Consumption Commitments and The Consumption Elasticity to Permanent Income

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Abstract

I propose a "lock-in" mechanism for understanding consumption's under-response to permanent income. Households choose a consumption path given expected income. However, when the uncertainty realizes, many only partially adjust their expenditure since adjusting some goods is costly, resulting in a depressed consumption response to permanent income. To support this claim, I document novel facts on the consumption elasticity to permanent income: how it changes with age, its dependence on past permanent income growth, and how it changes after a household fully adjusts its bundle. Second, I simulate a life-cycle model which incorporates lumpy goods adjustment and other competing mechanisms that the literature has used to explain consumption's under-response to permanent income. The "lock-in" mechanism is necessary for the model to generate the documented fact, and it decreases the importance of preference explanations in explaining wealth distribution.

Keywords: Permanent Income, Life-cycle Consumption, Lumpy Adjustment

JEL - Classification: D15, D31, D52, E21

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1 Introduction

Since Milton Friedman's *A Theory of the Consumption Function (1957)*, economists have formalized the consumption-savings trade-off under income risk by adopting the concept of permanent income. However, evidence suggests that current models fail to accurately capture the consumption response to income. Most relevant to this paper, consumption responds too little to unexpected permanent income shocks (Campbell and Deaton, 1989; Blundell, Pistaferri, and Preston, 2008; Kaplan and Violante, 2010), and high lifetime income consumers save a larger fraction of their income (Dynan, Skinner, and Zeldes, 2004; Straub, 2019).[1] I will refer to these puzzles as the consumption's under-response to permanent income.

In this paper, I show that a mechanism of "lock-in" at past consumption choices is important to understand consumption's under-response to permanent income. Households commit themselves to an expenditure path given some expectation about future income. However, when the uncertainty realizes in a positive direction, some households do not fully adjust their consumption bundle because adjusting the quantity demanded of some goods is costly.[2] As a result, those who choose not to fully adjust their consumption bundles have a depressed consumption relative to what canonical models would predict given permanent income levels. To support this claim, I provide empirical evidence and use a quantitative model. Empirically, I document new facts about the consumption response to permanent income that corroborate my mechanism. Quantitatively, I simulate a life-cycle model which incorporates lumpy goods adjustment and other competing mechanisms that the literature has used to explain consumption's under-response, such as non-homothetic preferences and luxury bequest motive. Lumpy adjustment is needed to explain the documented empirical facts. Moreover, the importance of preference explanations in explaining wealth distribution diminishes, which implies less wealth inequality in the long run after an increase in permanent income inequality.

To formalize the "lock-in" mechanism and to derive its implications for household behavior, I start by modifying an off-the-shelf life-cycle consumption model (Deaton, 1991; Carroll, 1997; Gourinchas and Parker, 2002) to incorporate two consumption goods, one of which is hard-to-adjust. I model the hard-to-adjust good by assuming that the agent has to pay a non-convex adjustment cost to change the consumed quantity (Chetty and Szeidl, 2007; Berger and Vavra, 2015).

[1]With current consumption theories, I mean models in which the permanent income concept is central to their predictions, such as the Certainty Equivalence Model (Hall, 1978), the Standard Incomplete Model (SIM) (Deaton, 1991; Carroll, 1997), and their variation. Another finding of the literature is that consumption is excessively sensitive to anticipated transitory income shocks, see Flavin (1981), Hsieh (2003), and Ganong and Noel (2019). For an extensive literature review, see Jappelli and Pistaferri (2017).

[2]Chetty and Szeidl (2007, 2016) call these goods consumption commitments – goods subject to transaction costs and infrequently adjusted.

I also allow for other competing mechanisms used by the literature to explain consumption's under-response, such as non-homothetic preferences (Straub, 2019) and luxury bequest motive (De Nardi, 2004).

I calibrate the model using moments computed from the Panel Survey of Income Dynamics (PSID). In particular, I match the consumption's response to permanent income in the model to its sample analogous. For that, I perform a measurement exercise and construct a time-varying measure of permanent income at the household level. In the theory and the data, permanent income is defined as current assets plus the discounted future expected path of income. Crucially for the data measurement, I estimate expected income by assuming an income process and forecasting the income profile for each household, while I measure net worth by total assets minus total debt.

The first moment used to calibrate the model is a consumption elasticity to permanent income of approximately 0.70, a result initially documented by Straub (2019) and Abbott and Gallipoli (2019). The second moment used is the existence of path dependence in the consumption response to permanent income, a new fact that has not been documented yet in the literature. Conditional on current permanent income, past permanent income growth decrease current consumption. In other words, two households with the same permanent income today consume differently depending on when they learn later about their permanent income. In the data, households with faster permanent income growth consume less than those with lower growth.

Measuring permanent income in the data is not a straightforward exercise and demands strong assumptions. I address possible concerns with my measure by performing different robustness checks. First, I confirm the quality of the PSID data in measuring households' flows and assets over the life cycle. In particular, I compare and confirm that the reported assets in the PSID are consistent with an implied asset measure constructed with the period-by-period reported expenditure and income. Also, this exercise reveals that households with faster permanent income growth report more assets. Second, I check the model performance in non-target moments. The model is able to generate: i) a consumption response that decreases with age, ii) a path dependence in consumption response that increases with age, and iii) a path dependence in reported savings.

Two additional exercises shed light on the mechanism. First, using the detailed consumption categories available in the PSID, I estimate an expanded AIDS demand system allowing each consumption category's expenditure share to depend on current log expenditure and past expenditure growth. The former captures the traditional income effect, allowing the recovery of good's Engel curves. The latter captures how households with faster permanent income growth allocate their expenditure differently across consumption categories. The data reveal that high expenditure growth is associated with a higher share of easy-to-adjust goods consumption (nondurables, such as food) and lower for hard-to-adjust goods consumption, especially shelter. Second, I investigate how households that adjusted their consumption commitments' quantity behave. I focus on shelter consumption (housing flow for homeowners and rent for renters) since it accounts for a significant share of a typical household's consumption bundle and is subject to substantial transaction costs. Using past moving decisions as a proxy for adjusting, I show that households who adjust their consumption commitments exhibit little or no path dependence in the demand system or in the consumption response to permanent income. Both facts are compelling evidence in favor of the explanation that some households can freely adjust some goods but are locked up in some hard-to-adjust goods, being the calibrated model able to match these facts.

With a calibrated model consistent with the micro evidence on households' consumption response to permanent income, I perform contractual exercises. First, I show that only a model with lumpy goods adjustment can account for all the target moments. I do this by shutting off different mechanisms and recalibrating the model. However, this exercise also informs that preference explanations are also important to account for the documented facts. Second, I investigate the model's implication for wealth distribution. Similar to the previous result, the model needs lumpy goods adjustment and preferences explanations to explain the wealth distribution. However, the latter is quantitatively much less important once one allows for the former. Lastly, I solve the model for transition dynamics and the long-run impact of a permanent increase in permanent income inequality. Lumpy adjustment is a transitory phenomenon and translates to a smaller increase in wealth inequality.

Related Literature My paper relates to three strands of the literature. First, it adds to the vast empirical literature that tests the Permanent Income Hypothesis (PIH). Starting with Friedman (1957), this literature focuses on predictions about consumption responses to transitory or permanent income changes. The PIH predictions have been tested on aggregate time series (Hall, 1978; Flavin, 1981; Campbell and Deaton, 1989) and microdata (Hall and Mishkin, 1982; Altonji and Siow, 1987; Shea, 1995). I contribute to this literature in two dimensions. First, I show that the aggregate bundle masks substantial heterogeneity among less aggregated consumption categories and demonstrate how this heterogeneity can help distinguish between various consumption theories. Bils and Klenow (1998) and Aguiar and Hurst (2013) also look at less aggregated consumption categories in a different context. Second, I use the recent data of the PSID that has broad information on household expenditure. Using these later years is an improvement relative to studies that use only food or imputed consumption. Other studies also used recent PSID data, such as Blundell, Pistaferri, and Saporta-Eksten (2016) and Arellano, Blundell, and Bonhomme (2017).

Second, I add to works that compare the consumption response to permanent income in simulated models and data. Kaplan and Violante (2010) find that the permanent income shocks pass-through to consumption is close to 0.78 in a simulated consumption model, while Blundell et al. (2008) find a pass-through of 0.64 using PSID data. More related to my work, Straub (2019) defines permanent income as an individual-specific fixed effect in the log labor income process. By assuming that agents know this "permanent income fixed effect" and that it is riskless, Straub estimates a consumption elasticity to the permanent fixed effect of 0.7 and shows that canonical models would have an elasticity of 1. This evidence leads Straub to motivate the addition of non-homothetic preferences in the model as a way to capture backloaded consumption, such as health expenditures and intervivos transfers.

Third, I add to the literature that studies the implications of adjustment costs to household behavior. Chetty and Szeidl (2007) study implications for individual risk preferences. Berger and Vavra (2015); Chetty and Szeidl (2016) study the implications for the aggregate consumption dynamic. Kaplan and Violante (2014) use a model in which households can hold two assets, one subject to adjustment costs, to study consumption responses to fiscal stimulus. I contribute to this literature by showing that consumption commitments are a key mechanism behind the consumption under-response to permanent income. I also contribute to the broad literature on housing consumption dynamics (Yang, 2009) and their aggregate implications (Hurst and Stafford, 2004; Berger, Guerrieri, Lorenzoni, and Vavra, 2018; Beraja, Fuster, Hurst, and Vavra, 2019).

Roadmap. Section 2 presents a standard incomplete markets life cycle model nesting lumpy goods adjustment and key features proposed by the literature to explain consumption's under-response to permanent income. Section 3 describes the calibration procedure and how I measure permanent income in the data and model. Section 4 presents the estimate of the consumption's response to permanent income in the data and model. Significant part of the section explores how the model performs in non-target moments. Section 5 has the model aggregated implications. Finally, Section 6 concludes. The appendix contains additional empirical and quantitative results.

2 A Life-Cycle Model with Lumpy Goods' Adjustment

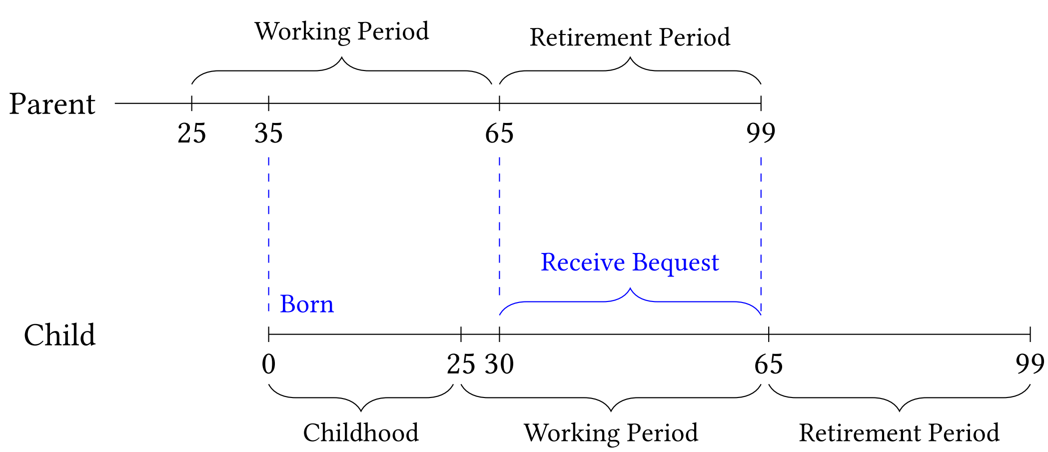
In this section, I describe a canonical incomplete markets model (Deaton, 1991; Carroll, 1997; Gourinchas and Parker, 2002) extended to incorporate two consumption goods, one of which the household has to pay a non-convex adjustment cost to change the consumed quantity (Chetty and Szeidl, 2007; Berger and Vavra, 2015). Households insure idiosyncratic labor risk using a single risk-free bond and the stock of hard-to-adjust goods, which can be interpreted as housing or durables. They are also subject to a borrowing constraint. In addition, the model also allows for other competing mechanisms used by the literature to explain consumption's under-response, such as non-homothetic preferences (Straub, 2019) and luxury bequest motive (De Nardi, 2004).

2.1 Environment

Demographic I consider the problem of a continuum of households in an overlap generation structure. In the model, each period corresponds to one year, such that j indexes the age of the household. Households enter the labor market at age $j = 0$, which corresponds to a biological age of 25, and retire at model age $R = 40$ (biological age 65). Once retired, households face a probability, denoted by ψ_j, of dying between age j and $j+1$, and they die with certainty at model age $J = 74$ (biological age 99).

Figure 1 displays the overlap structure of the model. Households have a child-household at age $j = 10$ (biological age 35), which implies that the child enters the labor market when the parent is at age j=35 (biological age 60) and retires when the parent has already passed away at a hypothetical age $j = 75$ (biological age 100). Parents and children are connected by bequest and intergeneration transmission of skill, both to be explained further in the text. Since parents face a positive mortality risk during retirement, children might receive bequest between age $j = 5$ (biological age 30) and age $j = 64$ (biological age 59). This timing ensures that only two generations are alive simultaneously in the model, and no bequests are transferred directly from grandparents to grandchildren. There is no population growth in the model.

Figure 1: Overlap Generation Structure



Preferences Households have standard time-separable preferences with discount factor, β, and period utility defined over an aggregated consumption bundle composed of two commodities. The first commodity comprises easy-to-adjust goods, and I will refer to it as nondurable consumption, n. The second one comprises hard-to-adjust goods, and I will denote it as housing flow,ζh, where ζ is the return (in utility terms) on the housing stock h. I focus on housing since it is the principal hard-to-adjust good in the data, accounting for a significant share of a typical household's consumption bundle and being subject to substantial transaction costs. Both commodities are aggregated by a CES function,

$$c = g(\zeta h, n) = \Big(\omega(\zeta h)^{\gamma} + (1-\omega)n^{\gamma}\Big)^{\frac{1}{\gamma}}$$

where ω is the share parameter that determines the weight of housing flow in the aggregator function, and $1/(1-\gamma)$ is the elasticity of substitution. An aspect in which my model differs from the one of Kaplan and Violante (2014) is that distortions in the allocation of expenditure across different consumption categories play an important role in my model, while they assume a frictionless rental market for housing, which implies that total expenditure is allocated optimally across categories. In their model, households maximize an indirect utility function.

Dynan et al. (2004), Straub (2019), and others have identified in the data that households with higher lifetime incomes display higher saving rates, which contradicts the predictions of standard homothetic life cycle models. The main reasons for this saving behavior are intergenerational transfers (such as bequests and intervivos transfers) and other expenses later in life (such as health expenditures). I capture these different motives using non-homothetic preferences as Straub (2019) and luxury bequest motives as De Nardi (2004).

In particular, I assume that the period utility for a household at age j is given by

$$u_j(c) = \frac{(c/o)^{1-\sigma_j} - 1}{1-\sigma_j}$$

where $\sigma_j > 0$ is an age-dependent elasticity. As in Straub (2019), the coefficient of risk aversion in the utility function follows a simple exponential decay, $\sigma_{j+1}/\sigma_j = \sigma_{slope}$ during one's working life and flat after that. The model is parameterized such that σ_j decreases as the household ages, resulting in a high-income elasticity for consumption when old. In other words, these preferences imply a back-loaded consumption profile for higher-income households and are a tractable way of capturing their later-in-life expenses, such as payments for college education, charitable giving, or expensive medical treatments. $o > 0$ is a normalization parameter, which can be used to retain aggregate scale invariance.

Preferences over bequests are given by

$$\mathcal{B}(a,h) = \frac{\phi_1}{1-\sigma}\left(\frac{\phi_2 + a + h}{o}\right)^{1-\sigma}$$

in which a is a risk-free bond, ϕ_1 is a weight parameter, and ϕ_2 governs the degree of luxury associated with the bequest motive. I assume that housing and assets are perfect substitutes in the bequest function, implying that households are indifferent between leaving one or another to their children. Estate taxes are paid by the child-household, so they do not distort parents' decisions. Again, $o > 0$ is a normalization parameter.

