1/\gamma}}{1+r_{t+1}}} \tag{13}$$

$$\frac{\partial c_{2t+1}}{\partial \pi} = \Phi_{t+1}^{1/\gamma}\left(\frac{\tau_t w_t e_t - (1+n)\tau_{t+1}\frac{w_{t+1}e_{t+1}}{(1+r_{t+1})}}{1+\frac{\Phi_{t+1}^{1/\gamma}}{1+r_{t+1}}}\right) \tag{14}$$

$$\frac{\partial \widehat{c}_{1t}}{\partial \pi} = \frac{\tau_t w_t e_t - (1+n)\tau_{t+1}\frac{w_{t+1}e_{t+1}}{(1+r_{t+1})}}{1+\frac{\beta(1+r_{t+1})}{1+r_{t+1}}} \tag{15}$$

The effect is greater for the over-consumers than the standard ones $\left|\frac{\partial c_{1t}}{\partial \pi}\right| > \left|\frac{\partial \widehat{c}_{1t}}{\partial \pi}\right|$ when $\frac{1+\zeta_2}{1+\zeta_1} < 1$. Also, if it is satisfied that $(1+n)\tau_{t+1}w_{t+1}e_{t+1} > (1+r_{t+1})\tau_t w_t e_t$, then an increase in fundedness π will decrease consumption because of the reduced lifecycle income with a high π. Likewise, the effect of π on savings is

$$\frac{\partial S_{t+1}}{\partial \pi} = \frac{(1+n)\tau_{t+1}\frac{w_{t+1}e_{t+1}}{(1+r_{t+1})} - \tau_t w_t e_t}{1+\frac{\Phi_{t+1}^{1/\gamma}}{1+r_{t+1}}} \tag{16}$$

which is also greater for the over-consumers than the standard ones $\left|\frac{\partial S_{t+1}}{\partial \pi}\right| > \left|\frac{\partial S^*_{t+1}}{\partial \pi}\right|$ when $\frac{1+\zeta_2}{1+\zeta_1} < 1$. Under the same condition of $(1+n)\tau_{t+1}w_{t+1}e_{t+1} > (1+r_{t+1})\tau_t w_t e_t$, when the funding intensity increases, the total private savings increase. This implies that the private savings increase while consumption decreases at steady states as we move toward a more funded system if population growth rate is higher than the net interest rate. Likewise, under the condition as we move toward a more funded system the total nation-wide asset accumulation $\Gamma_{t+1} = S_{t+1} + \pi(1+r_{t+1})\tau_t w_t e_t$

[2] $c_{1t} = \frac{(1\text{-}\tau_t+\pi\tau_t)w_t e_t + (1\text{-}\pi)(1+n)\tau_{t+1}\frac{w_{t+1}e_{t+1}}{(1+r_{t+1})}}{1+\frac{\Phi_{t+1}^{1/\gamma}}{1+r_{t+1}}}$

increases because

$$\frac{\partial \Gamma_{t+1}}{\partial \pi} = \chi(1+n)\tau_{t+1}w_{t+1}e_{t+1} + (1-\chi)(1+r_{t+1})\tau_t w_t e_t > 0 \tag{17}$$

for $0 < \chi \equiv \frac{1}{(1+r_{t+1})+\Phi_{t+1}^{1/\gamma}} < 1$.

3 Equivalence in steady states

In this section, I briefly discuss the implication of the three models (time-inconsistent preferences (hyperbolic discounting), time-consistent preferences with temptation and self-control, and reference-dependence with loss aversion) in terms of each model's long-run outcome regarding consumption. For a production economy with Cobb-Douglas by which the output per capita is given by $y_t = f(k_t) = k_t^\alpha$, where $k_t = K_t/L_t$ and $y_t = Y_t/L_t$, the competitive market equilibrium generates $r_t = f'(k_t) - \delta = \alpha k_t^{\alpha-1} - \delta$ and $w_t = f(k_t) - k_t f'(k_t) = (1-\alpha)k_t^\alpha$. The market clearing condition implies $(1+n)k_{t+1} = S_{t+1} + (1+r_{t+1})\pi\tau_t w_t$, because the economy wide total savings should be equal to the capital stock at $t+1$. By substituting r_{t+1} and w_t into the equation, with assuming $e_t = 1$, the law of motion for the economy is derived:

$$(1+n)k_{t+1} = \frac{\Phi_{t+1}^{1/\gamma}(1-\tau_t)\frac{w_t}{1+r_{t+1}} - \frac{T_{t+1}}{1+r_{t+1}}}{1+\frac{\Phi_{t+1}^{1/\gamma}}{1+r_{t+1}}} + \pi\tau_t w_t \tag{18}$$

