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RESEARCH PAPER

Buffer-Stock Saving and the Marginal Propensity for Consumption from Human Wealth in Iran

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Abstract
This study presents a Buffer-Stock version of the Life Cycle Permanent Income Hypothesis (LC/PIH) model calibrated to incorporate microeconomic evidence on the income dynamics of Iranian households. The results show that the predictions of the buffer-stock version of LC/PIH predictions are consistent with the consumption/income profile of Iranians and the extensive microeconomic evidence indicating that the marginal propensity to consume (MPC) from human wealth is lower than the 0.02 implied by standard microeconomic models. This paper also shows that the buffer-stock version of the LC/PIH model can explain why consumption in Iran does not closely follow income and differs from income at the household level. It also explains why the ratio of household wealth to permanent income in Iran is low and has remained stable despite a sharp slowdown in the expected income growth rate due to global economic sanctions on Iran.
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JEL Classification: D12, D31, D91, E21.

1. Introduction

Due to the global sanctions against Iran, labor income has faced extreme uncertainties, leading to permanent and transitory shocks to labor income, which according to Carroll (1992) are major factors affecting Marginal Propensity to Consume (MPC). This paper attempts to match these shocks to the consumption and saving behavior of Iranians to get a better understanding of what is happening to human wealth in Iran and how the response to these shocks affects the MPC from human wealth.

Carroll et al. (1997) argue that a "buffer-stock" model could better describe the savings of the typical household than the traditional model of the "Life Cycle-

Permanent Income Hypothesis" (LC/PIH). The "buffer-stock" behavior holds that consumers are both impatient and prudent in the sense of Kimball (1990) in the face of current income uncertainty. Consumers are prudent in the sense that they have a precautionary savings motive, and impatient in the sense that if future income is known with certainty, they will consume more than their current income (Carroll et al., 1997)[1]. Therefore, consumers may engage in a saving behavior that Carroll (1992) refers to as a Buffer-Stock. Buffer savers have a target ratio of wealth to permanent income, so when wealth is below target, the precautionary savings motive outweighs impatience. When wealth is above target, impatience dominates over prudence and the consumer dissaves; evidence for this is a target wealth-to-income ratio provided in Carroll (2019: 25-27). It is important for our study because Iranians are sufficiently impatient and prudent due to the high inflation rate. They are impatient because a higher inflation rate makes "cash on hand" (to be spent on goods) worthless over time, and they are prudent because in a high inflation economy, no prudent consumer will lend, accordingly no one can borrow (which is a self-liquidity constraint in the sense of Carroll, 1992).

Another reason this study uses buffer-stock theory to model consumer behavior is that 43%of consumers who responded to the Federal Reserve Board's Survey of Consumer Finances said that "precautionary saving" was the most important motive for saving. Only 15% said "preparing for retirement" was the most important reason for saving; 29% reported that "buying something for the family" and 7% that "investing" was the most important savings motive. These are not the responses one would expect from the standard interpretation of the LC/PIH model of saving (without the buffer stock version).

The most surprising finding of Carroll et al. (1997) is that when consumers are sufficiently impatient, average consumption growth eventually equals average labor income growth, specifically at the individual household level. This conclusion holds even if consumers in the model behave according to the Euler equation, which widely implies that consumption growth depends solely on preferences, not on the growth rate of income that the buffer-stock model assumes.

We present evidence documenting key differences between the implications of the buffer-stock model, in which utility is Constant Relative Risk Averted (CRRA), and the Certainty Equivalent (CEQ) model, in which utility is quadratic and the future is a particular event. Compared to the CEQ model, the buffer-stock model predicts a lower MPC from Human Wealth and a much lower effective discount rate

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[1]. In Carroll's buffer-stock model, precautionary saving determines the wealth used to absorb random income shocks.

for future labor income. The only reason other types of MPCs are not discussed in this study is that data on capital wealth are not available for either individuals or households. The focus is thus on human wealth, which by definition is the present discounted value of the expected stream of future income.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 presents and discusses the basic intertemporal optimization model. Section 4 provides the results, and Section 5 concludes the paper.

2. Literature Review

Our applied framework is based on the model of Carroll et al. (1997). Following Carroll et al. (2015), we consider transitory and permanent shocks in the microeconomic income process, which is an implementation of ideas dating back to Friedman (1957).

A large body of literature beginning with Zeldes (1989) has examined life cycle models in which consumers face transitory and permanent shocks, more recent examples that reflect the state of the art include Kaplan (2012), Carroll et al. (2017), and Carroll (2019). Most of this literature focuses on patterns of saving and consumption over the consumer's life cycle rather than MPC. These types of life-cycle models are very complex, which is the reason they have not been embedded in a DSGE context. However, in the next section, we present a life-cycle model, which indicates that our conclusions about the size of the MPC and the importance of income shocks to households are also valid in the framework we present.

A separate strand of the literature has examined various mechanisms, including the transmission of heredity and human capital across generations, heterogeneity of preferences, and the risks associated with high earnings, to fit the empirical treatments of the model[1]. De Nardi (2015) constructs a household-level income process with serial autocorrelation. He also constructs a transitory shock construction to balance some key factors about the distributions of income in the household-level microeconomic data. The income process calibrated by De Nardi (2015) does not follow the household-level evidence on income dynamics, as rich households are most likely to face persistently bad income shocks.

The empirical literature (Deaton, 1991; Carroll, 1992; Carroll, 2019) has shown that Friedman's (1957) household income dynamics are well-defined to account for transitory and permanent shocks. Since then, the most difficult part of theoretical work has been to deal with the uncertainty to which labor income is

[1]. See De Nardi (2015) for a concise overview.

exposed. Kimball (1990), Deaton (1991) and Carroll (1992) are the leading authors in developing such uncertainty in labor income.

Kimball (1990) develops the theoretical implications of labor income uncertainty for the MPC from transitory shocks[1]; Deaton (1991) discusses the nature of uncertainty stemming from permanent income shocks; and Carroll (1992) presents the theoretical foundations of Buffer-Stock saving that simultaneously incorporates both transitory and permanent income shocks.

Fakhraei and Mansouri (2010), Roshan et al. (2013), Yazdan and Sina (2013), Zarra-Nezhad et al. (2014) and other studies have been carried out in this field (Emami and Darbani, 2015), in which the factors affecting consumption expenditure of households have been investigated. By summarizing the findings, it can be argued that a limited number of studies have been carried out on the assessment of transmission of income shocks, separated as temporary and permanent, on household consumption expenditures, especially food commodities abroad. In Iran, due to the occurrence of significant economic changes since 2009, such as a surge in energy prices, the beginning of oil and banking sanctions, currency fluctuations, and the entry of various economic sectors into stagnant and negative growth, there is not a direct study on the survey and identification of household consumption insurance rates for shocks. Hence, doing this study for Iran is important and can provide a theoretical basis for further studies. The contribution of this paper follows the study of Blundell et al. (2008) and uses panel data that includes income and food expenditure data for Iranian households and social indicators of households such as age, gender, literacy, activity status, marital status; the rate of food consumption insurance for temporary and permanent income shocks over the period 2009-2021 is investigated.