Idiosyncratic Earnings Households are subject to idiosyncratic labor income risk. The labor productivity process is a combination of a Markov process and a deterministic age-related component. To clarify the notation, I use subscript i for time-invariant individual-specific income components, j for components common to all households, and both i and j for time-variant individual-specific components. In particular, for household i at age j, the productivity process is

$$\begin{aligned} z_{i,j} &= b_1 j + b_2 j^2 + \bar{z}_i + \alpha_{i,j} + \epsilon_{i,j} \\ \alpha_{i,j} &= \rho\alpha_{i,j-1} + \xi_{i,j} \end{aligned}$$

where b_1 and b_2 define the age-specific deterministic component, $\bar{z}_i$ is an individual fixed effect, $\alpha_{i,j}$ is a persistent component of productivity that follows an AR(1) process, and $\epsilon_{i,j}$ is a transitory income component. The fixed effect distribution depends on the household's parent fixed effect and will be defined later. The shocks $\epsilon_{i,j}$ and $\xi_{i,j}$ are independent and identically distributed (iid) across households i and ages j, with each following a normal distribution with variances σ^2_ϵ and σ^2_ξ, respectively. The total labor income is calculated as the product of the aggregate market wage per efficiency unit of labor (denoted as w) and the exponential of the productivity term: $w \times \exp(z_{i,j})$. It is important to note that labor income in the model corresponds to earnings after accounting for taxes and transfers. This concept is also applied when working with the PSID sample, ensuring consistency in the treatment of labor income.

Assets Households invest in liquid assets, a risk-free asset, and illiquid assets, housing stock. The risk-free asset carries a constant risk-free rate denoted as r. Housing stock provides a utility flow represented by ζ and experiences depreciation at a rate of δ per period. To adjust the housing stock, households must incur nonconvex costs, reflecting expenses such as brokers' fees or moving costs (Grossman and Laroque, 1990; Berger and Vavra, 2015). These costs are modeled as a proportional cost, meaning that households lose a fraction of the value of their housing when adjusting their housing stock. The adjustment cost function is specified as follows:

$$\mathcal{A}(h, h_{-1}) = \begin{cases} 0 & \text{doesn't adjust} \\ \kappa h_{-1} & \text{does adjust} \end{cases}$$

When households own a house, they incur a "required maintenance" parameter, χ, which accounts for maintenance needed to continue enjoying housing flows, such as repairing a broken furnace or reforming the electrical circuit system. Additionally, households face a borrowing constraint that depends on their housing stock: $a > -\theta h$. In other words, households can borrow using their house as collateral. They start their working lives with a given quantity of assets and housing drawn from an initial exogenous distribution.

Retirement Period Once retired, household lives off of financial wealth a, housing wealth h, and social security benefits, $pen(\bar{z})$, which is a function of the income fixed effect.

2.2 Recursive Formulation

Let s denote the state variables vector for a household, $s = \left\{j, a, h_{-1}, \bar{z}, \alpha, \epsilon, \bar{z}^p\right\}$. These variables indicate, respectively, age (j), bonds carried from the previous period (a), past housing stock (h_{-1}), productivity components ($\bar{z}, \alpha, \epsilon$), and the value of the parent-household's fixed income effect until the child-household inherits and zero thereafter ($\bar{z}^p$). This last variable has two purposes, as in De Nardi (2004). First, when it takes on a positive value, it is used to calculate the probability distribution of bequests that a household expects to receive from a parent. Second, it helps differentiate between agents who have already inherited (for whom $\bar{z}^{p'}$ is set to 0) and those who have not (for whom $\bar{z}^{p'}$ is strictly positive).

The first decision of the household is to adjust or not their housing consumption,

$$V(s) = \max\left\{V^{adj}(s), V^{noadj}(s)\right\} \tag{1}$$

where $V^{adjust}(s)$ and $V^{noadjust}(s)$ are the value functions conditional on adjusting and not adjusting. The adjustment decision takes place at the beginning of the period, after receiving the income shock, but before the consumption decision.

If $V^{noadjust}(s_j) > V^{adjust}(s_j)$, the household chooses not to adjust its housing consumption and solves the following problem:

$$V^{noadj}(s) = \max_{n,a'} \; u_j\Big(g(n,h)\Big) + (1-\psi_j)\,\beta\,\mathcal{B}\Big(a',h\Big) + \psi_j\,\beta\,\mathbb{E}\Big\{V(s')\Big|s\Big\}$$

s.t.

$$h = (1-\delta(1-\chi))h_{-1}$$

$$n + a' = pen(\bar{z}) + we^{z} + (1+r)a - \delta\chi h_{-1}$$

$$n > 0, \quad a \geq -\mu h$$

$$\bar{z}^{p'} = \begin{cases} \bar{z}^{p} & \text{with prob } (1-\psi_{j+35}) \\ 0 & \text{with prob } \psi_{j+35} \end{cases}$$

where z evolves according to a conditional c.d.f. Γ^{z} and next-period state vector is $s' = \Big\{j+1, a'+b', h_{-1}(1-\delta(1-\chi)), \bar{z}, \alpha', \epsilon', \bar{z}^{p'}\Big\}$. Observe that bequests, b, enter the household's state vector as an increase in next-period assets. Household's belief about the probability distribution of bequest sizes is a function of their age and its parent fixed effect and has conditional c.d.f $\Gamma^{j,\bar{z}^{p}}$.

If $> V_j^{adjust}(s_j) \geq V_j^{noadjust}(s_j)$, the household chooses to adjust its housing consumption and solves the following problem:

$$V^{adj}(s) = \max_{n,h,a'} \; u_j\Big(g(n,h)\Big) + (1-\psi_j)\,\beta\,\mathcal{B}\Big(a',h\Big) + \psi_j\,\beta\,\mathbb{E}\Big\{V(s')\Big|s\Big\}$$

s.t.

$$h = (1-\kappa)(1-\delta)h_{-1} + x$$

$$n + a' + x = pen(\bar{z}) + we^{z} + (1+r)a$$

$$n > 0, \quad a \geq -\theta h$$

$$\bar{z}^{p'} = \begin{cases} \bar{z}^{p} & \text{with prob } (1-\psi_{j+35}) \\ 0 & \text{with prob } \psi_{j+35} \end{cases}$$

where z evolves according to a conditional c.d.f. Γ^{z}, b has conditional c.d.f $\Gamma^{j,\bar{z}^{p'}}$, and next-period state vector is $s' = \Big\{j+1, a'+b', h, \bar{z}, \alpha', \epsilon', \bar{z}^{p}\Big\}$.

I solve the model for the partial equilibrium with $w = 1$ and $r = 0.04$. Appendix C describes the computational algorithm used to solve the problem.

2.3 Mechanism

In the optimization problem, households choose savings and consumption to maximize their lifetime utility given their assets (a and h) and expected income path. In a model with homothetic preferences and without adjustment costs, the optimal allocations of savings and consumption are approximately linear in permanent income – the sum of total assets and the present value of future income. This implies that consumption has an elasticity of 1 with respect to permanent income, and any increase in permanent income leads to a proportional increase in consumption. In other words, the intertemporal indifference curves have constant slopes along rays originating from the origin, and the intertemporal Engel curve is linear.

However, when non-convex adjustment costs are present, households can only partially adjust their consumption bundle in response to an increase in permanent income. As a result, the allocation of expenditure across consumption categories is not optimal, which works as a utility wedge (or a tax on current consumption). Consequently, households will substitute present consumption for future consumption. This substitution allows households to mitigate the inefficiencies caused by the suboptimal expenditure allocation and consume when the bundle is closer to the optimal allocation.

Households that experienced an increase in permanent income should exhibit depressed consumption and higher savings because increases in their consumption of easily adjustable goods will exacerbate the distortion in the allocation of expenditure. On the other hand, households that experienced a decrease in permanent income should overconsume and reduce savings, avoiding reductions in easy-to-adjust goods and increases in allocation distortions. In other words, permanent income when households have determined the current hard-to-adjust goods quantity is important to understanding their current consumption choices. Appendix D presents a two-period model and explains the mechanism using Fisher diagrams.

In the next section, I will use PSID data to measure how much current consumption depends on current and past permanent income, and I will calibrate the model to match this evidence. This dependence on lagged variables, which I will refer to as path dependence, arises due to the trade-off between maintaining an optimal allocation of expenditure across categories and adjusting consumption in response to changes in permanent income. This path dependence gives rise to three key implications. First, for households with the same level of permanent income, the elasticity of consumption to permanent income is lower for those whose permanent income has grown faster. Second, households with faster-growing permanent income allocate a higher share of their expenditure towards easy-to-adjust goods. Finally, these implications apply to constrained households, and unconstrained households, i.e., those that adjust their consumption bundle, should not exhibit path dependence in their consumption patterns.

3 Calibration

In this section, I proceed by explaining how I use data from the Panel Study of Income Dynamics (PSID) to calibrate the model. First, I define permanent income and explain how I measure it in the data and the model. Second, I explain how I use the measured of permanent income to calibrate the model. Third, I describe other moments used to calibrate the model. Finally, I discuss the calibrated parameters.

I use data from the 1999 – 2019 waves of PSID, which has broad consumption, income, and wealth measures. This unique feature of the data allows analyses focusing on the households' path of consumption, income, and wealth.[3] To construct the panel, I define the focal person in the household as the head (or reference person). I consider all households whose head is between 25 and 80 years old, but I focus only on working-age heads in most regressions. To minimize the bias caused by outliers and measurement error, I trim total income below \$2,000.00 or above the 99th percentile of its wave distribution and total expenditure below the 1st or above the 99th percentile of its wave distribution. After the previous sample selection and considering only entries without missing information in any of the used demographic characteristics, the sample has 18,213 observations corresponding to 5,724 households. I use the CPI to express all monetary values in 2017 US dollars. Appendix B.1 presents some sample descriptions.

3.1 Measuring Permanent Income

Permanent income is defined as the sum of household's current assets plus its discounted future expected path of income. In the model, for household i with age j, it is measured as

$$\text{PI}_{i,j} = a_{i,j} + h_{i,j} + \mathbb{E}_{i,j}\left[\sum_{s=j}^{99} \frac{y_{i,j}}{R^{s-j}}\right]$$

where $a_{i,j}$ are bonds carried from the previous period, $h_{i,j-1}$ is past housing stock, $y = we^{z_{i,j}}$ is labor income, and $R = 1 + r$ is the risk-free rate. The expectation is computed using all available information for the household.

[3] The PSID was conducted annually until 1996 and biennially since 1997. I use data from the 1980 - 2019 PSID waves to estimate an income process to compute expected income growth. From waves before 1999, I use only odd survey years for consistency.

I follow closely this definition and implement permanent income for household i at time t in the PSID data as

$$\widehat{\mathrm{PI}}_{i,t} = \text{net worth}_{i,t} + \sum_{s=t}^{age_i(s)=100} \frac{\psi\Big(age_i(t), age_i(s)\Big)}{R^{s-t}} \widehat{Y}_{i,s}^{t}$$

where $age_i(t)$ returns the age of household i as a function of the time period, $\psi(a_1, a_2)$ returns the survival probability of an individual aged a_1 surviving until age a_2, and $\widehat{Y}_{i,s}^{t}$ is the expected income for household i at time time s using the information set available at t.

First, I use net worth (the value of assets net of the debt value) as my empirical measure of assets.[4]. Second, I use a constant interest rate[5], $R = 1.05$, and age-specific survival probabilities to express expected future income in present value terms. Death probabilities are from the US Life Tables computed by the National Vital Statistics System.

The crucial step is to construct an expected income path for each household, which demands a set of assumptions that allows me to recover it. First, I assume that lagged income and some demographic characteristics describe the information set and that the household and the econometrician have the same information set. Second, I assume that the expectation process formation is approximated by linear autoregressive processes. Finally, I estimate all equations by OLS. In other words, I use the "linear least squares forecast."[6] Since the PSID runs biannually after 1999, I assume that the income at period t is a function of income at $t-2$, cubic in age, dummies for educational attainment, marital status, census region, and occupation and industry groups. As robustness, I allow the parameters of the income process to vary by occupation or industry.

As a benchmark, I use an 1-st order autoregressive process I construct the expected income

[4]Net worth is the sum of net illiquid and net liquid wealth. Following Kaplan, Violante, and Weidner (2014) and Aguiar, Bils, and Boar (2020), liquid assets are the sum of checking and savings (checking or savings accounts, money market funds, certificates of deposit, government bonds, and treasury bills) and stocks (shares of stock in publicly-held corporations, stock mutual funds, and investment trusts). Liquid debt is all debts other than mortgages (credit card charges, student loans, medical or legal bills, or loans from relatives). Net liquid wealth is liquid assets minus liquid debt. Net illiquid wealth is the sum of the household's home equity (the home value minus mortgages), the value of other real estates (net of debt), the value of any business or farm (net of debts), the value of any vehicles (net of debt), and holdings of IRAs and other pensions.

[5]My results are robust to different values of R.

[6]More formally, let $g(\mathbf{Y}_i^{t-1}, \mathbf{X}_{i,t})$ be the function that approximates the expectation process formation and assume that it is the same for every household, but I later allow it to be industry- or occupation-specific. It is a function of $\mathbf{Y}_i^{t-1}$, a vector with past income realizations, and $\mathbf{X}_{i,t}$, a vector with some demographic characteristics. I restrict $g(\cdot)$ to linear autoregressive processes, which are the best linear approximation (under quadratic loss) to the conditional mean $E(Y_t|\mathbf{Y}_i^{t-1}, \mathbf{X}_{i,t})$.

path for each household:

$$\begin{aligned}\mathbb{E}\Big[\ln Y_{i,t+1}\Big|I_t\Big] &= \mathbb{E}\Big[\ln Y_{i,t+1}\Big|\ln Y_{i,t}, \ln Y_{i,t-1}, \mathbf{X}_{i,t}\Big] \\ \ln \widehat{Y}^t_{i,t+1} &= \widehat{\theta}^t_0 + \widehat{\rho}^t_1 \ln Y_{i,t} + \mathbf{X}_{i,t}\widehat{\theta}^t_1 \ ,\end{aligned} \tag{2}$$

in which $\ln \widehat{Y}^t_{i,t+1}$ is the expected log income in period $t+1$ using the information set in t and is a function of lagged income and demographic characteristics, $\mathbf{X}_{i,\tau}$. To ensure that no future information is used to forecast income, I restrict the estimation sample to observations collected before t.[7] Then, to forecast log income in periods after $t+1$, I iterate forward equation 2, updating income and age but keeping other variables constant at their period t realization.[8] [9] [10]

I use household after-tax labor income as my measure of income, which is the sum of household labor earnings and government transfers minus payroll taxes. Household labor earnings are the sum of the head and the spouse's total labor income, including the labor component of income from any unincorporated business and excluding business and farm income. Government transfers are the sum of any head and spouse's government transfer income from AFDC, supplemental security income, other welfare payments, unemployment benefits, worker's compensation, or so-

[7] When estimating the process parameters to construct future expected income in period t, . This restriction deals with the fact that, for example, the income realization in 2000 is not in the household's information set in 1980. Thus, the log income $\ln Y_{i,\tau}$ in period $\tau \in \{t-x, \cdots, t\}$ is described by an autoregressive income process with parameters θ^t. The t-subscript is the last year in the sub-sample (i.e., the year that indexes the information set). For each permanent income estimate, I use 16 years when estimating the income process.