To compare the three models at steady states, it is necessary to assume that comparison will be made on the steady state in which the capital levels of the three over-consumption models are equivalent. Thus, with the steady state parameter $\Phi = \beta(1+r)\frac{1+\zeta_2}{1+\zeta_1}$, the consumption profile is

$$c_1 = \frac{\overline{w}}{1+\frac{\Phi^{1/\gamma}}{1+\overline{r}}}\left((1-\tau) + \pi\tau + (1-\pi)\tau\frac{1+n}{1+\overline{r}}\right)$$

$$c_2 = \frac{\Phi^{1/\gamma}\overline{w}}{1+\frac{\Phi^{1/\gamma}}{1+\overline{r}}}\left((1-\tau) + \pi\tau + (1-\pi)\tau\frac{1+n}{1+\overline{r}}\right) \tag{19}$$

By specifying the parameter function as follows,

$$\frac{1+\zeta_2}{1+\zeta_1} = \frac{\alpha}{1} \tag{20}$$

$$\frac{1+\zeta_2}{1+\zeta_1} = \frac{1+\varphi\psi}{1+\varphi} \tag{21}$$

$$\frac{1+\zeta_2}{1+\zeta_1} = \frac{1+\eta\omega\lambda}{1+\eta} \tag{22}$$

for the models of i) Q-hyperbolic discounting,[3] ii) temptation and self-control,[4] and iii) reference-dependence with loss aversion,[5] respectively, the steady state consumption in the three models of over-consumption at $t = 0$ can be recovered:

$$c_1^{Hyperbolic} = \frac{\overline{w}}{1 + \frac{(\alpha\beta(1+\overline{r}))^{1/\gamma}}{1+\overline{r}}} \left((1-\tau) + \pi\tau + (1-\pi)\tau\frac{1+n}{1+\overline{r}}\right) \tag{23}$$

$$c_1^{Temptation} = \frac{\overline{w}}{1 + \frac{\left(\beta(1+\overline{r})\frac{1+\varphi\psi}{1+\varphi}\right)^{1/\gamma}}{1+\overline{r}}} \left((1-\tau) + \pi\tau + (1-\pi)\tau\frac{1+n}{1+\overline{r}}\right) \tag{24}$$

$$c_1^{Gain-Loss} = \frac{\overline{w}}{1 + \frac{\left(\beta(1+\overline{r})\frac{1+\eta\omega\lambda}{1+\eta}\right)^{1/\gamma}}{1+\overline{r}}} \left((1-\tau) + \pi\tau + (1-\pi)\tau\frac{1+n}{1+\overline{r}}\right) \tag{25}$$

Likewise, for $t = 1$

$$c_2^{Hyperbolic} = \frac{[\alpha\beta(1+\overline{r})]^{1/\gamma}\overline{w}}{1 + \alpha^{1/\gamma}\frac{[\beta(1+\overline{r})]^{1/\gamma}}{1+\overline{r}}} \left((1-\tau) + \pi\tau + (1-\pi)\tau\frac{1+n}{1+\overline{r}}\right) \tag{26}$$

$$c_2^{Temptation} = \frac{\left(\beta(1+\overline{r})\frac{1+\varphi\psi}{1+\varphi}\right)^{1/\gamma}\overline{w}}{1 + \frac{\left(\beta(1+\overline{r})\frac{1+\varphi\psi}{1+\varphi}\right)^{1/\gamma}}{1+\overline{r}}} \left((1-\tau) + \pi\tau + (1-\pi)\tau\frac{1+n}{1+\overline{r}}\right) \tag{27}$$

$$c_2^{Gain-Loss} = \frac{\beta(1+\overline{r})\frac{1+\eta\omega\lambda}{1+\eta}\overline{w}}{1 + \frac{\left(\beta(1+\overline{r})\frac{1+\eta\omega\lambda}{1+\eta}\right)^{1/\gamma}}{1+\overline{r}}} \left((1-\tau) + \pi\tau + (1-\pi)\tau\frac{1+n}{1+\overline{r}}\right) \tag{28}$$

The three consumption points at $t = 0$ are equal to each other when $\frac{1+\zeta_2}{1+\zeta_1} = \alpha = \frac{1+\varphi\psi}{1+\varphi} = \frac{1+\eta\omega\lambda}{1+\eta}$. Furthermore, the standard consumption model is obtained whenever $\zeta_1 = 0$ and $\zeta_2 = 0$.