Bani Asadi and Mohseni (2018) examined the effect of temporary and permanent shocks of productivity on the intensity of energy consumption in Iran, using the Blunchad-Quah method. The results of model estimation showed that temporary shocks of productivity are the main source of short-term changes in energy intensity. In addition, the permanent shocks of productivity will lead to reduced energy intensity in the long run.

Mowlaei and Ali (2019) examined the effect of temporary and permanent income shocks on Iranian household’s consumption. The results of the estimated model confirm the validity of the permanent income hypothesis (PIH) in Iran. So

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[1]. A large literature has shown that transitory shocks can have enormous effects on MPC, and DeBacker et al. (2013) have shown that transitory shocks can have significant effects on MPC.

that household consumption almost entirely explained by permanent shocks income, but it does not show sensitively to temporary shocks.

Mowlaei and Ali (2020) investigated the effect of economic shocks on the consumption of Iranian households over the period 1974-2018, using ARDL method. They found that there was a positive and significant relationship between household consumption; temporary and permanent income and money shocks, but there is a significant and negative relationship between household consumption and permanent government spending shocks in Iran.

3. The Basic Model

The consumer optimization problem (Deaton, 1991 and Carroll, 1992) is defined by (period t is the beginning of the lifetime horizon and period T is the end of the lifetime horizon):

$$\text{Max } \mathrm{E}_t\left[\sum_{n=0}^{T-t} \beta^n u(\mathbf{c}_{t+n})\right] \quad (1)$$

where $u(c) = \frac{\mathbf{c}^{1-\rho}}{1-\rho}$ is a CRRA utility function. The CRRA utility function is strictly concavewith $\rho > 1$. The consumer's initial condition is defined by market resources or "cashon-hand" m_t and permanent non-capital-income p_t [1]. The consumer's Dynamic Budget Constraint (DBC) is:

$$\begin{aligned} a_t &= m_t - c_t \quad (2) \\ b_{t+1} &= a_t R \\ m_{t+1} &= b_{t+1} + \underbrace{p_{t+1}\theta_{t+1}}_{y_{t+1}} \\ p_{t+1} &= p_t \underbrace{\Gamma\psi_{t+1}}_{\Gamma_{t+1}} \end{aligned}$$

where a_t indicates the consumer's savings (or wealth) at the end of period t, growing by the interest factor $R = (1 + r)$. b_{t+1} is the consumer's capital income, m_{t+1} is the sum of capital income b_{t+1} and non-capital income $p_{t+1}\theta_{t+1}$.

[1]. Note that p_t is defined differently here Deaton's (1992) definition of permanent income. The amount a consumer could spend while leaving capital and non-capital assets unchanged is what Deaton (1992) calls permanent income. Our notion of permanent income is originally taken from Carroll (1997): permanent income is the amount a representative consumer expects to earn if things go normally (no extreme shock). Under this definition, wages could be a plausible proxy for permanent income in our study.

θ_{t+1} and ψ_{t+1} are respectively a mean-one iid transitory and permanent income shocks[1] assumed to satisfy $E_t\theta_{t+n} = 1$, $E_t\psi_{t+n} = 1$, ed.[2] Γ is the permanent income growth factor, which is 1.31% per year according to our data set.
In future periods $t + n \forall n \geq 1$ there is a small probability ϕ that income is zero:

$$\theta_{t+n} = \begin{cases} 0 & \text{with probability } \phi > 0 \\ \frac{\xi_{t+n}}{1-\phi} & \text{with probability} \end{cases}$$

where ξ_{t+n} is an iid mean-one random variable assumed to satisfy $E_t\xi_{t+n} = 1 \ \forall n \geq 1$.[3] Call the cumulative distribution functions F_ψ and F_θ (and F_ξ from Equation 3 and F_θ). Permanent income and the cashbalance are strictly positive at the outset, and we assume that the consumer cannot die in debt suchthat $c_t \leq m_t \ \forall t \leq T$. Carroll (2019) proves (Appendix B) that the application of this condition defines a sequence of continuously differentiable strictly increasing concave functions of the optimal consumption rule that follows from the maximization problem (4) below. For present purposes, the key point is that buffer stock savers will not spend all available resources on consumption because a consumer who spends all available resources would arrive in period $t + 1$ with balances b_{t+1} of zero. The consumer could earn zero non-capital income over the remaining horizon, implying that they would be forced to spend zero and have negative infinite utility (Inada condition).[4] To avoid this, the consumer never spends everything.[5]

The problem can be written in recursive form (the Bellman equation), but it would be useful to first normalize the problem and reduce the number of state variables from two (m and p) to one ($m = \frac{m}{p}$). Defining the non-bold variables as the bold counterpart normalized by p_t(just like m), the normalized Bellman equation is:

$$V_t(m_t) = \underbrace{\max}_{\{c\}_t^T} u(c_t) + E_t\beta\Gamma_{t+1}^{1-\rho}V_{t+1}(m_{t+1}) \quad (4)$$

s.t.

$$a_t = m_t - c_t \quad (5)$$

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[1]. For a full treatment of transitory and permanent shocks, see Carroll (2019).
[2]. According to Iranian Household Budget Survey, the standard deviations of the normalized transitory and permanent income shocks are set to 0.062 and 0.085, respectively.
[3]. See Li and Stachurski (2014) for analyses of cases where the shock processes are unbounded.
[4]. In a CRRA utility function, the following condition holds $\lim_{c_t \to 0} u'(c_t) = c_t^{-\rho} = \infty$ which is known as the Inada condition.
[5]. This is an example of the “natural borrowing constraint” induced by a precautionary motive.

$$m_{t+1} = \underbrace{\left(\frac{R}{\Gamma_{t+1}}\right)}_{\mathcal{R}_{t+1}} a_t + \theta_{t+1}$$

from the Euler equation we have Equation 6, which excludes optimal consumption:

$$u'(c_t) = E_t\{R\beta\Gamma_{t+1}^{-\rho}u'(c_{t+1})\} \tag{6}$$

From this point on, we divide the problem into two modules:

1. The Perfect Foresight (PF) specialization of the model by setting $\phi = 0$ and all shocks to 1 ($\theta = \xi = \psi = 1$).[1]
2. Uncertainty-Modified module in which ϕ is no longer zero and transitory-permanent shocks are included.

3.1 Perfect Foresight Module

The dynamic budget constraint and the cannot-die-in-debt condition imply an intertemporal budget constraint (IBC):

$$PDV_t(c) = \overbrace{m_t - c_t}^{b_t} + \overbrace{PDV_t(p)}^{h_t} \tag{7}$$

where h_t is human wealth (HW). With a constant $\mathcal{R} = \frac{R}{\Gamma}$ human wealth equals to:

$$\mathrm{h_t} = \mathrm{p_t} + \frac{\mathrm{p_t}}{\mathcal{R}} + \frac{\mathrm{p_t}}{\mathcal{R}^2} + \cdots + \frac{\mathrm{p_t}}{\mathcal{R}^{\mathrm{T-t}}} = \mathrm{p_t}\left(\frac{1-\mathcal{R}^{-(\mathrm{T-t+1})}}{1-\mathcal{R}^{-1}}\right) \tag{8}$$

For human wealth to be finite, the condition $\mathcal{R}^{-1} < 1$ must hold, called the Finite Human Wealth Condition (FHWC). Intuitively, the interest rate must be greater than the growth rate of permanent income for human wealth to be finite.