[8] For instance, the expected log incomes in period $t+2$ and $t+3$ are:

$$\begin{aligned}\ln \widehat{Y}^t_{i,t+2} &= \widehat{\theta}^t_0 + \widehat{\rho}^t_1 \ln \widehat{Y}_{i,t+1} + \mathbf{X}_{i,t}\widehat{\theta}^t_1 \\ \ln \widehat{Y}^t_{i,t+3} &= \widehat{\theta}^t_0 + \widehat{\rho}^t_1 \ln \widehat{Y}_{i,t+2} + \mathbf{X}_{i,t}\widehat{\theta}^t_1 \ .\end{aligned}$$

Observe that: 1) the previous estimates are used in the forecast equation, and 2) the income process parameters are fixed and indexed by the subscript t, meaning that only variables in the information set are used in the estimation.

[9] Subsection 4.6 addresses concerns that my expectation measure captures households' expectations imperfectly. First, I compute out-of-sample forecast errors and present several evaluation statistics, such as bias, error variance, mean squared error, and predictive R square. Second, I test whether the forecast errors are unforecastable using other variables available in the household's information set.

[10] For a significant fraction of households, retirement wealth, mainly through social security wealth, is the primary source of income when older. So, the expectation of household income when retired has to be forecasted. When forming expectations, I assume households under 63 years old retire at 65, and their income is 45% of their last pre-retirement income forecast. This replacement rate is consistent with data presented by Diamond and Gruber (1999). They also simulated the retirement incentives for a "typical" household in the US social security, showing that the system causes a disincentive to additional work after 65 years old. For households who are retired or disabled, I forecast their future income using the estimated income process. Also, for households who are working after 65, I forecast their future income using the estimated income process.

cial security benefits. My measure of payroll taxes comes from the NBER's TAXSIM.[11] [12]

3.2 Calibrating Consumption's Response to Permanent Income

With permanent income measures in the model and data, I proceed by documenting how consumption responds to permanent income in the model and data using linear regressions. In particular, I use these documented responses to calibrate the model by matching the model to the data estimates.

In the model, I measure the consumption elasticity to permanent income by estimating the following linear regression

$$\log c_i = \beta_0 + \beta_1 \log \mathrm{PI}_i + \Gamma \boldsymbol{Z}_i + \epsilon_i \ , \tag{3}$$

in which PI_i is the true or estimated measure of permanent income and $\boldsymbol{Z}_i$ is cubic in age.

The data analogous to this regression is

$$\log c_{i,t} = \beta_0 + \beta_1 \log \widehat{\mathrm{PI}}_{i,t} + \Gamma \boldsymbol{Z}_{i,t} + \epsilon_{i,t} \ , \tag{4}$$

in which $\widehat{\mathrm{PI}}_{i,t}$ is the estimated measure of permanent income, $\boldsymbol{Z}_{i,t}$ is a vector of demographic controls for household i at time t. In particular, it has cubic in age, year fixed-effect, and dummies for education groups, marital status, census region, and family size. I measure $c_{i,t}$ in the data as total expenditure[13], but I also consider other expenditure measures for robustness.[14]

[11] In the PSID, when the head or spouse reports working any positive number of hours in their business/farm, the earned income is arbitrarily divided into labor and asset income (half for each). The IRS does not follow that process for taxing an individual's business/farm income. Following Kimberlin, Kim, and Shaefer (2014), both business/farm labor and asset income are treated as wages/salary for TAXSIM purposes and not as property income.

[12] As robustness, I use a broad measure of income, in which I add asset income to the previous measure of total labor income. Asset income is the sum of any head and spouse's business income, farm income, dividends, interest, rents, trust funds, and royalties. I consider two ways of accounting for the implicit rent for homeowners. When expenditure on shelter is the sum of rent for renters and implicit rent for homeowners, I follow Aguiar et al. (2020) and add 6 percent of the respondent's assessed home value to their total income to account for the implicit rent on their home. When expenditure on shelter is the sum of rent for renters, mortgage payments, and property taxes, I do not include implicit rent as income. Again, I compute the taxes using the NBER's TAXSIM (payroll and federal and state income taxes).

[13] Following Kaplan et al. (2014) and Blundell et al. (2016), I construct total expenditure using food (food at home, food away from home, and delivered food), utilities (gas for home, electricity, water and sewer, and other utilities), transportation (gasoline, parking, public transportation, taxi, and other transportation expenditure), medical expenses (doctors, hospitals, prescription drugs, and health insurance), childcare, education, insurance (auto insurance and home insurance), vehicle repair, vehicle, and shelter. Spending on shelter reflects rent payments for renters and implicit rent for homeowners. Since the PSID only started asking about implicit rent in the 2017 wave, I set it to 6 percent of the respondent's house value. Spending on vehicles reflects service flow, and I set it to 10 percent of the respondent's vehicle net worth.

[14] For robustness, I also consider other expenditure measures. First, I construct nondurable expenditures, excluding

My measurement of consumption's response to permanent income relies on the assumption that idiosyncratic taste shocks or consumption measurement errors are orthogonal to the permanent income measure, conditional on demographic controls and time-fixed effects. The demographic variables control for some of the correlations related to preference heterogeneity, in line with Attanasio and Weber (1995). The time-fixed effects control for any business cycle impacts.

Moreover, since I am using survey data, measurement error biases downward the estimated coefficient. Using noisy data to construct permanent income will also imply a noisy measure. Under classical measurement error, I show that my measure of permanent income is unbiased. Moreover, instrumental variables can deal with measurement errors in income. The formal discussion is in Appendix A. Measurement errors in assets are harder to address, so I rely on the same set of instruments used to deal with errors in income.[15]

Moments for Calibration I calibrate the model by matching β_1 in model regression 3 to the coefficient estimated in the data using equation 3. I also modify the past regression to include past permanent income growth, and I use the slope coefficient in this augmented regression as additional moments to match. In particular, I use the slope coefficient of the current permanent income and the past 10 years' permanent income growth. I discuss the model and data results in the next section.

3.3 Moments and Calibrated Parameters

In this subsection, I provide an overview of the calibrated parameters. First, I discuss the exogenous set of parameters calibrated to common values in the literature. Second, I discuss the set of parameters endogenously calibrated to match data moments computed from the PSID sample. Table 1 presents the model parameters and Table 2 presents the data moments and their corresponding counterparts in the model.

all spending on vehicles and shelter except insurance and vehicle repair. These last two are services expenditures and are easy to adjust. Second, I construct broad expenditures using more categories included in the 2005 wave (home repairs, home furnishings, clothing, vacations, recreation, and telecommunications) and donations expenditures. Third, I construct an expenditure measure defining shelter expenditure as the sum of all housing expenditures (rent, mortgage payments, and property taxes) and vehicle expenditure as the sum of down payments, lease payments, loan payments, and additional vehicle costs. My base expenditure measure relative to total after-tax income averages 58.3 percent for the whole sample. For the broad expenditure measure, this average is 76.2 percent. Aguiar et al. (2020) compute the same averages and find 58.3 and 73.2 percent, respectively.

[15] Using logit models, Pfeffer and Griffin (2015) ask which variables forecast extreme fluctuations in measured wealth in the PSID. They find that demographic variables account for a greater share of the variation. Moreover, "measurement issues" have small predictive power. With measurement issues, they refer to i) wealth having some imputed component or ii) a change in the interview respondent (e.g., the head in some wave and the spouse in another).

Table 1: Parameters

Parameters	Description	Value	Source
	Demographics and Initial Asset Positions		
$\{\psi_j\}$	Survival probability		CDC, 2011
a_0	Initial Asset Distribution		PSID
h_0	Initial Housing Distribution		
R	Retirament age	65	
T	Death age	99	
	Preferences		
β	Discount factor	0.95	Endogenously Calibrated
o	Scale term in utility function	0.20	
σ_{init}	Initial CRRA	4.00	
σ_{slope}	Ratio of elasticities σ_{j+1}/σ_j	0.98	
ω	Consumption aggregator	0.30	
γ	Goods Elasticity of Substitution	-0.25	
ϕ_1	Bequest preference (weight)	110.00	
ϕ_2	Bequest preference (luxury)	11.50	
	Income Process		
b_1	Linear trend	0.03	PSID
b_2	Quadratic trend	-0.0007	
$\sigma_{\bar{z}}$	Fixed-effect variance	0.17	
σ_ϵ	Transitory variance	0.12	
σ_ν	Persistant variance	0.02	
ρ	Persistance parameter	0.98	
$p_{inherit}$	Prob. of intergen. skill transmission	0.35	
	Housing		
ζ	Utility flow from housing	0.04	Katz (2017)
δ	Housing depreciation	0.08	BEA
χ	Maintenance cost	0.80	Berger & Vavra (2014)
θ	Collateral Parameter	0.85	Greenwald (2018)
κ	Adjustment cost	0.10	Endogenously Calibrated

Exogenously Set Parameters

Demographic and Initial Distributions. All demographic parameters in the model are set exogenously. In particular, I exogenously set when households begin their working life, when they retire, their certain death, and the duration of the retirement period. The mortality risk that households face when retired is calibrated with data from the Life Tables computed by the Center for Disease Control for 2011. I use the observed wealth portfolios in the PSID for households aged 23 to 27 to calibrate the initial asset positions.

Income Process. I use the PSID sample to estimate a second-order polynomial in age to extract the common life-cycle earnings profile, b_1 and b_2, and the persistence parameter. The variance of the individual fixed effect is set to reproduce the dispersion of initial earnings at age 25. In addition, the inheritance probability of parental skill is calibrated to match the slope between parental and child income ranks measured in the literature.[16]

Housing parameters. I set the depreciation rate to 9%, which is the declining-balance rate for residential capital used by the BEA (Fraumeni, 1997). The maintenance cost is set to 0.80, the value estimated by Berger and Vavra (2015). This cost captures any expenditures on repairs and improvements that delay the depreciation, implying that 7.2% of the house value has to pay each period for maintenance.[17] The utility flow of owning a house is not so easy to identify in the data since it refers to the consumption utility flow of owning and living in a given house rather than the expenditure (or implicit rent) that owning this house provides.[18] Considering this caveat, I set this parameter to 4%, a slightly lower rent-to-value ratio than the only Katz (2017) estimate for a $400,000 house. Lastly, I set the maximum collateral parameter to 0.85 following Greenwald (2018) and Boar, Gorea, and Midrigan (2022).

Endogenously Set Parameters

Preferences and Adjustment Cost I calibrate the parameters governing preferences and the adjustment cost in order to match certain data moments. Parameters $\{\omega, \gamma, \kappa\}$ play a crucial role in

[16]In particular, because there is no human capital investment by the parents, the dependence between parental and child income is deterministic and only determined by the calibrated income process and the inheritance probability of parental skill.

[17]For comparison, in the Consumer Expenditure Survey (CE) of 2021, households, on average, spend 6.3% of their total income and 7.5% of their total expenditure on housing maintenance or improvement (categories i) Maintenance, repairs, insurance, and other expenses; ii) Household furnishings and equipment).

[18]Usually, the methods in the literature focus on measuring prices, such as measuring implicit rent for homeowners by extrapolating it from actual rental prices. For example, the BEA, when computing the personal consumption expenditures (PCE), imputes a value for the services of owner-occupied housing based on the rents charged for similar tenant-occupied housing (Katz, 2017). The BLS uses a similar approach, the Owners' Equivalent Rent (OER), see Verbrugge (2012). The "opportunity cost" approach also measures prices. Verbrugge (2008) and Garner and Verbrugge (2009) discuss the differences when estimating rents using the user costs versus the rental equivalence approaches.

generating the moments: i) the frequency of households that have moved at least once in the past two years, ii) the average shelter expenditure as a fraction of average total expenditure, and iii) the average housing wealth as a fraction of average total wealth. Parameters $\{\beta, o, \sigma_{init}, \sigma_{slope}, \phi_1, \phi_2\}$ are important in generating the moments: i) the average wealth as a fraction of average income, ii) the estimation of consumption's response to permanent income, as presented in Table 3, Column 4, iii) and iv) the estimation of consumption's response to permanent income and lagged permanent income, as presented in Table 6, Column 1, v) a 30% share of households with bequest below 6.25% of average income, and vi) a bequest flow over GDP amounting to 5%.

Table 2: Calibrated Moments

Description	Data	Model
Frequency of households that have movedin the past two years	0.29	0.00
Average shelter expenditure as a fraction of average total expenditure	0.22	0.00
Average housing wealth as a fraction of average total wealth	0.64	0.00
Average wealth as a fraction of average income	3.37	0.00
C's response to PI (Table 3 Column 4)	0.79	0.00
C's response to PI (Table 4, Column 1)	0.62	0.00
C's response to lagged PI (Table 4, Column 1)	0.33	0.00
Share of households with bequest below 6.25% of average income	0.30	0.00
Bequest flow over GDP	0.05	0.05

4 Results

In this section, I present my empirical results. Subsection 4.1 focuses on the evidence of the under-response of consumption to permanent income and provides a novel result that consumption depends on its lagged permanent income. Subsection 4.3 builds on the previous subsection by showing the reflected result that the under-consumed income goes to asset accumulation. After documenting the basic facts, I delve into the mechanism behind this data pattern by estimating demand systems. Subsection 4.4 provides evidence that high past expenditures are associated with less easy-to-adjust goods consumption and higher hard-to-adjust goods consumption. Subsection 4.5 studies how the previous results change when a household adjusts its consumption bundle. Subsection 4.6 provides additional results.

Throughout the paper, I report bootstrap estimates of the standard errors since permanent income is a generated regressor.

4.1 Consumption Elasticity to Permanent Income

Table 3 reports the OLS and IV estimates of equation 4. The first column displays the consumption response to the estimated permanent income measure. For each 1% increase in permanent income, the household's consumption increases by 0.6%, a number close to the results found by Straub (2019). However, this result is odd with the prediction of benchmark consumption models, which predicts an elasticity close to 1. In the second column, I control for education dummies since college-educated workers systematically show higher savings rates, possibly reflecting preference heterogeneity. The consumption elasticity with respect to permanent income does not seem to vary within educational groups.

A possible concern is that measurement error in permanent income measure biases downward my estimates. For that, I instrument the log of permanent income with lagged income and with industry and education dummies. The third column shows that, once instrumented, the consumption elasticity to permanent income is still far from the elasticity of benchmark models. The estimated consumption elasticity is again 0.6. Interestingly, when controlling for education groups in the second stage, the consumption elasticity to permanent income increases to almost 0.8. This result highlights how correcting measurement errors is important. I use Column 4 of Table 3 as my baseline specification. I discuss the results using alternative income, consumption, and asset measures at the end of this subsection. I address concerns about the quality of my expected income growth measure in Subsection 4.6. Lastly, the F statistic is sufficiently high, so it does not raise any concerns about weak instruments.

Table 3: Expenditure Response to Permanent Income

	OLS		IV	
	(1)	(2)	(3)	(4)
	log(expenditure)	log(expenditure)	log(expenditure)	log(expenditure)
log(PI)	0.57	0.59	0.61	0.79
	(0.01)	(0.02)	(0.01)	(0.02)
Educ Dummies		Y		Y
KP-F test			1,676.7	616.3
Observations	54,970	54,970	54,970	54,970

Age Groups

Table 4 presents the estimated consumption elasticity to permanent income for different age groups. I only present results correcting for measurement error using IV regressions and controlling for education dummies. The first column repeats the result of the previous table, showing a consumption elasticity to permanent income is close to 0.8 for the whole sample. Second through fifth columns presents the results for five age groups: 25 to 35, 35 to 45, 45 to 55, and 55 to 65. Interestingly, the estimated elasticity decreases with age, going from close to 0.9 for the youngest group to 0.6 for the oldest one. Later in the paper, I will propose consumption commitments as the mechanism behind the consumption under-response, through which this result could be interpreted as older households being more "locked" in past consumption choices. The fact that the moving probability decreases with age is compelling evidence favoring this interpretation.