4 Conclusion

By exploring a class of non-standard consumer preferences for an OLG economy with Social Security, this paper not only provides the mathematical equivalence of the three well-known behavioral models for over-consumption, in terms of the key mechanism, but also contributes to the literature on intergenerational distribution related to the pension system. The proposed model in the paper is versatile enough to incorporate over-consumption, as well as under-consumption, in a unified

[3] The q-hyperbolic model assumes $Max\ u_t + \alpha \sum_{\tau=t+1}^{T} \beta^{\tau-t} u_\tau,\ where\ \alpha, \beta \leq 1$

[4] The model assumes $\underset{\{c_t,c_{t+1}\}}{Max}\{u(c_t,c_{t+1}) + v(c_t,c_{t+1})\} - \underset{\{\tilde{c}_t,\tilde{c}_{t+1}\}}{Max}\{u(\tilde{c}_t,\tilde{c}_{t+1}) + v(\tilde{c}_t,\tilde{c}_{t+1})\} = \frac{c_t^{1-\gamma}}{1-\gamma} + \beta\frac{c_{t+1}^{1-\gamma}}{1-\gamma} + \varphi\left(\frac{c_t^{1-\gamma}}{1-\gamma} + \beta\psi\frac{c_{t+1}^{1-\gamma}}{1-\gamma}\right) - \varphi\left(\frac{\tilde{c}_t^{1-\gamma}}{1-\gamma} + \beta\psi\frac{\tilde{c}_{t+1}^{1-\gamma}}{1-\gamma}\right)$, where φ is the temptation parameter and $\psi \in [0,1]$ is its intensity.

[5] The model assumes Max $U(c_t, c_{t+1}|c_t^*, c_{t+1}^*) = \frac{c_t^{1-\gamma}}{1-\gamma} + \eta\left(\frac{c_t^{1-\gamma}}{1-\gamma} - \frac{c_t^{*1-\gamma}}{1-\gamma}\right) + \beta\left[\frac{c_{t+1}^{1-\gamma}}{1-\gamma} + \eta\omega\lambda\left(\frac{c_{t+1}^{1-\gamma}}{1-\gamma} - \frac{c_{t+1}^{*1-\gamma}}{1-\gamma}\right)\right]$, where $\lambda > 1$ is the coefficient of loss aversion and ω the psychological weighting for the gain/loss feeling. η is the weight of gain-loss utility relative to consumption utility.

framework among the decision makers who deviate from the standard consumption behavior due to non-exponential time discounting, temptation utility and self-control cost, or low loss aversion.

Furthermore, by utilizing an integrated scheme for social security system which allows partial intergenerational transfers, this paper can determine the transition effect from a movement toward a more funded social security system when consumers are prone to over-consume.

References

[1] Gul, F. and W. Pesendorfer. (2001). Temptation and Self-Control, Econometrica 69, 1403-1435.

[2] Gul, F. and W. Pesendorfer. (2004). Self-Control and the Theory of Consumption, Econometrica 72, 119-158.

[3] Imrohoroglu, A., Imrohoroglu, S. and D. Joines. (2003). Time-Inconsistent Preferences and Social Security, Quarterly Journal of Economics 118, 745-784.

[4] Kőszegi, B. and M. Rabin. (2009). Reference-Dependent Consumption Plans, American Economic Review 99, 909-936.

[5] Kumru, C. and A. Thanopoulos. (2008). Social security and self control preferences, Journal of Economic Dynamics and Control 32, 757-778.

[6] Pagel, M. (2017). Expectations-Based Reference-Dependent Life-Cycle Consumption, The Review of Economic Studies 84, 885-934.

[7] Park, H. (2016). Loss Aversion and Consumption Plan with Stochastic Reference Points, B.E. Journal of Theoretical Economics 16, 303-336.

[8] Park, H. (2017). Loss aversion and social security: a general equilibrium approach, International Review of Economics 65, 51-75.

[9] Schwarz, M. and E. Sheshinski. (2007). Quasi-hyperbolic discounting and social security systems, European Economic Review, 1247-1262.

[10] Sheshinski, E. and Y. Weiss. (1981). Uncertainty and Optimal Social Security Systems, The Quarterly Journal of Economics 96, 189-206.