According to the consumption Euler equation in PF with a CRRA utility function ($\frac{c_{t+1}}{c_t} = \frac{(R\beta)^{\frac{1}{\rho}}}{\Gamma} \equiv \mathcal{D}_\Gamma$),a similar algebra yields the $PDV_t(c)$:[2]

$$PDV_t(c) = \left(1 + \frac{\mathcal{D}_\Gamma}{\mathcal{R}} + \left(\frac{\mathcal{D}_\Gamma}{\mathcal{R}}\right)^2 + \cdots + \left(\frac{\mathcal{D}_\Gamma}{\mathcal{R}}\right)^{T-t}\right)c_t \tag{9}$$

$\frac{\mathcal{D}_\Gamma}{\mathcal{R}} \equiv \mathcal{D}_R$ is called the return impatience factor.[3] At infinite horizon ($T \to \infty$) to $PDV_t(c)$be finite, $\mathcal{D}_R$ must be strictly less than one ($\mathcal{D}_R < 1$) which is called Return Impatience Condition (RIC).

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[1]. This realization implies: in PF consumers know future expected income with certainty ($\phi = 0$), hence there are no unexpected transitory or permanent shocks to income.

[2]. Note that consumption grows by $\mathcal{D}$, but is discounted by R.

[3]. Note that $\frac{\mathcal{D}_\Gamma}{\mathcal{R}} = \frac{\frac{(R\beta)^{\frac{1}{\rho}}}{\Gamma}}{\frac{R}{\Gamma}} = \frac{(R\beta)^{\frac{1}{\rho}}}{R} \equiv \mathcal{D}_R$

According to Equations 7-9, we can define a normalized consumption function for a finite horizon with perfect foresight:

$$\overline{c_t} = \underbrace{\left(\frac{1-\mathcal{D}_R}{(1-\mathcal{D}_R)^{T-t+1}}\right)}_{\underline{\kappa}}(b_t + h_t) \tag{10}$$

where $\underline{\kappa}$ is the MPC in the module PF. The over-bar on c_t reflects the fact that this is an upper bound, as we modify the problem to account for constraints and uncertainty; analogously, the under-bar for κ indicates that it is a lower bound.

3.2 Uncertainty-Modified Module

When uncertainty is introduced, the expected value of human wealth (we assume that $E_t[\psi_{t+1}] = E_t[\psi_{t+2}] = \cdots = E_t[\psi]$):

$$h_t^u = \mathrm{E_t[h_t]} = \mathrm{p_t} + \frac{\mathrm{p_t E_t[\psi]}}{\mathcal{R}} + \frac{\mathrm{p_t E_t[\psi]^2}}{\mathcal{R}^2} + \cdots + \frac{\mathrm{p_t E_t[\psi]^{T-t}}}{\mathcal{R}^{\mathrm{T-t}}} = \mathrm{p_t}\left(\frac{1-\mathcal{R}^{-(\mathrm{T-t+1})}\mathrm{E_t[\psi]^{T-t+1}}}{1-\mathcal{R}^{-1}\mathrm{E_t[\psi]}}\right) \tag{11}$$

and the uncertainty-modified Euler equation for consumption from Equation 6 will be:

$$\frac{c_{t+1}}{c_t} = \mathcal{D}_\Gamma E_t(\psi_{t+1})^{\frac{1}{\rho}} \tag{12}$$

We can obtain the uncertainty-modified PDV(c):

$$PDV_t(c) = \left(1 + \frac{\mathcal{D}_\Gamma E_t(\psi)^{\frac{1}{\rho}}}{\mathcal{R}} + \left(\frac{\mathcal{D}_\Gamma E_t(\psi)^{\frac{1}{\rho}}}{\mathcal{R}}\right)^2 + \cdots + \left(\frac{\mathcal{D}_\Gamma E_t(\psi)^{\frac{1}{\rho}}}{\mathcal{R}}\right)^{T-t}\right)c_t \tag{13}$$

From the IBC we can define the normalized finite-horizon uncertainty-modified consumption function:

$$\overline{c_t}^u = \underbrace{\left(\frac{1-\mathcal{D}_\mathrm{R} E_t(\psi)^{\frac{1}{\rho}}}{\left(1-\mathcal{D}_\mathrm{R} E_t(\psi)^{\frac{1}{\rho}}\right)^{T-t+1}}\right)}_{\overline{\kappa}^u}(b_t + h_t) \tag{14}$$

where $\overline{\kappa}^u$ is the MPC when uncertainty is imposed on the model.

3.3 Bounds for MPCs

In an infinite horizon ($T \to \infty$), the MPC in PF and uncertainty-modified modules are $\underline{\kappa} = 1 - \mathcal{D}_R$ and $\overline{\kappa}^u = 1 - \mathcal{D}_\mathrm{R} E_t(\psi)^{\frac{1}{\rho}}$, respectively. As the cash balance m_t approaches infinity, the expected consumption growth factor goes to $\mathcal{D}_\mathrm{R}$, indicated by the lower bound in Equation 10, and the marginal propensity to consume approaches to $\underline{\kappa} = 1 - \mathcal{D}_\mathrm{R}$, the same as the consistent with MPC with perfect foresight. Carroll (2019) proves that with $\mathrm{m_t} \rightarrow 0$, the consumption growth factor approaches $\infty$and the MPC approaches $\bar{\kappa} = 1 - \phi^{\frac{1}{\rho}}\mathcal{D}_{\mathrm{R}}$. Carroll (2019) also proves in a recursive expression (Appendix F) that the inverse of the bounded MPC as $m_t \rightarrow \infty$ can be approximated as:

$$\underline{\kappa}_{\mathrm{t}}^{-1} = 1 - \mathcal{D}_{\mathrm{R}}\underline{\kappa}_{\mathrm{t+1}}^{-1} \quad (15)$$

It turns out that the limiting upper bound for the MPC as $\mathrm{m_t} \rightarrow 0$ can be approximated as:

$$\bar{\kappa}_{\mathrm{t}}^{-1} = 1 - \phi^{\frac{1}{\rho}}\mathcal{D}_{\mathrm{R}}\bar{\kappa}_{\mathrm{t+1}}^{-1} \quad (16)$$

Then $\{\bar{\kappa}_{\mathrm{T-n}}^{-1}\}_{\mathrm{n=0}}^{\infty}$ is a decreasingly convergent sequence if $0 \leq \phi^{\frac{1}{\rho}}\mathcal{D}_{\mathrm{R}} < 1$(the approximation RIC). The approximate Equations 15 and 16 are used to derive the experimental values. Figure 1 shows the consumption function rules and the limiting MPCs graphically. Further discussion can be found in Carroll (2019: 12-18).