Table 4: Consumption Response by Age Groups

	(1)	(2)	(3)	(4)	(5)
	All Sample	25<age<35	35<age<45	45<age<55	55<age<65
log(PI)	0.79	0.86	0.89	0.75	0.64
	(0.02)	(0.04)	(0.03)	(0.03)	(0.03)
Educ Dummies	Y	Y	Y	Y	Y
KP-F test	616.3	823.6	423.9	359.2	152.7
Observations	54,970	14,770	17,556	15,704	11,475

Model Results

Table 5: Consumption Response by Age Groups (Model Results)

	(1)	(2)	(3)	(4)	(5)
	All Sample	25<age<35	35<age<45	45<age<55	55<age<65
$\log(\mathrm{PI}_t)$	1.04	1.12	1.10	1.03	0.96
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	200000	50000	50000	50000	50000

Different Income Process

Remember that when computing the permanent income measure, I need an estimate of the expected income path for each household. I accomplish this by approximating the expectation process formation by an AR(1) process. In Table 9 of Appendix 2, I redo the analysis of Column B1 of Table B using different assumptions about the income process. Precisely, I also present results assuming that an industry-specific AR(1), an occupation-specific AR(1) process, an AR(1) process for total income instead of labor income, and an AR(2) process. Overall, the table suggests that the consumption elasticity to permanent income is close to 0.6, with a slight variation depending on the specific measure of PI used.

Different Expenditure Measures

Throughout the main text, I use the expenditure measure with all categories available since 1999 and define shelter expenditure as rent payments for renters and implicit rent for homeowners. In

Table B2 of Appendix B, I present the result using other consumption measures. I define a measure using categories available since 1999 but using the alternative definition of shelter consumption, one using the categories available since 2005, one using the categories available since 2005 but using the alternative definition of shelter consumption, and one considering only nondurable categories. The table suggests a slight variation in the estimated elasticity depending on the specific expenditure measure used, but overall the values are close to each other. Subsection 3.2 discusses in detail the different consumption measures.

Different Asset Measures

In the previous result, I used the PSID definition of net worth, total assets minus total debt, to construct the measure of permanent income. In Table B3 of Appendix B, I also used different measures of wealth. Specifically, I follow Cooper, Dynan, and Rhodenhiser (2019) and use the information about defined-contribution (DC) pension accounts available in the "pension module" of the PSID to create a more comprehensive measure of wealth. I also control for the increase in permanent income driven by asset valuation by creating a wealth measure at constant prices. The table suggests that the different choices do not impact the measured elasticity.

4.2 Path Dependence

In Table 6, I test for the presence of path dependence in the consumption to permanent income. In detail, I allow consumption today to depend on log PI and 10-years lagged log PI. Column 1 shows that past consumption is associated positively with current consumption, with an estimated coefficient of 0.33. As a thought experiment, consider two households with the same permanent income today, but one has a lower permanent income in the past. In other words, one household already knew its permanent income level 10 years ago, while the other did not. Table 6 shows that the household with fast PI growth consumes less than the one with lower growth. This result is consistent with the implication derived in Section D and illustrated in Panel 10b that the consumption response in period t is a function of the expected permanent income in previous periods.

The remaining columns of Table 6 show the path dependence results by age groups. The first thing to notice is that the results in these columns are consistent with the results in column 1, indicating that past permanent income is positively associated with current consumption in all age groups. More importantly, the results suggest that the strength of the association between past permanent income and current consumption increases with age. For example, the estimated coefficient for log PI is the highest in the age group of 35 to 45, while the one for lagged log PI is

Table 6: Path Dependence on Consumption Response by Age Groups

	(1) All Sample	(2) 35<age<45	(3) 45<age<55	(4) 55<age<65
$\log(\mathrm{PI}_t)$	0.62	0.86	0.63	0.49
	(0.03)	(0.06)	(0.05)	(0.04)
$\log(\mathrm{PI}_{t-10})$	0.33	0.25	0.35	0.35
	(0.04)	(0.09)	(0.06)	(0.06)
Educ Dummies	Y	Y	Y	Y
KP-F test	130.4	67.7	69.1	56.5
Observations	15,180	4,322	5,900	6,054

the highest for the age group of 55 to 65. Again, this reinforces the notion of friction in adjusting the consumption bundle, with older households being more "locked" in past consumption choices (which is reflected in the past permanent income coefficient).

Model Results

Table 7: Path Dependence on Consumption Response (Model Results)

	(1) All Sample	(2) 35<age<45	(3) 45<age<55	(4) 55<age<65
$\log(\mathrm{PI}_t)$	1.08	1.21	1.07	0.92
	(0.00)	(0.00)	(0.00)	(0.00)
$\log(\mathrm{PI}_{t-10})$	-0.08	-0.15	-0.05	0.04
	(0.00)	(0.00)	(0.00)	(0.00)
N	150000	50000	50000	50000

4.3 Asset Accumulation

So far, I have used the PSID data to document that consumption under-responds to permanent income. Moreover, I showed that the consumption response decreases with age and that the consumption response in period t is also a function of the expected permanent income ten years ago. A natural question is where the not consumed income is going. The budget constraint ties together income and expenditure; thus, households must be saving if they are not consuming. An advantage of using the PSID is that, since 1999, it has collected biannually broad measures of wealth. In this subsection, I construct an implied net worth given the reported savings (measured by income - consumption). This exercise also works as a consistency check on the data that aims to alleviate any concern with its quality. Building on the previous subsection, I use regression analysis to investigate how a measure of active saving rates projects in current and lagged permanent income.

The budget constraint for a household at period t is

$$C_t + A_{t+1} = (1 + r_t)A_t + Y_t \,.$$

The left-hand side is the total expenditure, consumption plus next-period assets, and the right-hand side is cash on hand, last-period assets after capital gains plus income. The budget constraint holds with equality since I am using it as an accounting identity.

The budget constraint can also be expressed as

$$A_{t+1} - A_t = Y_t - C_t + r_t A_t \,,$$

in which the left-hand side is the total increase in assets and the right-hand side is savings, income minus consumption, plus capital gains on assets. Summing over T-periods, one gets

$$A_T - A_0 = \sum_{t=j}^{T}(Y_j - C_j) + \sum_{t=j}^{T} r_j A_j \,. \tag{5}$$

The asset increase between period t and period T is equal to the sum of each period savings and capital gains on assets.

I use this last form of expressing the budget constraint to construct a synthetic net worth, the net worth implied by the reported consumption and income. In the computation, I use my total expenditure[19] and income measures. However, I need to make some assumptions in the computation. First, I restrict the sample to households observed for 20 years. Second, the PSID is a biannual survey, so I approximate $(Y_t - C_t) + (Y_{t+1} - C_{t+1}) \approx 2 \times (Y_t - C_t)$. Third, the consumption categories present on every PSID wave since 1999 capture about 70% of expenditures surveyed in the Consumer Expenditure Survey (CE) and the US National Income and Product Accounts (NIPA). Consequently, I scale up consumption by 0.67, $C_t/0.67$.

A_t in Equation 5 is an aggregate measure that captures different asset classes.[20] It is worth

[19] In Subsection 3.2, I discussed two measures of consumption. For this exercise, I am using the consumption measure with reported expenditure in shelter and vehicles and without the implicit return of durable goods.

[20] In all PSID waves since 1999, one has measures of i) net worth of farm or business, ii) checking or savings accounts, money market funds, certificates of deposit, governmental savings bonds, or treasury bills, iii) stocks, mutual funds, or investment trusts, iv) private annuities or Individual Retirement Accounts (IRAs), v) net worth of vehicles, vi) home equity (house value - mortgage balances), vii) Net worth of real estate, viii) other assets (bond funds, cash value in a life insurance policy, a valuable collection for investment purposes, or rights in a trust or estate), ix) other debt (credit card charges, student loans, medical or legal bills, or loans from relatives). The "other debt" was divided

remembering that my total income already includes asset income, such as business income, farm income, dividends, interest, rents, trust funds, and royalties from the head and spouse. So, only one more assumption is needed to compute capital gains for each asset class. I aggregate home equity, other real estate's net worth, and farm and business net worth into a broad category and assume that their capital gain is given by the CPI-deflated price change of the S&P Case-Shiller U.S. National Home Price Index. The stock return is the CPI-deflated change of the Wilshire 5000 Price Index, which already excludes dividends distribution. The Individual Retirement Accounts (IRAs) return is a constant 5% annual return. The vehicle's net worth return is a 15% annual depreciation rate. The checking or savings account return is the FED fund rate. I assume the "other debt" has a 10% annual interest rate. For last, I assume that all the savings go into home equity. My results do not change when savings go into the private pension account.

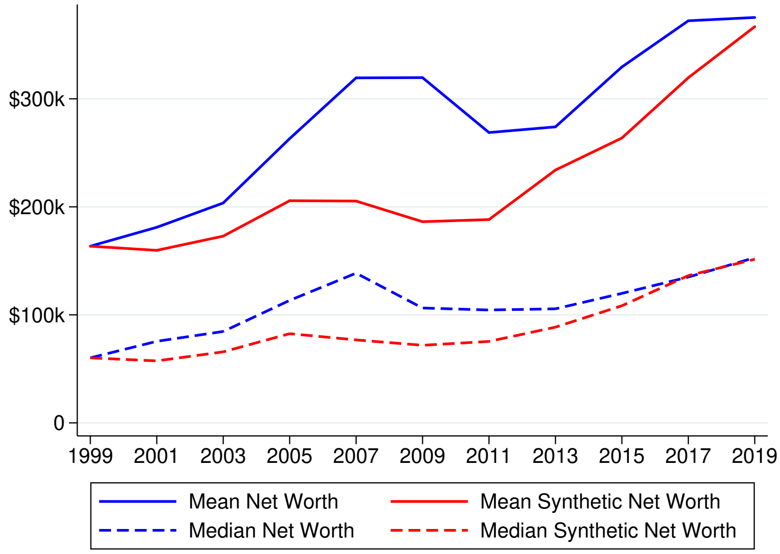
Figure 2 plots the median reported net worth (dashed blue line) and the median synthetic net worth (dashed red line). Both series move closely and have a similar level. However, the synthetic net worth does not capture well the increase and later decrease in net worth around the 2008 Financial Crisis. A possible explanation for the lower level of the synthetic measure is that the capital gains I am using are too small for someone at the top of the wealth distribution. Indeed, Fagereng, Holm, Moll, and Natvik (2021) documents for Norway that wealthier households own assets that experience more capital gains. Figure 2 also plots the mean reported net worth (solid blue line) and the mean synthetic net worth (solid red line). Both series walk more closely than the mean net worth series.

The past exercise also serves as a consistency check of the quality data of the PSID. In particular, checking if savings measured by consumption and income are consistent with the reported asset evolution helps verify that the data collected is accurate and reliable in measuring the long lifecycle behavior of a household's wealth. In other words, the exercise verifies that the data is consistent with the budget constraint in an accounting sense, thereby ensuring that the results obtained about the under-response of consumption are meaningful.

Figure 3 replicates the prior analysis, dividing the sample into two groups. Panel 3a plots those households that experienced positive permanent income growth, and Panel 3b plots those that did not. Similar to the previous graph, the median reported net worth is displayed as the dashed blue line and the median synthetic net worth as the dashed red line. First, it is immediately noticeable that in both panels, both series track closely and are of comparable magnitude. Again, this result reinforces the quality of the PSID for studying lifecycle wealth. Second, households that experienced permanent income growth accumulated more wealth than those that did.

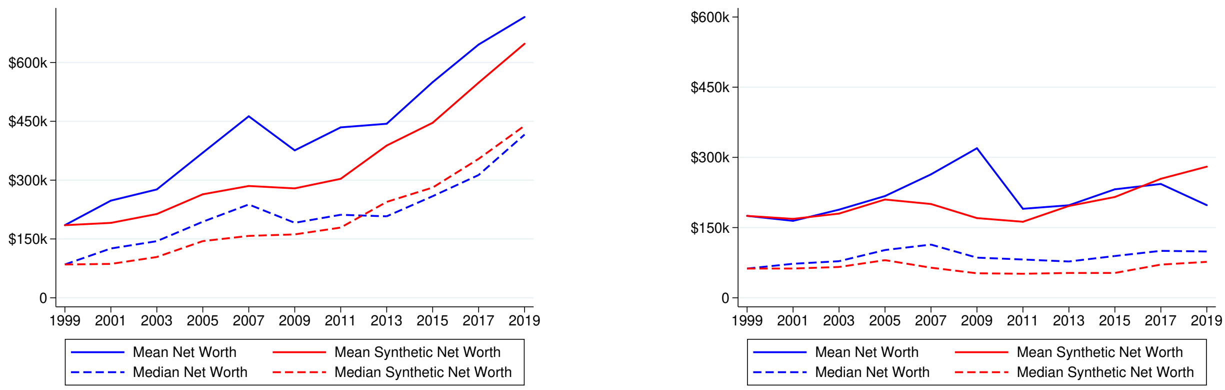
into different questions since the 2011 wave. Student loans and credit card charges are the main components of this aggregate category.

Figure 2: Asset Path Implied by Expenditure and Income



Importantly, both groups begin from similar starting points. Figure 3 also displays the median reported net worth (solid blue line) and the median synthetic net worth (solid red line). Both panels of Figure 3 reinforce the observation that households that experienced positive permanent income growth accumulated more wealth than those that did not.

Figure 3: Asset Accumulation



(a) Positive PI growth

(b) Negative PI growth

Active Savings

The previous figure showed that households that experienced faster permanent income growth accumulated more wealth. However, one may inquire into the behavior of active savings. Active savings capture only the portion of savings voluntarily aside from current income and do not include any capital gains or changes in asset valuation. This measure is arguably a better savings measure than those that capture capital gains because it reflects households' actual, conscious decisions about how much to save from their current income. In contrast, savings measures that include capital gains may reflect changes in asset values beyond households' control. For example, a sudden increase in asset values due to a change in market conditions may inflate the savings measure and give a false impression of the household's actual saving behavior. I clean questions available in the PSID Wealth Module to construct a measure of active saving following Hurst, Luoh, and Stafford (1998). These questions measure money flows into and out of different assets and allow for distinguishing between active savings and capital gains. I define savings rate by dividing total active savings by labor income.

Table 8 presents the regression results of the savings rate on permanent income and its lagged value. The first column shows the regression model results with only log(PI) as the independent variable. The third column has log(PI) and its lagged value as regressors. Since the number of observations in each column differs, Column 2 estimates the first model in the third column sample. The coefficient of log(PI) is positive and significant in all three models while increasing when I control for lagged permanent income. The estimated coefficient increases from 0.16 in the second column to 0.24 in the third. The coefficient of lagged permanent income is negative and significant, with a value of -0.17.

Table 8 is the mirror image of Table 6. However, it is important to notice two things. First, lagged permanent income enters negatively in Table 8, while it enters positively in Table 6. A household that already knew its permanent income level 10 years ago shows a lower saving rate than one that did not know. Alternatively, returning to the implication derived in Section D and illustrated in Panel 10b, the consumption response in period t is concave in permanent income growth. Table 8 shows that the saving rate is convex in permanent income growth. Second, this result also shows the PSID data's quality. Since the active saving measure is constructed from a completely different set of questions to the expenditure measure, it is reassuring that both analyses display consistent results.

4.4 Expenditure Components

In the previous two subsections, I showed that households' consumption choices depend on the timing that the permanent income uncertainty resolves. Conditional on the same permanent income level today, households with faster permanent income growth consume less and actively save more. In the current subsection, I explore the detailed categories available in the PSID to dig into the possible mechanism for the documented facts. In particular, I test if for the household whose permanent income grew faster, its consumption bundle skews toward more adjustable

Table 8: Savings Response to Permanent Income

	(1) Savings Rate	(2) Savings Rate	(3) Savings Rate
log(PI)	0.19	0.16	0.24
	(0.02)	(0.03)	(0.04)
$\log(\text{PI}_{t-10})$			-0.17
			(0.05)
Educ Dummies	Y	Y	Y
KP-F test	709.6	380.6	153.9
Observations	48,852	14,402	14,402

goods as in Panel 10a.

I test this implication by estimating demand systems to capture how past income growth is associated with the expenditure allocation among different goods, conditioning on a given level of total expenditures. In particular, based on the almost ideal demand system (AIDS) of Deaton and Muellbauer (1980), I estimate

$$w_{jit} = \alpha_{jt} + \alpha_j \log X_{it} + \beta_j \Delta \log X_{it} + \Gamma_j \mathbf{Z}_{it} + u_{jit} \,, \tag{6}$$

in which i indexes household, j indexes expenditure component, t indexes time, $\log X_{it}$ is log expenditure, $\mathbf{Z}_{it}$ are demographic controls, and w_{ijt} is the expenditure share of component j. I allow the past income growth from period $t-s$ to period t, $\Delta \log X_{it}$, to enter the specification. In the AIDS specification, the log of each component price index and the overall price index are normally used as controls. I use year-fixed effects to capture all the relative price effects. In this section, I use expenditure data after 2005 since it gives the best picture of household intra-period allocation.

In the AIDS specification, total expenditure appears on the right as a control and in the denominator on the left, making this specification vulnerable to measurement error. I deal with the measurement issue by instrumenting total expenditure with a cubic polynomial of log income and of lagged log income. I assume that income shocks and the error term in the AIDS specification are not correlated.

Table 9 shows the demand system regression results for two household spending types, "Nondurable Share" and "Shelter Share." I use shelter expenditure as the consumption commitment measure given its large share in the total consumption bundle and given the empirical high cost to adjust it. Adjusting shelter expenditures implies moving house, which includes packaging and transportation costs, brokerage fees, and searching time. The first two columns show the results of the regression of Nondurable and Shelter expenditure shares only on the log of expenditures. The third and fourth columns show the regression results on the log of expenditures and expenditure growth. The coefficients are presented with standard errors in parentheses and the implied Engle curve in square brackets.

I will only focus on the implied Engle curves for a more straightforward interpretation. Columns 1 and 3 imply an Engel curve around 0.8 for nondurables expenditure, being the coefficients close to each other in both specifications. This value implies that nondurable goods are a necessity, with their expenditure increasing by 0.8% for each 1% increase in total expenditure. Conversely, Columns 2 and 4 imply an Engel curve around 1.1 for shelter expenditure, which implies that shelter is a luxury good, with their expenditure increasing by 1.1% for each 1% increase in total expenditure. Again, the coefficients have similar magnitudes in both specifications.

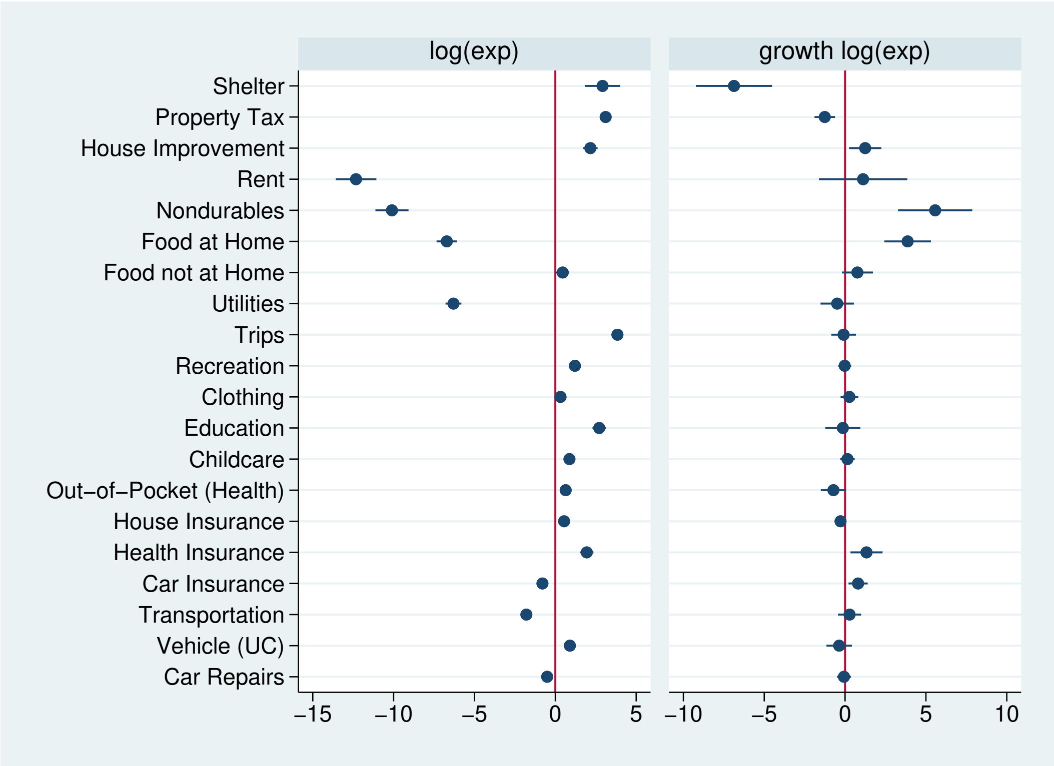
The second row of Table 9 shows the impact of past expenditure growth on the allocation of expenditure between different consumption goods. This result confirms the implication of Panel 10a that, for the household whose permanent income grew faster, its consumption bundle skews toward more adjustable goods. Conditional on the same level of expenditure today, a household with faster expenditure growth consumes less shelter e more nondurables. For example, a 10% growth in total expenditure decreases shelter expenditure by 0.3% and increases nondurable one by 0.1%. In light of the consumption commitments, a household that knew with certainty its permanent income chose a higher housing consumption path than that that did not know its permanent income in the past and, thus, experienced faster expenditure growth.

Table 9: Consumption Categories' Shares

	(1) Nondurable Share	(2) Shelter Share	(3) Nondurable Share	(4) Shelter Share
log(exp)	-10.20	2.37	-9.98	3.21
	(0.60)	(0.69)	(0.81)	(0.86)
	[0.80]	[1.09]	[0.81]	[1.12]
Δ log(exp)			5.66	-8.01
			(1.52)	(1.64)
			[0.11]	[-0.31]
Educ Dummies	Y	Y	Y	Y
KP-F test	294.0	294.0	17.1	17.1
Observations	26,046	26,046	9,950	9,950

For last, Figure 4 presents the results of the previous table for other consumption categories. I present the estimated coefficients and not the Engle curve. Again, households with the same current total expenditure but with different income paths distribute their expenditure differently. The second panel shows that households with faster expenditure growth consume more non-durables, food, and insurance. On the other side, those with lower expenditure growth consume more shelter services, utilities, and out-of-pocket health expenditures.

Figure 4: Consumption Categories



4.5 Reset Consumption Bundle

In the previous subsections, I have presented empirical evidence supporting that adjustment frictions are an important mechanism explaining why consumption responds so little to permanent income. Households choose the consumption path based on their permanent income expectation. When the uncertainty realizes, those that did not reoptimize their bundle have depressed consumption. The inability of households to readjust their bundles is largely due to "consumption commitments," which are goods and services that are costly to adjust in response to income fluctuations. In the data, shelter consumption is the main consumption commitment and encompasses rent payments for renters and implicit rent for homeowners.

As a last empirical support for this claim, I delve into the behavior of households that adjust their consumption bundles. As a proxy for adjustment, I utilize the moving history of households, evaluating whether they have relocated at least once within the prior decade. Using 10-

year lagged permanent income to measure path-dependence on prior regressions makes the use of this proxy a natural one.[21] The argument is that households that have moved should have a weaker path dependence on their past permanent income, and their consumption should respond differently compared to those who have not moved. I should also see a result in their savings rate and between-goods expenditure allocation. In Appendix B.4, I discuss the consumption response of renters, as adjusting their consumption is arguably less costly.

Table 10 presents the heterogeneous consumption and savings rate responses by past moving decisions. In Column 1, we see the consumption response of households that did not move loads significantly in the past permanent income, with an estimated elasticity of 0.35 for the contemporaneous measure and 0.45 for the lagged one. However, for those households that moved at least once in the past, the consumption response loads more in the current permanent income, with an estimated elasticity of 0.61 for the contemporaneous measure and 0.22 for the lagged one. These results align with the economic intuition: consumption for households that adjust their basket depends on the current permanent income and not on their past decisions.

In Column 2, we see that, as a mirror image of the consumption case, the saving rate response of households that did not move also loads significantly in the past permanent income, with an estimated semi-elasticity of 0.40 for the contemporaneous measure and -0.36 for the lagged one. The negative coefficient in the lagged measure implies that locked households with positive permanent income growth accumulate assets. However, for those households that moved in the past, the saving rate loads almost exclusively in the current permanent income, with an estimated semi-elasticity of 0.15 for the contemporaneous measure and -0.03 for the lagged one. Again, these results align with the economic intuition: the savings rate for locked households is higher, and it does not depend on past decisions for those that adjust their basket.

Using the same proxy for adjustment, Table 3 presents the relationship between nondurable and shelter consumption to log expenditure and expenditure growth. As in the previous analysis, households that have moved should have a weaker path dependence on their past expenditure growth, and their expenditure allocation should respond differently compared to those who have not moved. In Column 1, we see the nondurable consumption response of households that did not move loads significantly in the past expenditure, with an estimated coefficient of -13.40 for the log expenditure and 12.43 for the growth rate. However, for those households that moved at least once in the past, the nondurable consumption loads more in the current expenditure, with an estimated coefficient of -10.40 for the log expenditure and 3.52 for the growth rate. The results for shelter consumption follow the same logic but with different signs. These results align with

[21] In Appendix B.3, I show that permanent income growth is positively associated with the likelihood of having moved at least once in the past.

Table 10: Heterogeneous Effect by Moved or Not

	(1) log(expenditure)	(2) Savings Rate
log(PI)	0.35	0.40
	(0.07)	(0.09)
$\log(\text{PI}_{t-10})$	0.45	-0.36
	(0.09)	(0.10)
Moved $\times$ log(PI)	0.26	-0.25
	(0.12)	(0.12)
Moved $\times$ $\log(\text{PI}_{t-10})$	-0.23	0.33
	(0.14)	(0.14)
Educ Dummies	Y	Y
KP-F test	15.8	23.6
Observations	14,531	14,402

economic intuition.

4.6 Additional Results

For last, this subsection presents additional results. First, it discusses the concern that my measure of permanent income does not correctly measure agents' expectations. Second, it addresses the question of what "locked" households do with their additional savings. I showed that these households consume less and save more. Thus, I investigate if these households die with more assets or if they report more transfers (intervivos transfers or bequests) to their children.

Quality of the Expected Income Growth Measure

My assumption that households' information set can be captured by lagged income, age, and demographic characteristics and that these factors enter linearly in the expectation formation process is a strong one. There is the possibility that a fraction of permanent income growth is already known to households, which would be reflected in their current consumption choices, which would invalidate my results. To address this concern, I present evidence in Table B7 that advanced information is not a major issue by analyzing the forecasting errors of future income at various time periods. The results suggest that households do have some additional degree of information about their income path, though the magnitude of the effect is relatively small.

Bequest

Table 11: Heterogeneous Effect by Moved or Not

	(1) Nondurable Share	(2) Shelter Share
log(exp)	-13.40	6.26
	(0.92)	(0.97)
Δ log(exp)	12.43	-19.38
	(2.58)	(2.87)
Moved $\times$ log(exp)	3.32	-3.34
	(1.03)	(1.12)
Moved $\times$ Δ log(exp)	-8.91	14.83
	(2.73)	(3.10)
Educ Dummies	Y	Y
KP-F test	7.7	7.7
Observations	10,163	10,167

To further investigate the consumption commitments mechanism, I examine the bequests that parents leave for their offspring in Table B8. I start by merging households with their death year and split-off families, aggregating all reported inheritance, and constructing two variables: a binary indicator of whether the household left a bequest and the logarithm of the bequest amount. I then regress these two variables on my measure of current and lagged permanent income, using the last observed measure prior to the household's death. The results show that current and lagged permanent income are positively correlated with a higher likelihood and amount of bequests, with no evidence that locked households leave more bequests. However, the sample size is limited, restricting the precision of the parameter estimates.

I also look at the assets that households have then they die. Table B9 show a negative correlation between lagged permanent income and the amount of assets at death, although the sample size is small, and the coefficient for lagged income is not statistically significant.

Transfers

I also analyze the intervivos transfers (money given to support offspring during the parent's lifetime) that households make. I use a PSID question that asks about the money given for support of anyone living outside the household. The results in Table B10 show that the current permanent income is positively associated with a higher likelihood of helping children and the amount of money given to support them. However, the association between lagged permanent income and the likelihood of helping children is not economically or statistically significant. Also, the sample size is small in the regression analyzing the amount of money given to support children, so the results are not conclusive.

Donations

The PSID has collected data on philanthropic giving and volunteer time since 2001. It is the only detailed giving data collected in a major panel survey in the US. Table B11 shows the association between total donation expenditure and current and lagged permanent income. Both measures are positively associated with the likelihood of marking reporting a donation expenditure and with the amount donated. There is no evidence that locked households donate more.

Parent-Child Pairs

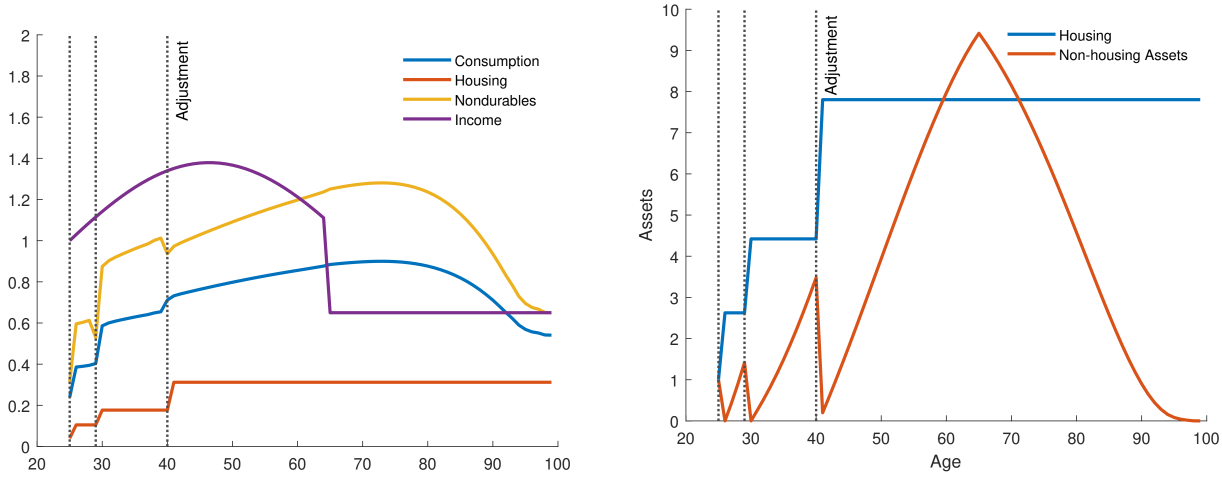
For last, I examine if splitoff families of locked households exhibit higher consumption. For that, I merge the split-off families with their reference person's or spouse's parent household. Table B12 shows a positive correlation between the splitoff expenditure and their parent's current and lagged permanent income. This finding implies that locked parents are not transferring money to their children, which would imply a negative correlation between parents' lagged permanent income measure and children's expenditure. Table B12 is consistent with the results of intervivos transfers.

4.7 Other Model Results

Life-Cycle Profiles

To illustrate the interaction between consumption commitments and the life-cycle profiles, Panel 5a of Figure 5 plots consumption and income profiles as well as housing and nondurable expenditures for a particular household. Meanwhile, Panel 5b plots housing and non-housing asset profiles. I assume that all realized zero income shocks are zero for this household. The profiles reveal that this household initially accumulates assets for housing adjustments, as evidenced by the jumps in housing expenditure during the early stages of life and its constancy thereafter. After reaching the desired level of housing, households start accumulating wealth for retirement. Lastly, the figure highlights that households prefer to consume when their bundle is not distorted, as reflected by the jumps in consumption during housing adjustments and by the nondurables increases between housing adjustments but decreases at the adjustment moments.