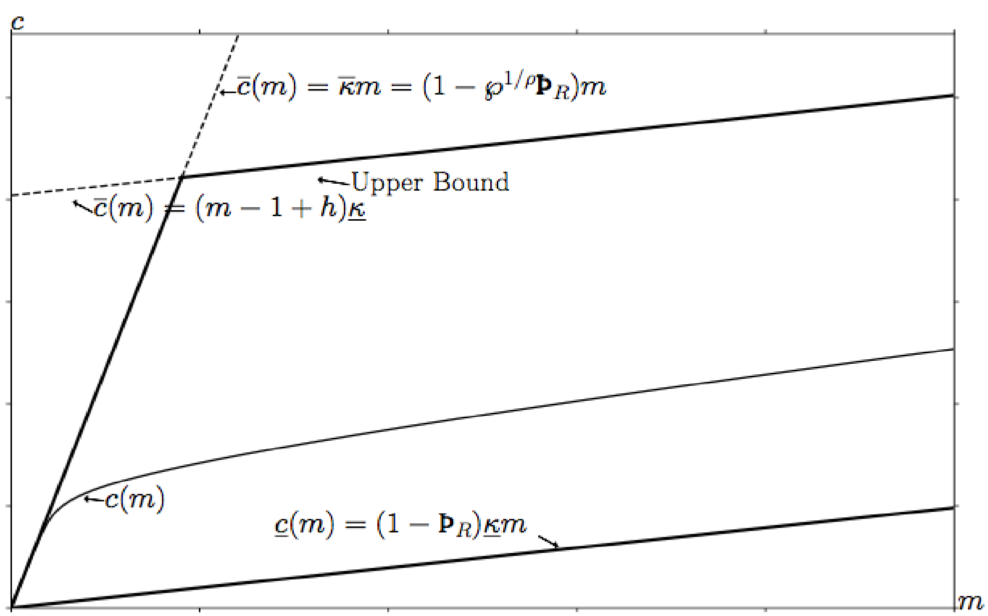

Figure 1. Bounds
Source: Carroll (2019).
Note: $c(m)$is the stable arm; $\underline{c}(m) = (1 - \mathcal{D}_R)\underline{k}m$ and$\bar{c}(m) = (m - 1 + h)\underline{k}$ are the lower and upper bounds on consumption, respectively. $\bar{c}(m) = (m - 1 + h)\underline{k}$is the normalized consumption function that follows strictly from (10) in an infinite horizon, but $\bar{c}(\mathrm{m}) = \bar{\mathrm{k}}\mathrm{m}$ is the consumption function as $\mathrm{m} \rightarrow 0$.

3.4 Analysis of Consumption Growth Path and the Steady State of the Model

Carroll and Toche (2013) state that the consumption rule from the Euler equation is for two possible states where the consumer remains employed (c_{t+1}^{e}) or becomes unemployed (c_{t+1}^{u}) is:

$$\frac{c_{t+1}^{e}}{c_{t}^{e}} = \mathcal{D}_{\Gamma}\left\{1 + \phi[\left(\frac{c_{t+1}^{e}}{c_{t+1}^{u}}\right)^{\rho} - 1]\right\}^{\frac{1}{\rho}} \tag{17}$$

In addition, the consumption rule from a logarithmic utility function can be approximated as:

$$\frac{c_{t+1}^{e}}{c_{t}^{e}} \approx [1 + \phi\nabla_{t+1}]\mathcal{D}_{\Gamma} \tag{18}$$

$\nabla_{t+1} = \frac{c_{t+1}^{e} - c_{t+1}^{u}}{c_{t+1}^{u}}$ is the amount by which consumption would fall if unemployment occurred. It is sometimes referred to as “consumption risk”. ∇_{t+1} is a positive number because consumption under employment c_{t+1}^{e} is greater than consumption under unemployment c_{t+1}^{u}. Since $\mathcal{D}_{\Gamma}$ is the value that $\frac{c_{t+1}^{e}}{c_{t}^{e}}$ would have in a PF model, we can conclude from Equations 17 and 18 that introducing uncertainty into the model increases consumption. The amount of consumption increase is proportional to the probability of becoming unemployed ϕ multiplied by ∇_{t+1}, the consumption risk.

For a consumer with no precautionary motive, for a given m_t the wealth effect of an increase in uncertainty would be zero because an increase in uncertainty represents mean-reverting dispersion in wealth. Since a change in uncertainty has no effect on the interest rate, the conventional determinants of consumption are not affected by a change in uncertainty. Therefore, an increase in consumption growth resulting from an increase in uncertainty is the result of the precautionary motive. Moreover, the introduction of uncertainty leads to a precautionary decrease in consumption and an increase in saving because faster consumption growth can only lead to the same PDV if the faster growth starts from a lower initial level of consumption, for any given initial value of m_t.

To find the steady-state level of consumption and cash balance, consider a consumer who was employed in period t and would be unemployed in the next period. The normalized DBC in PF (5) gives $m_{t+1}^{u} = b_{t+1}^{u} = \mathcal{R}(m_{t}^{e} - c_{t}^{e})$. The steady-state levels of m^{e} and c^{e} (if any) will be the intersection between the $\Delta m^{e} = 0$ and $\Delta c^{e} = 0$ loci, therefore, substituting $c_{t+1}^{e} = c_{t}^{e}$ and $C_{t+1}^{u} = k^{u} m_{t+1}^{u}$ into Equation 17 yields:

$$c_{t+1}^{e} = \Pi c_{t+1}^{u} \tag{19}$$

where $\Pi = \left(\frac{\mathcal{D}_{\Gamma}^{-\rho} - 1 + \phi}{\phi}\right)^{\frac{1}{\rho}}$. Setting $\Delta m^e = 0$ and $\Delta c^e = 0$ into Equation 19 gives, respectively:

$$c^e = \frac{\Pi k^u \mathcal{R}}{1 + \Pi k^u \mathcal{R}} m^e \tag{20}$$

$$c^e = \left(1 - \frac{1}{\mathcal{R}}\right) m^e + \frac{1}{\mathcal{R}} \tag{21}$$

The steady-state levels of m^e and c^e are the values for which both Equations 20 and 21 hold. This system of two equations in two unknowns can be solved explicitly. For a further discussion, see Carroll and Toche (2013) (see Appendix).

Figure 2 illustrates some of the key points of the steady state solution. It shows the expected growth rate of consumption as a function of the cash balance. As shown in the graph, consumption growth is equal to what it would be in the absence of uncertainty, plus a precautionary term.