Figure 6 shows the average profiles in this economy. Consumption is backloaded, reflecting that households save early in life to accumulate housing and consume later when their bundle is not distorted. The path of housing accumulation is steeper early in life than other assets, but it reaches a plateau around retirement time. On the other hand, other assets reach a peak during

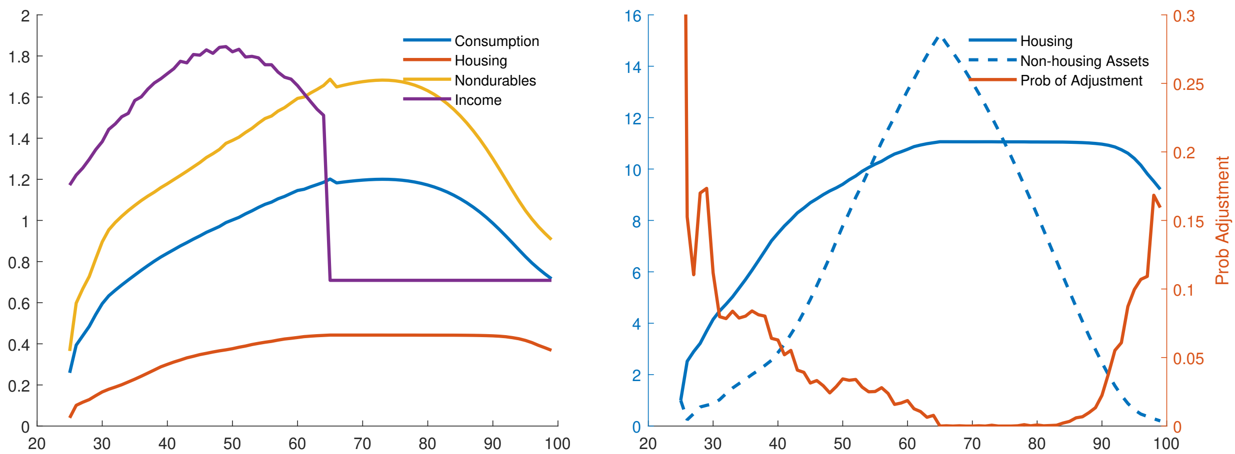


(a) Consumption

(b) Assets

Figure 5: Example of Life-Cycle

retirement time. The adjustment probability reflects this trend, decreasing monotonically during working life. Moreover, it only increases for households older than 80 when they start selling their housing to finance consumption. Finally, most of the consumption adjustment when old occurs on nondurable consumption.



(a) Consumption

(b) Assets

Figure 6: Mean Life-Cycle Profiles

5 Aggregated Implications

In the this section, I explore the consumption commitments implications for wealth inequality and the intergenerational transmission of wealth. The literature has found that high-wealth households have high-wealth children, with luxury bequests being an important source of perpetuating wealth in the dynasty. How much is this intergeneration wealth persistence explained by preferences and restrictions on the household's budget set?

6 Conclusion

In conclusion, this paper investigates the mechanism behind the under-response of consumption to permanent income as observed in the data. Consumption commitments play a significant role in this under-response. The empirical results show that the consumption elasticity with respect to permanent income decreases with age and that the consumption response to permanent income is path dependent. Furthermore, the detailed consumption categories reveal that high expenditure growth is associated with more easy-to-adjust goods consumption and less hard-to-adjust goods consumption, supporting the hypothesis that goods' adjustability is critical to understanding the consumption response to permanent income.

I also quantify the implications of the consumption commitments mechanism for wealth inequality. With a model nesting different explanations from previous literature, I calibrate it using detailed data from the Panel Survey of Income Dynamics. The simulation exercise shows that the model can account for the documented facts and that consumption commitments are important to understand the consumption under-response to permanent income.

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A Measurement Error in Income

Let $Y_{i,t}$ be the observed income for household i in period t, which is a noisy measure of its actual income, $Y^*_{i,t}$. The measurement error is log-additive, such that

$$\log Y_{i,t} = \log Y^*_{i,t} + v_{i,t}.$$

Denote logged variables as lowercase, $x_{i,t} = \log(X_{i,t})$. I assume that the unobservables, $y^*_{i,t}$ and $v_{i,t}$, are mutually independent with variances σ^2_* and σ^2_v.

To simplify the notation, I will drop the i subscript. Let one-lagged income be a sufficient statistic for the household's information set, so the best linear forecast for y^*_{t+1} is

$$\widehat{y}_{t+1} = \rho y_t = \rho y^*_t + \rho v_t \ ,$$

where v_t is a measurement error. Clearly, $\widehat{y}_{t+1}$ is an unbiased forecast for y^*_{t+1} since $E(\widehat{y}_{t+1}) = \rho y^*_t$. Moreover, the difference between y^*_{t+1} and $\widehat{y}_{t+1}$ will be a forecast error, $y^*_{t+1} - \rho y^*_t$, and the measurement error, ρv_t.

In my empirical application, I measure expected income using income forecasts from an autoregressive process. To see how measurement error will impact my permanent income measure, index the year of the information set as 0 such that $\widehat{Y}_1$ is the forecast 1 year ahead, $\widehat{Y}_2$ is the forecast 2 years ahead, and so on. Given my already-stated assumption,

$$\begin{aligned}
\widehat{Y}_1 &= \exp(\widehat{y}_1) = \exp(\rho y^*_0 \ + \rho v_0) \ \ = \ \exp(\rho y^*_0)\exp(\rho v_0) \\
\widehat{Y}_2 &= \exp(\widehat{y}_2) = \exp(\rho^2 y^*_0 + \rho^2 v_0) = \exp(\rho^2 y^*_0)\exp(\rho^2 v_0) \\
&\ \vdots \\
\widehat{Y}_j &= \exp(\widehat{y}_j) = \exp(\rho^j y^*_0 + \rho^j v_0) = \exp(\rho^j y^*_0)\exp(\rho^j v_0)
\end{aligned}$$

My empirical measure of PI will be

$$
\begin{aligned}
\widehat{\mathrm{PI}}_t = \sum_{j=1}^{J} \frac{\widehat{Y}_j}{R^j} &= \sum_{j=1}^{J} \frac{\exp(\rho^j y_0^*) \exp(\rho^j v_0)}{R^j} \\
&\approx \sum_{j=1}^{J} \frac{\exp(\rho^j y_0^*)}{R^j}(1+\rho^j v_0) \\
&= \sum_{j=1}^{J} \frac{\widehat{Y}_j^*}{R^j} + v_0 \sum_{j=1}^{J} \left(\frac{\rho^j}{R^j}\right) \exp(\rho^j y_0^*) \\
&= \sum_{j=1}^{J} \frac{\widehat{Y}_j^*}{R^j} + v_0 f(y_0^*) \ ,
\end{aligned}
$$

in which I used the approximation $\exp(\rho^j v_0) \approx 1 + \rho^j v_0$ in the second line. $f(y_0^*)$ is a general function of y_0^*.

Any regression that uses a Permanent Income measure constructed using Y_t as an explanatory variable will suffer attenuation bias. I deal with this problem using instrumental variable. First, the classical measurement error implies that $E[v_0 f(y_0^*)] = E[f(y_0^*)E[v_0|f(y_0^*)]] = 0$ and traditional instrumental variables can be used.[22] For example, y_{-1} is a good instrument, which is the one that I used in this paper.

[22]In the univariate case, the IV estimator is

$$
\frac{\mathrm{Cov}(z,y)}{\mathrm{Cov}(z,x)} = \frac{\mathrm{Cov}(z,y^*)}{\mathrm{Cov}(z,x)} + \frac{\mathrm{Cov}(z,f(y^*)v)}{\mathrm{Cov}(z,x)} = \frac{\mathrm{Cov}(z,y^*)}{\mathrm{Cov}(z,x)} + \frac{E[zvf(y^*)]}{\mathrm{Cov}(z,x)} = \frac{\mathrm{Cov}(z,y^*)}{\mathrm{Cov}(z,x)}
$$

B Additional Tables and Figures

B.1 Sample Description

B.2 Alternative Definitions

Table B1: Different Measures of Permanent Income

	log(expenditure)
log(PI), AR(1) process	0.57
	(0.01)
log(PI), industry-specific AR(1)	0.58
	(0.01)
log(PI), occupation-specific AR(1)	0.56
	(0.01)
log(PI), AR(1) with total income	0.60
	(0.01)
log(PI), AR(2) process	0.55
	(0.02)

Sample: 53327, 39427.

Column 1 of Table 3 shows that without controlling for education groups, the consumption elasticity to permanent income is close to 0.6. The control variable is the constructed permanent income measure under the assumption of an AR(1) process. The above table shows the results for other PI measures. In particular, the first row shows the results when assuming an AR(1) process. The second row shows the results assuming that the AR(1) process is industry-specific. The third row shows the results assuming the AR(1) process is occupation-specific. The fourth row assumes an AR(1) process for total income instead of labor income. Finally, the fifth row shows the results when assuming an AR(2) process. Overall, the table suggests that the consumption elasticity to permanent income is close to 0.6, with a slight variation depending on the specific measure of PI used. The results are reported with their standard errors in parentheses.

Table B2: Different Measures of Expenditure

	log(PI)
log(exp), categories available in 1999	0.57
	(0.01)
log(exp), categories available in 1999, alt. measure	0.53
	(0.01)
log(exp), categories available in 2005	0.62
	(0.01)
log(exp), categories available in 2005, alt. measure	0.58
	(0.01)
log(exp), nondurables categories	0.47
	(0.01)

Sample: 54752 42323

Throughout the main text, I use the expenditure measure with all categories available since 1999 and with implicit rent as the measure of shelter consumption. The table above displays the result when using other measures of consumption. The first row shows the result when I use categories available since 1999. The second row shows the result when I use categories available since 1999 but use the alternative definition of shelter consumption. The third row displays the result of using the categories available since 2005. The fourth row also uses the categories available since 2005 but uses the alternative definition of shelter consumption. Finally, the fifth row displays the result when considering the nondurable categories. The table suggests a slight variation in the estimated elasticity depending on the specific expenditure measure used, but overall the values are close to each other.

Table B3: Different Measures of Asset

	log(PI)
PSID Measuerd Net Worth	0.59
	(0.01)
Net Worth plus Retirement Accounts	0.58
	(0.01)
Price-adjusted Net Worth	-
	-

Sample: 55320.

The table above presents the estimated consumption elasticity to permanent income using different measures of wealth to construct permanent income. The table presents three different measures of wealth: PSID Measured Net Worth, Net Worth plus Retirement Accounts, and Price-adjusted Net Worth. The first show the result when using the PSID definition of net worth, that is, total assets minus total debt. The second row follows Cooper et al. (2019) and uses the pension data available in the PSID to create a more comprehensive measure of wealth. The third row tries to control for the increase in permanent income driven by asset valuation. The table suggests that the different choices do not impact the measured elasticity.

B.3 Prob of Adjustment

Table B4: Prob of Adjustment

	(1) Moved Past 10 Yrs	(2) Moved Past 10 Yrs	(3) Might Move	(4) Might Move
$\lvert\log(\text{PI}/\text{PI}_{t-10})\rvert$	0.235	0.180	0.102	0.022
	(0.018)	(0.026)	(0.017)	(0.030)
Own $\times$ $\lvert\log(\text{PI}/\text{PI}_{t-10})\rvert$		0.007		0.048
		(0.035)		(0.036)
Own		-0.336		-0.346
		(0.026)		(0.023)
N	15421	14980	15075	14653

Table B4 presents the likelihood of households having moved at least once in the past 10 years as a function of the past permanent income growth. Columns 1 and 2 show that the absolute growth of permanent income is positively associated with the likelihood of having moved in the past. Also, if the household is a homeowner, its average probability of having moved is smaller, which is consistent with the intuition that it is easier for renters to move. Interestingly, the interaction between permanent income growth and an indicator for homeownership is not economically or statistically significant.

Figure 7: Probability of Moving

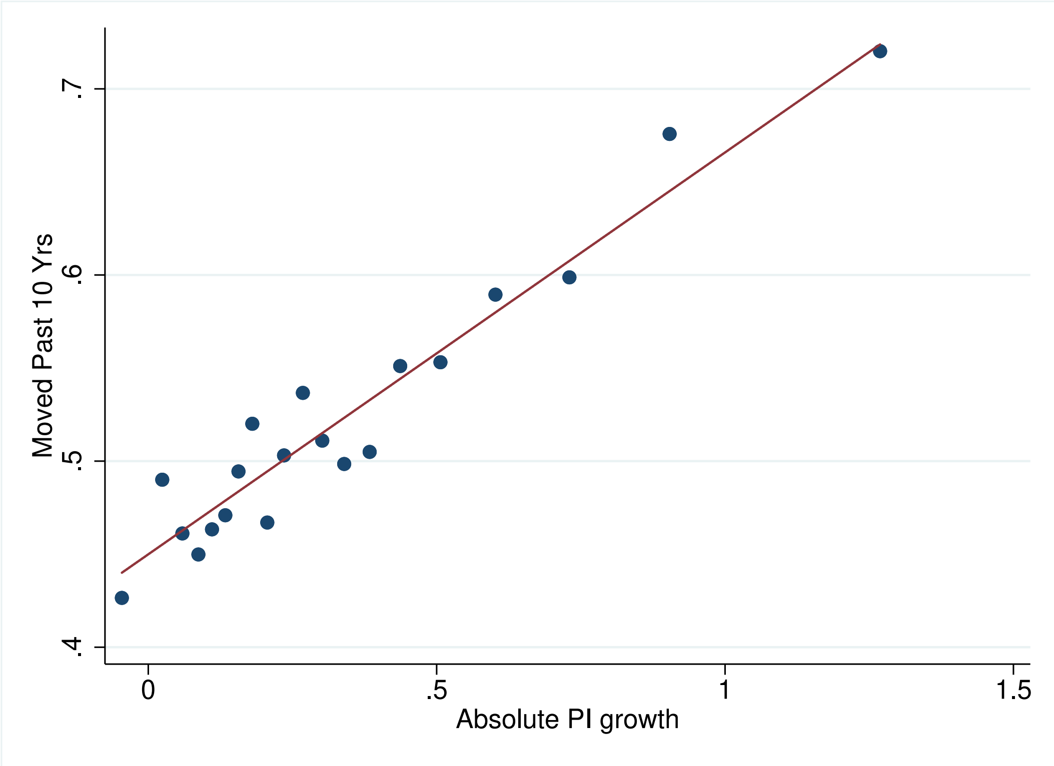


Figure 7 is the graphic representation of Table B4, and it presents the likelihood of households having moved at least once in the past 10 years as a function of the past permanent income growth. It is a binned scatterplot, which divides the past permanent income growth into equal-sized bins, computes the mean probability of having moved in the past in each bin, then creates a scatterplot of these data points. The figure also displays a linear fit line using OLS.

B.4 Results by Ownership

Table B5: Heterogeneous Effect by Own or Not

	(1) log(expenditure)	(2) Savings Rate
log(PI)	0.48	0.21
	(0.08)	(0.07)
$\log(\mathrm{PI}_{t-10})$	0.41	-0.08
	(0.10)	(0.09)
Own $\times$ log(PI)	0.01	0.04
	(0.11)	(0.09)
Own $\times$ $\log(\mathrm{PI}_{t-10})$	-0.13	-0.08
	(0.13)	(0.10)
Educ Dummies	Y	Y
KP-F test	20.5	43.1
Observations	14,164	14,046

If consumption commitments are behind the under-response and path-dependence of the consumption response to permanent income, it is natural to expect that households that do not own housing should display weaker results since their consumption adjustment cost is arguably less costly. Table B5 presents the heterogeneous consumption and savings rate responses for renters and owners. In Column 1, we see the consumption response of households that do not own a house loads significantly in the past permanent income, with an estimated elasticity of 0.48 for the contemporaneous measure and 0.41 for the lagged one. However, for those households that own houses, the estimated elasticity is 0.49 for the contemporaneous measure and 0.28 for the lagged one. A possible explanation is that moving is costly for renters as well since it incurs the same packaging and transportation costs, brokerage fees, and searching time.

Column 2 shows that the saving rate response of households that did not own a house almost does not load in the past permanent income, with an estimated semi-elasticity of 0.21 for the contemporaneous measure and -0.08 for the lagged one. However, for those households that own a house, the saving rate loads more in the past permanent income, with an estimated semi-elasticity of 0.25 for the contemporaneous measure and -0.16 for the lagged one.

Table B6: Heterogeneous Effect by Own or Not

	(1) Nondurable Share	(2) Shelter Share
log(exp)	-2.24	-3.76
	(1.04)	(1.21)
Δ log(exp)	-0.16	-2.01
	(1.39)	(1.57)
Moved $\times$ log(exp)	-13.38	11.01
	(1.10)	(1.23)
Moved $\times$ Δ log(exp)	4.30	-6.23
	(1.96)	(2.09)
N	9831	9826

As in the previous table, if consumption commitments are behind the under-response and path-dependence of the consumption response to permanent income, it is natural to expect that households that do not own housing should display weaker path dependence in their expenditure allocation across categories. In Column 1, we see the nondurable consumption response of households that did not own houses loads significantly in the current expenditure, with an estimated coefficient of -3.63 for the log expenditure and 1.94 for the growth rate. However, for those households that own houses, the nondurable consumption loads more in the current and past expenditure, with an estimated coefficient of -17.24 for the log expenditure and 6.90 for the growth rate. The results for shelter consumption follow the same logic but with different signs.

B.5 Quality of the Expected Income Growth Measure

Table B7: Income Growth Forecast Equation

	(1)	(2)	(3)	(4)	(5)	(6)
	Error_{t+2}	Error_{t+4}	Error_{t+6}	Error_{t+8}	Error_{t+10}	MSE
log(c/y)	-0.006	0.010	0.019	0.023	0.023	0.144
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.038)
N	43586	35110	27885	21804	16589	14830

A possible concern with my empirical results is that my measure of expected income growth does not correctly measure agents' expectations. Indeed, I assume that a household information set is well captured by lagged income, age, and some demographic characteristics and that all enter linearly in the expectation formation process. However, the econometrician does not observe the information set, and neither the functional form has to be linear. As noticed by Cunha, Heckman, and Navarro (2005) and Blundell et al. (2008), if part of the permanent income growth were known in advance by the households, then they should already incorporate this information in their current choices.

To alleviate concerns with my measure, I provide evidence that advanced information is not a serious problem. Table B7 presents the forecasting errors of future income at different periods of time. Precisely, I compute the difference between the realized income in $t+j$ and the expected in t, $y_{t+j} - \mathbb{E}_t y_{t+j}$. The table has two main sections, the first section shows the error values for different forecast periods, which are $t+2$, $t+4$, $t+6$, $t+8$, and $t+10$, and the second section shows the mean squared error (MSE) value. As the explanatory variable, I use the log of the consumption-income ratio since a higher ratio means that the household expects higher income in the future. A higher consumption-income ratio today is associated with positive forecast error, meaning that households indeed have more information about their income path. However, the magnitude of the effect is small.

Using information available at period t to estimate the income processFor $\tau \in \{t-x, \cdots, t\}$, the log income follows

$$\ln Y_{i,\tau} = \theta_0^t + \rho_1^t \ln Y_{i,\tau-1} + \mathbf{X}_{i,\tau}\theta_1^t + \epsilon_{i,\tau} \ , \tag{7}$$

in which log income The latter captures in-sample forecast error, $\ln Y_{i,\tau} - \mathbb{E}_{i,t}[\ln Y_{i,\tau}]$, and approximation error, $\mathbb{E}_{i,t}[Y_{i,\tau}] - g(\ln Y_{i,\tau-1}, \mathbf{X}_{i,\tau}; \theta^t)$.

B.6 Bequest

Table B8: Bequest

	(1) wrt bequest	(2) wrt bequest	(3) log(bequest)	(4) log(bequest)
log(PI)	0.174	0.063	0.626	0.623
	(0.035)	(0.084)	(0.135)	(0.462)
log(PI$_{t-10}$)		0.240		0.209
		(0.094)		(0.472)
N	523	190	197	65

To further investigate the consumption commitments mechanism, I examine what households do with their saved income. My initial examination focuses on the bequests that parents leave for their offspring. First, I merge households with the year of their death. Second, I merge households with their split-off families. Third, I aggregate all reported inheritance of the split-off families within five years of the father/mother's death. Fourth, I construct two variables: a binary indicator of whether the household has left any bequest and, in the case of a positive bequest, the logarithm of the bequest amount. Lastly, I regress these two variables on my measure of permanent income and lagged permanent income. I use the last observed PI measure prior to the household's death.

Columns 1 and 2 of table B8 show that current and lagged permanent income are positively correlated with a higher likelihood of leaving a bequest. So, there is no evidence that locked households leave more bequest, which would be associated with a negative coefficient for the lagged permanent income. Columns 3 and 4 similarly show that current and lagged permanent income is associated with more bequests. Again, there is no evidence that locked households leave more bequests. It is worth noting that the sample size is limited, which restricts the precision of the parameter estimates.

Table B9: Assets when dead

	(1) Wtr Net Worth > 0	(2) Wtr Net Worth > 0	(3) log(net worth)	(4) log(net worth)
log(PI)	0.100	0.093	2.164	2.502
	(0.041)	(0.064)	(0.271)	(0.360)
log(PI$_{t-10}$)		0.071		-0.121
		(0.089)		(0.410)
Educ Dummies	Y	Y	Y	Y
KP-F test	16.0	6.7	36.1	5.9
Observations	666	294	589	261

My second examination focuses on the assets that households have then they die. Again, I merge households with the death year and use the last observed permanent measure before their death. In Columns 1 and 2 of Table B9, the dependent variable is a binary indicator of whether the household's net worth is greater than 0, while in Columns 3 and 4 the dependent variable is the logarithm of the household's net worth. The results reveal a correlation between present and lagged permanent income and the likelihood of having positive assets at death. In addition, current permanent income is associated with the amount of assets at death, while the lagged permanent income is negatively associated with the amount of assets at death. This result is consistent with the consumption commitment mechanism, yet the sample size is small, and the coefficient for lagged income is statistically insignificant.

B.7 Intervivos Transfers

Table B10: Intervivos Transfers

	All Sample		Reported Child	
	(1) Wrt. Help Child	(2) log(Help Child)	(3) Wrt. Help Child	(4) log(Help Child)
log(PI)	0.116	0.723	0.111	0.721
	(0.021)	(0.297)	(0.024)	(0.297)
$\log(\text{PI}_{t-10})$	-0.019	0.472	0.004	0.474
	(0.027)	(0.238)	(0.031)	(0.239)
Educ Dummies	Y	Y	Y	Y
KP-F test	131.0	13.2	124.1	13.2
Observations	15,421	542	13,064	538

Another look at what households do with their saved income is to look at intervivos transfers that parents do during life for their offspring. I use an expenditure question of the PSID that asks whether and the amount given toward the support of anyone living outside the household, including child support, alimony, and the money given to parents. I focus only on money for child support, even though the results are the same for a broad measure. Again, I construct two variables: a binary indicator of whether the household transferred any money and, in the case of a positive amount, the logarithm of it. Lastly, I regress these two variables on my measure of permanent income and lagged permanent income.

Table B10 has two parts, one for the full and another for the only households who have ever reported at least one child. The coefficient of the current permanent income is positively associated with a higher likelihood of helping children, but the one for the lagged measure is not economically or statistically significant. On the other hand, the coefficient of the current and lagged permanent income is positively associated with the log of the amount expended in helping children. However, the sample size is small, not allowing for a meaningful conclusion.

The results are the same if I merge households with their split-off families and analyze the reported private-transfer income children report receiving from people outside the household.

B.8 Donations

Table B11: Donations

	(1) Wrt. Donations	(2) log(Donations)
log(PI)	0.219	0.717
	(0.014)	(0.055)
$\log(\mathrm{PI}_{t-10})$	0.161	0.290
	(0.019)	(0.068)
N	15421	9257

The PSID has collected data on philanthropic giving and volunteer time since 2001. It is the only detailed giving data collected in a major panel survey in the US. Table B11 shows the association between total donation expenditure and current and lagged permanent income. Both measures are positively associated with the likelihood of marking reporting a donation expenditure and with the amount donated. There is no evidence that locked households donate more.

B.9 Parent-Child Pairs

Table B12: Child-Parent Pairs

	(1) Child's log(exp)	(2) Child's log(exp)
Child's log(PI)	0.532	0.802
	(0.022)	(0.040)
Dad's log(PI)	0.072	0.141
	(0.026)	(0.029)
Dad's log(PI_{t-10})	0.047	0.051
	(0.031)	(0.036)
Educ Dummies		Y
KP-F test	69.7	63.0
Observations	7,846	7,846

As a last investigation on the implications of the consumption commitments mechanism, I examine if splitoff families of locked households exhibit higher consumption. For that, I merge the split-off families with their reference person's or spouse's parent household. Table B12 shows a positive correlation between the splitoff expenditure and their parent's current and lagged permanent income. This finding implies that locked parents are not transferring money to their children, which would imply a negative correlation between parents' lagged permanent income measure and children's expenditure. Table B12 is consistent with the results of intervivos transfers.

C Computational Appendix

In this section, I will explain how I solve the model. First, I provide a detailed description of the model. Second, I explain the algorithm used to find the optimal policy functions. Third, I provide details of the interpolation technique used.

C.1 Description of the Model

I use a recursive formulation of the problem. Let s denote the household's state variable vector: $s = \{j, a, h_{-1}, \bar{z}, \alpha, \epsilon, \bar{z}^p\}$, where j represents age, a denotes liquid assets, h_{-1} represents past housing decisions (commitment goods), $\bar{z}$ represents the income fixed effect, α represents the persistent income shock, ϵ represents the transitory income shock, and $\bar{z}^p$ represents the parent-household's fixed effect. For ease of notation, I denote $z \equiv (\bar{z}, \alpha, \epsilon)$.

The value function for a household with state s is

$$V(s) = \max\left\{V^{adj}(s), V^{noadj}(s)\right\}.$$

where $V^{adj}(s)$ and $V^{noadj}(s)$ are the value functions conditional on adjusting and not adjusting housing consumption, respectively. The adjustment decision is made at the beginning of the period, after receiving bequest and income shocks but before deciding on consumption and savings.

In the no-adjustment case, the household solves the following problem:

$$V^{noadj}(s) = \max_{n,a'} \; u_j\Big(g(n,h)\Big) + (1-\psi_j)\,\beta\,\mathcal{B}\Big(a',h\Big) + \psi_j\,\beta\,\mathbb{E}\Big\{V(s')\Big|s\Big\} \tag{8}$$

subject to

$$\begin{aligned}
h &= (1-\delta(1-\chi))h_{-1} \\
n + a' &= pen(\bar{z}) + y(z) + (1+r)a - \delta\chi h_{-1} \\
\bar{z}^{p\prime} &= \begin{cases} \bar{z}^p & \text{with probability } (1-\psi_{j+35}) \\ 0 & \text{with probability } \psi_{j+35} \end{cases} \\
n > 0, &\quad a \geq -\theta h
\end{aligned}$$

and where the next-period state vector is $s' = \Big\{j+1,\; a'+b',\; h_{-1}(1-\delta(1-\chi)),\; \bar{z},\; \alpha',\; \epsilon',\; \bar{z}^{p\prime}\Big\}$.

On the other hand, in the adjustment case, the household solves the following problem:

$$V^{adj}(s) = \max_{n,h,a'} \; u_j\Big(g(n,h)\Big) + (1-\psi_j)\,\beta\,\mathcal{B}\Big(a',h\Big) + \psi_j\,\beta\,\mathbb{E}\Big\{V(s')\Big|s\Big\} \tag{9}$$

subject to

$$
\begin{aligned}
h &= (1-\kappa)(1-\delta)h_{-1} + x \\
n + a' + x &= pen(\bar{z}) + y(z) + (1+r)a \\
\bar{z}^{p'} &= \begin{cases} \bar{z}^{p} & \text{with probability } (1-\psi_{j+35}) \\ 0 & \text{with probability } \psi_{j+35} \end{cases} \\
n > 0, &\quad a \geq -\theta h
\end{aligned}
$$

and where the next-period state vector is $s' = \left\{ j+1,\ a'+b',\ h,\ \bar{z},\ \alpha',\ \epsilon',\ \bar{z}^{p'} \right\}$.

The last variable in the state vector has two purposes, as in De Nardi (2004). First, when it takes on a positive value, it is used to calculate the probability distribution of bequests that a household expects to receive from a parent. Second, it helps differentiate between agents who have already inherited (for whom $\bar{z}^{p'}$ is set to 0) and those who have not (for whom $\bar{z}^{p'}$ is strictly positive).

Figure 8 depicts two parallel timelines, the first representing the parent and the second the child households. Both households start working at the age of 25 and retire with certainty at 65. I assumed that households have uncertain lifespans, meaning they may pass away at any time between the ages of 65 and 99. The child is born when the parent is 35 years old; therefore, it begins working when their parent is 60 years old and retires when they would have completed 100 years old. Given the timing of the lifetime events, the child may inherit bequests at a random age between 30 and 64. Note that this structure does not allow for situations where the child receives a bequest from their grandparents.

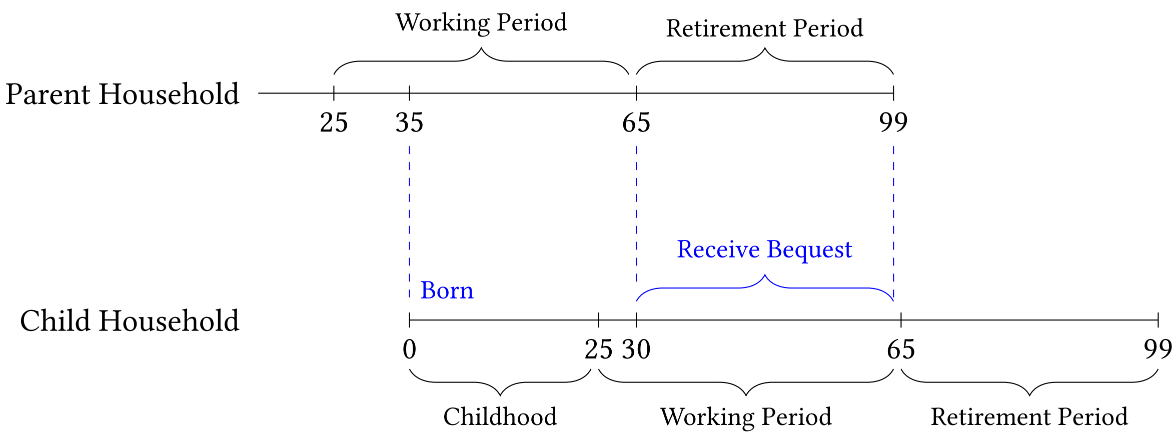


Figure 8: Overlapping Generations Structure

C.2 Optimal Decision Rules

I solve the method using first-order conditions. Since the problem features non-convex adjustment costs, first-order conditions are necessary but not sufficient. Thus, following the algorithm used by Kaplan and

Violante (2014), I examine all solutions to each set of first-order conditions, then determine the optimal solution by evaluating the value functions at each candidate solution. This includes considering all corner solutions at all corners and evaluating the value functions at these points. This search for the optimal solution is done at each point in the state space.