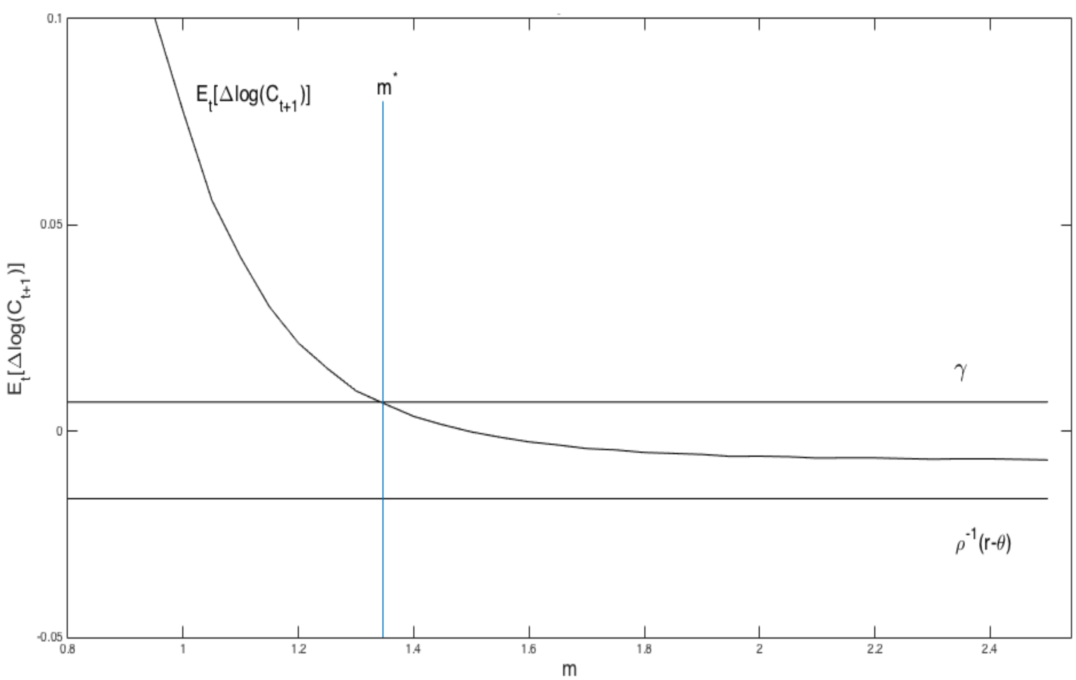

Figure 2. Expected Consumption Growth

Source: Research finding.

Note: The approximated growth rate of consumption from Equation 17 is: $\Delta \log c_{t+1}^{e} \approx \frac{r-\theta}{\rho} + \phi \nabla_{t+1}$. Thus consumption growth is equal to what it would be in the absence of uncertainty ($\frac{r-\theta}{\rho}$), plus a precautionary term ($\phi \nabla_{t+1}$).$\gamma$is the approximated value of $\log\Gamma$.

3.5 Details of the Method of Solution

The dynamic optimization problem solved in this paper corresponds to the consumption Euler equation (Equation 4 in Carroll et al., 1997) of the form[1]:

$$u'(c_t) = R\beta E_t\left\{u'\left(c_{t+1}\left(\frac{R[m_t - c_t]}{\Gamma\psi_{t+1}\theta_{t+1}}\right)\Gamma\psi_{t+1}\right)\right\} \quad (22)$$

Our solution method for the finite horizon version of the model is to solve recursively backward from the last life period T, in which the optimal plan is to consume all assets, $\mathrm{C_T}(\mathrm{m_T}) = \mathrm{m_T}$. At any given value of m_{T-1}, we can find the c_{T-1} that satisfies Equation 22 by the numerical algorithm introduced by Carroll (2020). In the period $(T - 1)$, Equation 22 is solved recursively for the optimal value of consumption for a lattice of m values, as described in Carroll (2020). The numerical approximation to the optimal consumption rule $c_{T-1}(m_T - 1)$ is obtained by exponential interpolation[2] between the values of the function at the grid points. By having $c_{T-1}(m_T - 1)$, a grid of m values is chosen for the period (T – 2). The numerical solution at m_i is calculated from Equation 22, and $c_{T-2}(m)$ is given by exponential interpolation. A further discussion can be found in Carroll (2020).

As described earlier, we assumed that income in period $t + 1$ $(\theta_{t+1} = 0)$ is zero with probability ϕ. We assume that if income is not zero, then ψ_{t+1} and θ_{t+1} have a lognormal distribution and the expected values are $(1 - \phi)$ and 1, respectively. When we started solving the model, we assumed that the lognormal distributions were truncated at two standard deviations from the mean, which gives the minimum and maximum values $\underline{\psi}, \overline{\psi}, \underline{\theta}, \overline{\theta}$. The lognormal distributions were approximated by a discrete probability distribution as described in Carroll (2012)[3]. The distance $(\overline{\psi} - \underline{\psi})$ was divided into 7 regions of size $\frac{(\overline{\psi} - \underline{\psi})}{7}$ with boundaries

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[1]. Equation 22is slightly different from Equation 12. The reason is that the shocks embedded in $\mathrm{c}_{t+1}\left(\frac{\mathrm{R}[\mathrm{m}_t - \mathrm{c}_t]}{\Gamma\psi_{t+1}\theta_{t+1}}\right)$ are not involved in the total expectation process and are only held for the consumption of the next period, so the total expectation at time t does not hold for the consumption of the next period (c_{t+1}).

[2]. After experimenting with both linear and quadratic interpolation, we decided that exponential interpolation fitted the data better.

[3]. For further discussion, see Carroll (2012: 7-12).

denoted B_j. Each of these regions was assigned the average value of ψ within the region, which was obtained by calculating the numerical integral $\hat{\psi}_j = \int_{B_j}^{B_{j+1}} \psi dF(\psi)$. The probability of drawing a shock with value $\hat{\psi}_j$, is given by $F(B_{j+1}) - F(B_j)$. See Carroll (2012) for a further discussion.

In solving the problem numerically, we need a convergence criterion to determine when convergence is achieved. The criterion is:

$$\left(\frac{1}{a}\right)\sum|c_i(m_i) - c_{i+1}(m_i)| < 10^{-6}$$

where i indexes the grid points of m's. Following Carroll (2012), the model is assumed to have a grid of ten values for the m'sThis method is similar to those used by Deaton (1991), Hubbard et al. (1995), Carroll (2012), and Carroll et al. (2020).

4. Results

4.1 Data and Calibration

This study mainly uses data from the Iranian Household Budget Survey (IHBS) to calibrate the parameters. Table 1 presents approximate values for parameters. Permanent income growth factor (Γ) is the growth rate of permanent income using wages as a proxy to calculate permanent income; interest rate factor (R) is the real interest rate factor calculated as $\mathrm{R} = \frac{\sum_{t=1996}^{t=2016}(\mathrm{int}_t - \mathrm{infl}_t \times 100\,)}{(2016-1996)+1}$. int_t and infl_t are nominal interest rate and inflation rate at time *t*; the time preference factor is calculated as $\beta = \frac{(1+\dot{c_t})^{\rho}}{\mathrm{R}}$, where$\dot{c_t}$ is consumption growth at time t. The coefficient of relative risk aversion (ρ) and the probability of zero income (ϕ) are taken from Carroll (2019), which are widely used values in the literature. The standard deviations of the logarithms of the permanent and transitory shocks are calculated from IHBS.[1]

[1]. Standard deviation of transitory shocks are calculated as the standard deviation of lognormal distribution of current income and Standard deviation of permanent shocks are calculated as the Standard deviation of lognormal distribution of permanent income.

Table 1. Parameter Calibrated Values

Description	Parameter	Approximate value	Source
Permanent income growth factor	Γ	1.0131	Research calculations
Interest factor	R	1.0342	Research calculations
Time preference factor	β	0.9683	Research calculations
Coefficient of relative risk aversion	ρ	2	Research Carroll (2019)
Probability of zero income	ϕ	0.005	Research Carroll (2019)
Stddev of log permanent shock	σ_ψ	0.0620	Research calculations
Stddev of log transitory shock	σ_θ	0.0852	Research calculations

Source: Research finding.

4.2 Results

Table 2 summarizes the steady-state solution of the buffer-stock version of the LC/PIH model. The standard model under the baseline parameter values summarized in Table 1 implies an average MPC from wealth of almost 24%. No commonly used value for parameters in the non-buffer-stock model implies an MPC of less than about 44%. Also, the average net wealth ratio (normalized wealth ratio) for buffer-stock savers is nearly 44%, which is again less than commonly used values in the literature (nearly 67%), such as Carroll et al. (1997), Carroll and Toche (2013), De Nardi (2015), Saez and Zucman (2016), Carroll (2019).

Table 2. Steady-state Results

Growth rate of aggregate consumption	0.0154
Average growth rate of household permanent income	0.0070
Average growth rate of household consumption	0.0087
Aggregate personal saving rate	0.0159
Average MPC out-of-wealth	0.2384
Average net wealth	0.4450
Target net wealth	0.4610

Source: Research finding.

An interesting question is: What is the relationship between the savings rate and expected income growth? If the average net wealth ratio in Steady State equilibrium is w* and the income growth rate is γ[1], then the savings rate necessary to grow wealth at the rate γ and keep the ratio of wealth to permanent income constantwill be $\gamma\ .w^*$ if the interest rate were zero. If the desired ratio of wealth to permanent income w* wereconstant, s = $\gamma\ ,w^*$ would be higher when γ were higher.

[1]. γ is the approximated value of logΓ.

For the parameter values reported in Table 1, the effect of human wealth is much smaller than in the models without buffer-stock LC/PIH, so we can conclude that the elasticity of the savings rate with respect to the growth rate of income will be positive throughout the steady state. This result is consistent with Carroll et al. (1997).

For the comparison of the relationship between growth and saving, the effect of human wealth in the buffer-stock version of LC/PIH compared to the non-buffer-stock module is also an interesting result. Results from empirical studies such as Carroll et al. (1997) can demonstrate that current consumption is less affected by expected future income than implied by the standard non-buffer-stock model LC /PIH. Carroll et al. (1997) calculate the effect of an innovation in current income on human capital and find that consumption underreacts to such innovations leading to human capital accumulation. Carroll and Toche (2013) find that predictable future income growth does not affect current consumption. Saez and Zucman (2016) and Carroll et al. (2017) point out that the post-1973 productivity decline in the US should have caused savings rates to rise sharply; instead, savings rates have fallen, which a buffer-stock model could easily predict as a positive relationship between the savings rate and the growth rate of income.

The question is if the MPCs from human wealth in a buffer-stock model are consistent with these results. The answer is difficult. The MPC from future income in precautionary savings models such as buffer-stock models depends on capital wealth, the distribution of future income, and the consumption rules that are expected to apply over the rest of the consumer's lifetime horizon. Therefore, the question of "how responsive consumption is to human wealth" cannot be answered directly. It depends on the case study. However, the question "how consumption respond to an increase in the expected growth rate of income" can be answered in this context.

Consider Figure 3, which plots the MPC from human wealth for infinite horizon versions of the buffer-stock model and the CEQ version of the LC/PIH model in the case where expected income growth is either 1.3% (permanent income growth factor from the data) or 2%(hypothetical growth rate), and the other parameters are assumed to be the values shown in Table 1. The straight lines represent the consumption functions in the PF (CEQ) module and the curved functions show the buffer-stock version of the consumption functions. The dashed lines represent the $\gamma = 2$ cases and the solid lines represent the $\gamma = 1.3$ cases. Increasing the income growth rate from 1.3% to 2% increases human wealth and consumption in the standard model (without buffer stock). Since buffer-stock consumers spend less of their expected future income than other consumers, consumption increases far less than in the CEQ version. The same point is illustrated numerically in Table 3.

Under the baseline parameter values, the MPC from human wealth in the CEQ model is a constant 4.4%for all plausible ratios of wealth to permanent income. In the buffer-stock version, the MPC increases as the wealth ratio increases, but remains small over the entire range. Our estimates are small enough and consistent with empirical estimates such as those in Carroll et al. (1997).

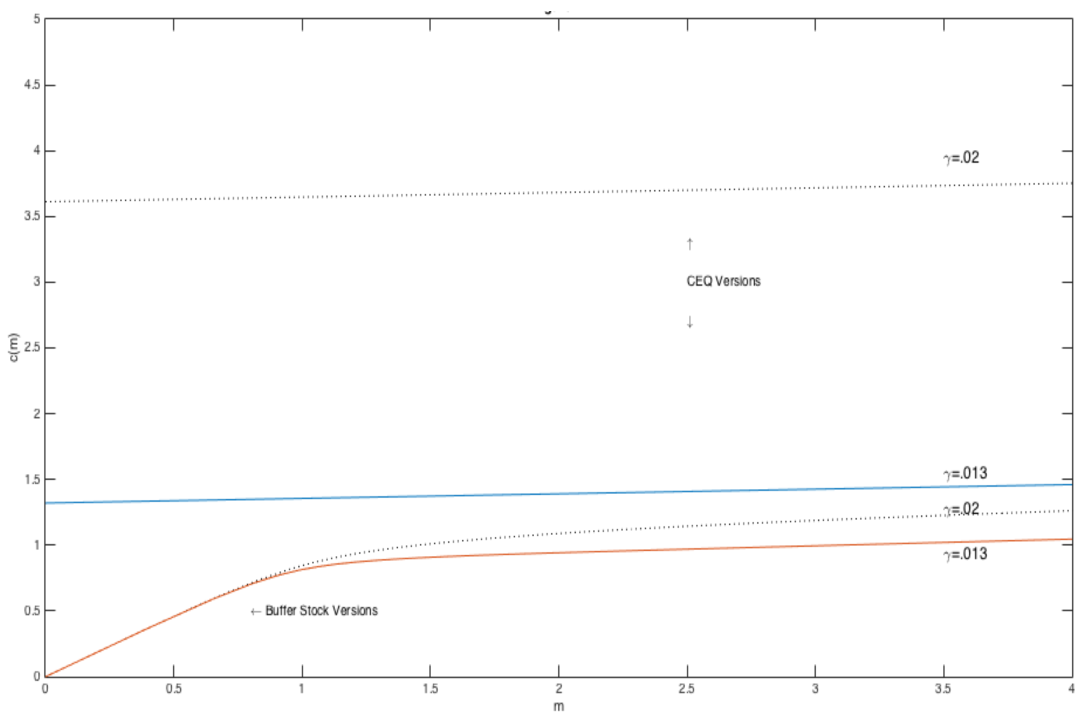

Figure 3. Consumption Function for the CEQ and Buffer Stock Models
Source: Research finding.

Table 3. Marginal Propensity to Consume out of Human Wealth

	Certainty model			**Buffer stock model**		
Gross wealth ratio	Consumption		MPC out of human wealth	Consumption		MPC out of human wealth
	$\gamma = 1.3$	$\gamma = 2$		$\gamma = 1.3$	$\gamma = 2$	
0.2	1.0082	1.5711	0.0442	0.1847	0.1850	0.0000
0.4	1.0170	1.5800	0.0442	0.3686	0.3698	0.0001
0.6	1.0259	1.5888	0.0442	0.5423	0.5460	0.0003
0.8	1.0347	1.5977	0.0442	0.6893	0.7092	0.0016
1	1.0435	1.6065	0.0442	1.7718	0.8354	0.0050
1.2	1.0524	1.6153	0.0442	0.8035	0.9123	0.0085
1.4	1.0612	1.6242	0.0442	0.8214	0.9578	0.0107
1.6	1.0701	1.6330	0.0442	0.8354	0.9892	0.0121
1.8	1.0789	1.6419	0.0442	0.8477	1.0132	0.0130
2	1.0878	1.6507	0.0442	0.8596	1.0327	0.0136
2.2	1.0966	1.6596	0.0442	0.8712	1.0495	0.0140
2.4	1.1054	1.6684	0.0442	0.8827	1.0646	0.0143
2.6	1.1143	1.6772	0.0442	0.8942	1.0786	0.0145
2.8	1.1231	1.6861	0.0442	0.9056	1.0920	0.0146
3	1.1320	1.6949	0.0442	0.9170	1.1050	0.0148

Source: Research finding.