I solve the model recursively from the last period of life to the first. To do this, I follow Kaplan and Violante (2014) and define a new operator, $\widetilde{\max}\{\cdot,\cdot\}$, which chooses between two objects based on which of the corresponding value functions is higher. For example, $\widetilde{\max}\{n^{adj}, n^{noadj}\}$ selects nondurable expenditures n^{adj} when $V^{adj} > V^{noadj}$ at the specific point in the state space. I also compute partial derivatives of value functions using envelope conditions, which are constructed recursively alongside the value function and policy functions. The value functions and the partial derivatives may not be continuous due to the discrete choices in the model. However, (i) if there is enough uncertainty in the problem, the jumps tend to be smoothed away, and (ii) there are a finite number of points of discontinuity.

Given the life-cycle structure of the problem, I describe the first-order conditions for the retirement and working periods separately.

C.2.1 Retirement-period

For a household in its retirement period $R \leq j < J$ and that decided to not adjust their housing consumption, its decision is determined by a standard Euler Equation,

$$(1-\omega)c^{1-\sigma_j-\rho}n^{\rho-1} = (1-\psi_j)\,\beta\,\phi_1\Big(\phi_2 + a' + h\Big)^{-\sigma} + \psi_j\,\beta\,\widetilde{\max}\left\{\frac{\partial V^{adj\prime}}{\partial a'}, \frac{\partial V^{noadj\prime}}{\partial a'}\right\},$$

by the budget constraint defined in the previous subsection, and by $h = (1-\delta(1-\chi))h_{-1}$.

For a household in its retirement period $R \leq j < J$ and that decided to adjust their housing consumption, its decision is determined by a standard Euler Equation for assets, a portfolio problem that equates the marginal value of investing in assets and housing:

$$\begin{aligned}
(1-\omega)c^{1-\sigma_j-\rho}n^{\rho-1} &= (1-\psi_j)\,\beta\,\phi_1\Big(\phi_2 + a' + h\Big)^{-\sigma} + \psi_j\,\beta\,\widetilde{\max}\left\{\frac{\partial V^{adj\prime}}{\partial a'}, \frac{\partial V^{noadj\prime}}{\partial a'}\right\} \\
(1-\omega)c^{1-\sigma_j-\rho}n^{\rho-1} &= \omega\zeta c^{1-\sigma_j-\rho}(\zeta h)^{\rho-1} \\
&\quad + (1-\psi_j)\,\beta\,\phi_1\Big(\phi_2 + a' + h\Big)^{-\sigma} + \psi_j\,\beta\,\widetilde{\max}\left\{\frac{\partial V^{adj\prime}}{\partial h}, \frac{\partial V^{noadj\prime}}{\partial h}\right\}
\end{aligned}$$

and by the budget constraint defined in the previous subsection.

C.2.2 Working-period

A household during its working period $1 \leq j < R$ faces income uncertainty, but no mortality risk. Thus, its optimal decision of not adjusting its housing satisfies:

$$(1-\omega)c^{1-\sigma_j-\rho}n^{\rho-1} = \beta\mathbb{E}\left[\widetilde{\max}\left\{\frac{\partial V^{adj\prime}}{\partial a'}, \frac{\partial V^{noadj\prime}}{\partial a'}\right\}\Big|s\right]$$

and the budget constraint defined in the previous subsection. For a household that decided to adjust their housing consumption, its decisions satisfies:

$$\begin{aligned}
(1-\omega)c^{1-\sigma_j-\rho}n^{\rho-1} &= \beta\mathbb{E}\left[\widetilde{\max}\left\{\frac{\partial V^{adj\prime}}{\partial a'}, \frac{\partial V^{noadj\prime}}{\partial a'}\right\}\Big|s\right] \\
(1-\omega)c^{1-\sigma_j-\rho}n^{\rho-1} &= \omega\zeta c^{1-\sigma_j-\rho}(\zeta h)^{\rho-1} + \beta\mathbb{E}\left[\widetilde{\max}\left\{\frac{\partial V^{adj\prime}}{\partial h}, \frac{\partial V^{noadj\prime}}{\partial h}\right\}\Big|s\right]
\end{aligned}$$

and the budget constraint defined in the previous subsection.

C.2.3 Envelope Conditions

As already mentioned, I compute partial derivatives of value functions using envelope conditions, which are constructed recursively alongside the value function and policy functions. The value functions and the partial derivatives may not be continuous due to the discrete choices in the model. However, (i) if there is enough uncertainty in the problem, the jumps tend to be smoothed away, and (ii) there are a finite number of points of discontinuity.

The partial derivatives of the choice-specific value functions for the retirement period are

$$\begin{aligned}
\frac{\partial V^{noadj}}{\partial a} &= (1-\omega)(1+r)c^{1-\sigma_j-\rho}n^{\rho-1} \\
\frac{\partial V^{noadj}}{\partial h_{-1}} &= \omega\zeta\,(1-\delta(1-\chi))c^{1-\sigma_j-\rho}(\zeta h)^{\rho-1} - (1-\omega)\,\delta\chi\, c^{1-\sigma_j-\rho}n^{\rho-1} \\
&\quad + (1-\psi_j)(1-\delta(1-\chi))\,\beta\,\phi_1\Big(\phi_2 + a' + h\Big)^{-\sigma} \\
&\quad + \psi_j\,(1-\delta(1-\chi))\,\beta\,\widetilde{\max}\left\{\frac{\partial V^{adj\prime}}{\partial h}, \frac{\partial V^{noadj\prime}}{\partial h}\right\} \\
\frac{\partial V^{adj}}{\partial a} &= (1-\omega)(1+r)c^{1-\sigma_j-\rho}n^{\rho-1} \\
\frac{\partial V^{adj}}{\partial h_{-1}} &= (1-\omega)(1-\delta)(1-\chi)c^{1-\sigma_j-\rho}n^{\rho-1}
\end{aligned}$$

The partial derivatives for the working-period are easily derived from the ones computed above. With a recursion for the partial derivatives, I solve the model recursively.

D 2-Period Model

I begin by studying a 2-period model to provide intuition and reference values to interpret the empirical results of Section 4. In the model, a household commits itself to an expenditure path given some expectation about its permanent income. However, after an MIT shock, the household cannot adjust a good in its consumption bundle, which generates a depressed total consumption. In Section 2, I explore the quantitative predictions of a fully specified model.

D.1 Simple 2-period Model

Consider a partial equilibrium model in which a household earns a known income path $\{y_1, y_2\}$ and chooses savings s and the consumption path of two types of goods, non-adjustable goods $\{h_1, h_2\}$ and adjustable goods $\{n_1, n_2\}$.[23] Furthermore, assume that the aggregated consumption good is defined using a Cobb-Douglas aggregator, $c = g(h, n) = h^{\nu} d^{1-\nu}$, in which ν is the aggregated good elasticity with respect to non-adjustable goods. Before the first period – or period 0 – the household chooses consumption paths and savings to maximize lifetime utility subject to each period's budget constraint and the Cobb-Douglas aggregator:

$$
\begin{aligned}
v_0 = \max u(c_1) + u(c_2) \quad \text{s.t. } \; & c = h^{\nu} n^{1-\nu} \\
& h_1 + n_1 + s = y_1 \\
& h_2 + n_2 = y_2 + s \, .
\end{aligned}
$$

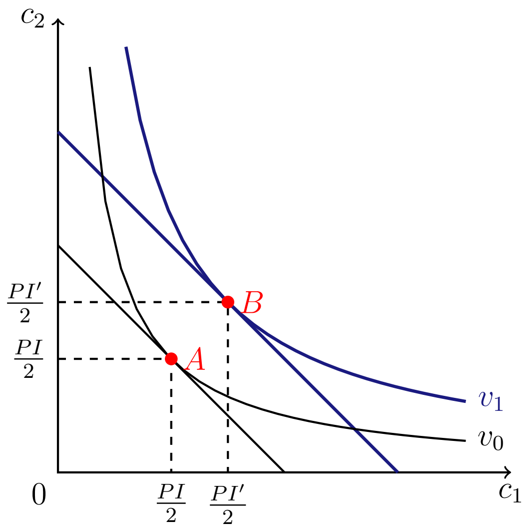
In this simplified problem, all goods' optimal allocations are a linear function of total wealth, $y_1 + y_2$. Permanent income is defined as the annuity value of total wealth, which is equal to half the total wealth in this model, $PI = \frac{1}{2}(y_1 + y_2)$. Therefore, in each period, consumption is a linear function of permanent income, which implies a consumption elasticity with respect to permanent income of 1, $\mathcal{E}_{C,PI} = 1$.[24]

Suppose that at the beginning of period 1, an MIT shock increases permanent income ($PI' > PI$). In this case, the household will re-optimize its consumption bundle, and aggregate consumption will increase proportionally to the increase in permanent income. Panel 9a of Figure 9 shows this case. Both c_1 and c_2 increase proportionally to the increase in permanent income, going from point A to point B. In Panel 9b of Figure 9, I draw the expansion path of the household when permanent income increases, which is linear. In other words, the slopes of indifference curves are constant along rays beginning at the origin, and the intertemporal Engel curve is linear. In most consumption models used in macroeconomics, the

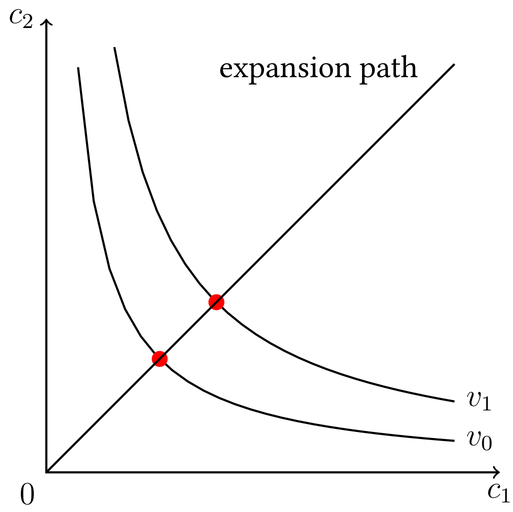
[23] I denote the non-adjustable goods h since, in the empirical part, I show that housing is the principal consumption commitment in a typical household consumption basket. I denote the adjustable goods with n to refer to non-durable goods.

[24] The allocations are $h_1 = h_2 = \nu \frac{PI}{2}$, $n_1 = n_2 = (1-\nu)\frac{PI}{2}$, and $c_1 = c_2 = \frac{PI}{2} \times$ constant

consumption elasticity with respect to permanent income is close to 1, and the intertemporal Engel curve is close to linear.



(a) Optimal Allocation



(b) Expansion Path

Figure 9: Model without Friction

D.2 Simple Model with a Non-adjustable Good

Suppose the same thought experiment as before. Before period 1, the household chooses allocations. In period 1, an MIT shock increases permanent income. However, assume a new friction: at $t = 1$, the household cannot adjust h_1, only n_1. At $t = 2$, the household can adjust both goods, h_2 and n_2. In the full quantitative model of Section 2, I relax the extreme assumption of complete non-adjustment by assuming that the household can adjust consumed quantity of the non-adjustable good if it pays a fixed adjustment cost.

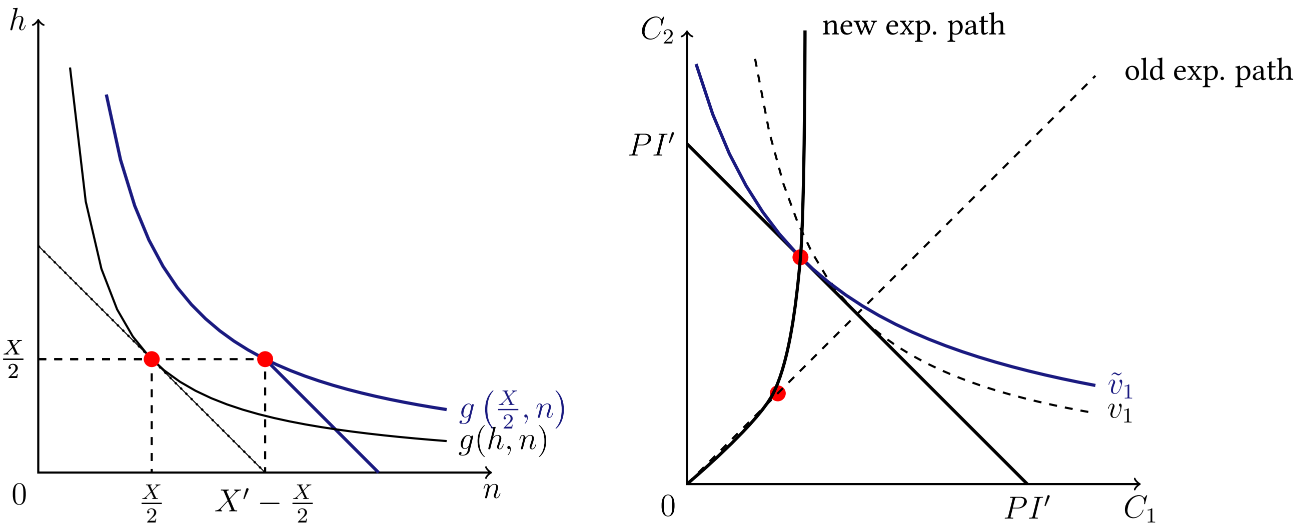
The maximization problem that the household solves in period 1 after the MIT shock is

$$
\begin{aligned}
\tilde{v}_1(h_1) = \max u(c_1) + u(c_2) \qquad \text{s.t. } & u(c) = c^{1-\sigma}/1-\sigma \\
& c = h^{\nu} n^{1-\nu} \\
& h_1 + n_1 + s = y_1 \\
& h_2 + n_2 = y_2 + s \\
& h_1 \text{ is given.}
\end{aligned}
$$

Assuming for convenience log-utility, the allocation on the non-durable good is constant across periods, $n_1 = n_2$. Also, the optimal allocations are still a function of total wealth, $y_1' + y_2'$, but also a function of the original commitment of the non-adjustable good consumption, h_1. Because the consumption of h_1 is fixed, the household divides the extra income between other goods, h_2, n_1, and n_2.[25]

Panel 10a of Figure 10 displays the intraperiod allocation of expenditure between the two types of goods. There is a kink in the budget constraint since the household is committed to consuming a predetermined quantity of h_1. Any increase in expenditure happens in the adjustable good, n_1, which causes the substitution rate between goods to be different from the slope of the budget constraint. In the second period, the household can adjust expenditure on both goods, which equalizes the between-goods substitution rate to the budget constraint slope.

The consumption elasticity to permanent income is no longer 1.[26] Panel 10b of Figure 10 shows the intertemporal impact of the adjustment friction. Since increases in the aggregated consumption bundle in period 1 have to be done by increases in the adjustable good, it creates an allocation distortion. Consequently, the household shifts consumption to period 2 since both goods are adjustable and the aggregate consumption bundle is optimal. The slopes of indifference curves are no longer constant along rays beginning at the origin, and the intertemporal Engel curve of the first-period good is concave.



(a) Intratemporal Allocation

(b) Expansion Path

Figure 10: Model with Adjustment Friction

The two main implications I test on the PSID data in Section 4 can be understood through this simple model and the diagrams in Figure 10. First, for two households with the same level of permanent income (or total wealth $y_1' + y_2'$), the consumption elasticity to permanent income will be lower for the one whose permanent income grew faster. In other words, the consumption response in period 1 will be a function of the expected permanent income in period 0 as in Panel 10b. Second, for the household whose permanent

[25]The allocations are $n_1 = n_2 = \frac{1-\nu}{1+\nu}(y_1' + y_2' - h_1)$, $h_2 = \frac{1-\nu}{1+\nu}(y_1' + y_2' - h_1)$, and $c_1 = (h_1)^{\nu}(PI' - h_1)^{1-\nu} \times$ constant.

[26]Using $d_1 = \nu PI$ and assuming PI' close to PI, we find that $\frac{\partial \log c_1}{\partial \log PI'} = \nu \frac{PI'}{PI' - h_1} \approx \frac{2\nu}{1+\nu} < 1$

income grew faster, its consumption bundle skews toward more adjustable goods as in Panel 10a. Both predictions hold for constrained households. However, households that are not constrained, i.e., those that adjusted their consumption bundle, should display no path dependence.