Note: "Gross wealth ratio" shows the ratio of wealth to permanent income, which are hypothetical values. In column 6, when the gross wealth ratio exceeds 1.6, consumers start to spend more than the permanent income because, in the buffer-stock model, there is a unique target wealth ratio to permanent income, so if the wealth is below the target, the buffer-stock consumer will save, and if the wealth is above the target, the buffer-stock consumer will dissave.

4.3 The Consumption/Income Parallel

Solving the buffer-stock version of the LC/PIH model by backward recursion to Equation 22 yields the optimal consumption rule for each life period. Average income and consumption are estimated and simulated as in Table 2 by randomly drawing shocks to permanent and current income for consumers with no initial capital wealth. We assumed that the representative consumer dies after age 75 and that the upward trend in consumption occurs in the last years of life because consumers with buffer stocks spend all their wealth at the end of the life period; this is due to the realization of a small amount of uncertainty after retirement. To replicate the results in Carroll et al. (1997), we would have had to modify the model to assimilate lifetime uncertainty.

The simulated results are shown in Figure 4. The results show that for the buffer stock savers, consumption closely matches income until age 45. After age 45, buffer stock savers save for retirement, which causes the income profile to rise above the consumption profile in the years before 65 when retirement occurs.

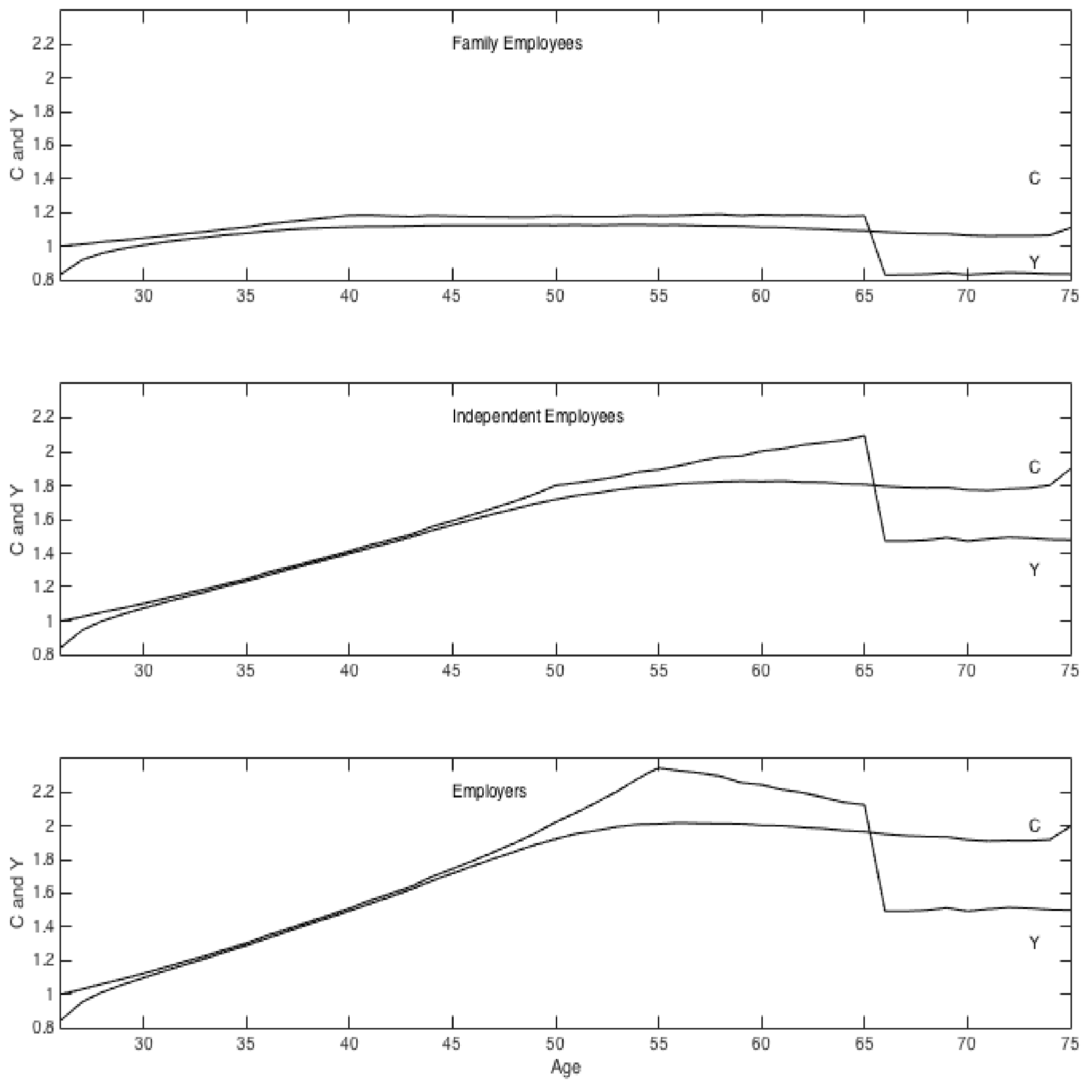

Figure 4. Age-specific Profiles of Consumption and Income
Source: Research finding.

It is worth noting that the results from Figure 4 do not necessarily argue against Friedman's (1957) permanent income hypothesis. Rather, it appears that he anticipated such results, as is clear from his statement on page 23 and page 93.

Friedman (1957) explains that the reason average income is not a good proxy for permanent income is that average lifetime income undermines the issue of the length of the lifetime horizon, which is essential to determining permanent income.

5. Conclusion

Until nowadays, despite ample evidence against the goodness of fit of the LC/PIH model to real-world data, the LC/PIH model remains the most widely used framework for macro and micro analysis of consumer behavior. This study shows that the buffer-stock version of the LC/PIH model is a better fit for the consumption and saving behavior of Iranians, mainly because of the nature of uncertainty faced by Iranians and because of the precautionary motive that arises from the uncertainty domain. We have shown that the MPC's lower estimates of human wealth in the buffer stock model can be obtained without imposing liquidity constraints. It also explains why the ratio of Iranian household wealth to permanent income is relatively small and stable, despite the recent slowdown in the economy, due to global sanctions on Iran.

The buffer-stock model cannot quite plausibly explain the behavior of the rich. Moreover, many consumers exhibit lifetime saving behavior via participation in retirement plans that cannot be explained by a buffer-stock model. This particular version of the LC/PIH model might provide a reasonable explanation for the "high frequency" saving behavior of the median consumer. Since wealth accumulation is low for median households in Iran, the average MPC from human wealth depends on the wealth measure targeted by the model.

Our estimate for MPCs is not consistent with most of the large estimates of MPCs reported in various studies such as Fakhraei and Mansoori (2010). Canbary and Grant (2019) investigate the marginal propensity to consume for UK households across different socio-economic groups. They find that households with higher socio-economic status and higher income-to-wealth ratio have a lower marginal propensity to consume which is in line with our finding (table 3). Gross et al (2020) estimated the marginal propensity to consume and found evidence that the household expenditure pattern was significantly affected by the anticipated shocks to income. These results are consistent with our findings too. Overall results from Borusyak and Jaravel (2017) show that for the most part professional and skilled households, indicate a lower marginal propensity to consume compared to unskilled and unoccupied which supports our finding (see Figure 4). While Kan et al. (2017) state around 80% of households plan their expenditure following the permanent income hypothesis, our results suggest this percentage to be around 46% (see Table 2), when investigating total expenditure and steady state net wealth to income ratio. Studies such as Hall and Mishkin (1982) and Carroll (1992) indicates that most of the variation in MPC estimates is related to the specification of the model, which would make the differences in our finding. The response to transitory or permanent (or both) income shocks depends on who receives the shocks. If the recipients of the exact same shocks were median households, this would have a smaller effect on MPC than wealthy households would; accordingly, it would have a larger effect relative to poor households.

References

Bani Asadi, M., & Mohseni, R. (2018). The Effect of Temporary and Permanent Shocks of Productivity on Intensity of Energy Consumption in Iran (Applied of Blanchard-Quah Method). *Iranian Energy Economics, 3*(10), 41-65.

Blundell, R., Pistaferri, L., & Preston, I. (2008). Consumption Inequality and Partial Insurance. *The American Economic Review, 98*(5), 1887-1921.

Borusyak, K., & Jaravel, X. (2017). Revisiting Event Study Designs, with an Application to the Estimation of the Marginal Propensity to Consume. *American Economic Journal: Macroeconomics, 24*(1), 69-110.

Broda, C., & Parker, J. A. (2014). The Economic Stimulus Payments of 2008 and The Aggregate Demand for Consumption. *Journal of Monetary Economics, Elsevier, 68*(S), 20-36.

Canbary, Z., & Grant, C. (2019). The Marginal Propensity to Consume for Different Socio-Economic Groups. *Economics and Finance Working Paper Series, 1916*, 1-40.

Carroll, C. D., Slacalek, J., & Tokuoka, K. (2015). Buffer-Stock Saving in a Krusell–Smith World. *Economics Letters, 132*, 97-137.

Carroll, C. D., Slacalek, J., Tokuoka, K., & White, M. N. (2017). The Distribution of Wealth and the Marginal Propensity to Consume. *Quantitative Economics, Econometric Society, 8*(3), 977-1020.

Carroll, C. D. (2019). Theoretical Foundations of Buffer Stock Saving. *Economics Letters, Elsevier, 132*(C), 97-149.

---------- (2012). Solution Methods for Microeconomic Dynamic Stochastic Optimization Problems. *Econometrica, 364*(4), 981-992.

---------- (1992). The Buffer-Stock Theory of Saving: Some Macroeconomic Evidence. *Brookings Papers on Economic Activity*, *23*(2), 61-156.

Carroll, C. D., & Toche, P. (2013). A Tractable Model of Buffer Stock Saving. *CFS Working Paper Series*, *15265*, 1-36.

Carroll, C. D., Tokuoka, K., & Weifeng, W. (2012). The Method of Moderation. *Johns Hopkins University Papers*, Retrieved from https://www.econ2.jhu.edu/people/ccarroll/papers/ctwmom/

Carroll, C. D., & Andrew, A. S. (1997). The Nature of Precautionary Wealth. *Journal of Monetary Economics*, *40*(1), 41-71.

De Nardi, M. (2015). Quantitative Models of Wealth Inequality: A Survey. *The Review of Economic Studies*, *71*(3), 743-768.

Deaton, A. (1991). Saving and Liquidity Constraints. *Econometrica, Econometric Society*, *59*(5), 1221-1248.

DeBacker, J., Heim, B., Panousi, V., Ramnath, S., & Vidangos, I (2013). Rising Inequality: Transitory or Persistent? New Evidence from a Panel of U.S. Tax Returns. *Brookings Papers on Economic Activity*, *44*(1), 67-142.

Emami, K., & Darbani, S. (2015). Determinants of Expenditures of Consuming Non-durable Goods in Iran. *Journal of Economic Modeling*, *2*(5), 91-110.

Fakhraei, E., & Mansoori, A. (2010). Estimating Marginal Propensity to Consume for Income Groups Based on Relative Permanent Income Hypothesis in Iran. *Knowledge and Development Journal*, *17*(29), 21-38.

Friedman, M. (1957). *A Theory of the Consumption Function*. Princeton, NJ: Princeton University Press.

Gross, T., Matthew, J., & Wang, J. (2020). The Marginal Propensity to Consume over the Business Cycle. *American Economic Journal: Macroeconomics*, *12*(2), 351-384.

Hall, R., & Mishkin, F. (1982). The Sensitivity of Consumption to Transitory Income: Estimates from Panel Data on Households. *Econometrica*, *50*(2), 1-46.

Hubbard, R. G., Skinner, J., & Zeldes, S. P. (1995). Precautionary Saving and Social Insurance. *Journal of Political Economy, CIII*(1995), 360-399.

Kan, K., Peng, S. K., & Wang, P. (2017). Understanding Consumption Behavior: Evidence from Consumers Reaction to Shopping Vouchers. *American Economic Journal: Economic Policy*, *9*(1), 137-153.

Kenneth, L. J. (1998). *Numerical Methods in Economics*. Massachusetts: The MIT Press.

Kimball, M. S. (1990). Precautionary Saving and the Marginal Propensity to Consume. *Econometrica, Econometric Society*, *58*(1), 53-73.

Li, H., & Stachurski, J. (2014). Solving the Income Fluctuation Problem with Unbounded Rewards. *Journal of Economic Dynamics and Control, 45*(C), 353-365.

Mowlaei, M., & Ali, O. (2020). The Effect of Economic Shocks on the Consumption Iranian Households. *Journal of Economic Research (Tahghigatt- E- Eghtesadi), 53*(4), 941-970 (In Persian).

---------- (2019). The Effect of the Temporary and Permanent Income Shocks to Household's Consumption in Iran, Using Blanchard-Quah Method. *Quarterly Journal of Applied Theories of Economics, 3*(3), 93-114.

Roshan, R., Bahlavani, M., & Shahiki Tash, M. (2013). Investigating the Rule-of-Thumb in Consumption by GMM Approach in Iran. *Journal of Economic Modeling, 8*(25), 53-65.

Saez, E., & Zucman, G. (2016). Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data. *The Quarterly Journal of Economics, 131*(2), 519-578.

Yazdan, F. G., & Sina, M. (2013). The Testing of Hall's Permanent Income Hypothesis: A Case Study of Iran. *Asian Economic and Financial Review*, *3*(3), 311-318.

Zarra-Nezhad, M. (2014). Estimating Consumption Function for both Rural and Urban Areas of Consumer Goods over the Period (1974-1998). *Iranian Economic Research*, *3*(5), 23-46.

Zeldes, S. P. (1989). Optimal Consumption with Stochastic Income: Deviations from Certainty Equivalence. *Quarterly Journal of Economics*, *104*(2), 275-298.

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