Consumption Commitments and The Consumption Elasticity to Permanent Income

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Abstract

In this paper, I propose consumption commitments – goods that are costly to adjust – as the key mechanism behind the concavity of consumption to permanent income. Households choose the consumption path given their expectation of permanent income. When the uncertainty realizes, those that did not reoptimize their bundle have depressed consumption. To support this claim, I provide empirical using PSID data. First, conditioning on the same permanent income today, households that experienced faster permanent income growth consume less. Second, those households have larger shares of easy-to-adjust goods in their bundles. Last, all results disappear or weaken when looking at only households that adjusted their consumption bundle. To quantify the mechanism relevance, I simulate a life-cycle model in which some goods are subject to non-convex adjustment costs. The model can account for all the facts documented in the data.

Keywords: Permanent Income, Consumption Commitments

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-transitory income. However, evidence suggests that current models fail to accurately capture the consumption response to income changes. In particular to this paper, consumption is excessively smooth 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] These findings all point to the fact that, in the data, consumption under-responds to permanent income relative to what the benchmark theory predicts.

In this paper, I investigate the mechanism behind the consumption under-response to permanent income. Empirically, I show that consumption commitments – goods subject to transaction costs and infrequently adjusted – play an important role in the data. Households commit themselves to an expenditure path given some expectation about their permanent income. However, once the uncertainty is resolved, many households do not adjust their consumption bundles, which generates a depressed consumption. Quantitatively, I propose a model nesting different explanations proposed by the literature to quantify the strength and importance of consumption commitments. Lastly, I revise the implications of consumption commitments versus those of behavioral (preference) explanations for wealth inequality.

In my empirical results, I use data from the Panel Survey of Income Dynamics (PSID). The PSID is a representative sample of the entire U.S. population that uniquely measures wealth, income, and expenditure in detail and follows households over time. I focus on the period from 1999 to 2019, which is the one with the most detailed consumption and wealth information.

I construct a new measure of permanent income at the household level. More important, my measure is time-varying, which allows me to see how consumption response to permanent income changes over the life cycle, especially after the permanent income uncertainty is resolved. A significant part of lifetime income is unknown at the time of entry into the labor market (Cunha, Heckman, and Navarro, 2005), which instigates the study of how the elasticity changes over the cycle. I define permanent income as current assets plus the discounted future expected path of income. To estimate the latter, I assume an income process and forecast the income profile for

[1] With current consumption theories, I mean models in which the permanent-transitory notion 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).

each household. I measure net worth by total assets minus total debt.

I document several facts regarding the consumption response to permanent income. First, I recover a consumption elasticity with respect to permanent income of approximately 0.60, a result initially documented by Straub (2019). Second, I show that the consumption response decreases with age, with young households having an elasticity of around 0.7 and old households around 0.5. Third, I document the existence of path dependence in the consumption response to permanent income. As a thought experiment, consider two households with the same permanent income today, but one experienced faster permanent income growth. In the data, this household consumes less than the one with lower growth. Conversely, I also reveal that households with faster permanent income growth have higher assets and saving rates, conditional on the same permanent income today.

To shed light on the mechanism behind the previous document facts, I use the detailed consumption categories available in the PSID since 1999 to estimate demand systems. Different explanations will result in different implications for how households allocate expenditures across consumption categories and how past growth affects current expenditures. In particular, I estimate AIDS demand systems allowing a particular 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 curve. The latter captures how households with faster permanent income growth allocate their expenditure differently across consumption categories. The data reveals that high expenditure growth is associated with more easy-to-adjust goods consumption (nondurables, such as food) and less hard-to-adjust goods consumption (shelter), highlighting that goods' adjustability is essential to understand the consumption response to permanent income.

Lastly, as a check for the consumption commitments mechanism, I investigate how households that adjusted their consumption bundle behave. I treat shelter consumption (housing flow for homeowners and rent for renters) as the main consumption commitment 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 reset their bundle exhibit little or no path dependence in the demand system or in the consumption response to permanent income. Furthermore, their consumption elasticity to permanent income is close to 0.80, consistent with the results of life-cycle model simulations (Kaplan and Violante, 2010). These 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 (consumption commitments).

Quantitatively, I explore the implication of the described mechanism through a quantitative model nesting different explanations proposed by the literature. In particular, I am extending a standard incomplete markets life cycle model (Deaton, 1991; Carroll, 1997) to include 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). I also allow for non-homothetic preferences following Straub (2019) and the bequest motive following De Nardi (2004).

I examine the relevance of the proposed mechanism by calibrating the quantitative model using moments computed from the PSID data. With the calibrated model, I simulate households' panels shutting down each time one of the different mechanisms in the model. I quantify each mechanism's importance by applying the same method of the empirical section and comparing model and data results. In addition, I also apply Straub (2019)'s method to the simulated data. Finally, I study the implications of consumption commitments to wealth inequality and revisit the implications of the recent increase in permanent income inequality in the U.S. since 1970.

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 simple 2-period model to illustrate the mechanism. Section 3 introduces the empirical strategy and the data. Section 4 presents the estimate of the response of consumption to permanent income. Section 5 presents the standard incomplete markets life cycle model nesting key features proposed by the literature. Section 6 has the model aggregated implications. Finally, Section 7 concludes. The appendix contains all proofs, as well as additional empirical and quantitative results.

2 Illustration of the Mechanism

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 5, I explore the quantitative predictions of a fully specified model.

2.1 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 $\{n_1, n_2\}$.[2] Furthermore, assume that the aggregated consumption

[2] 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.

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:

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

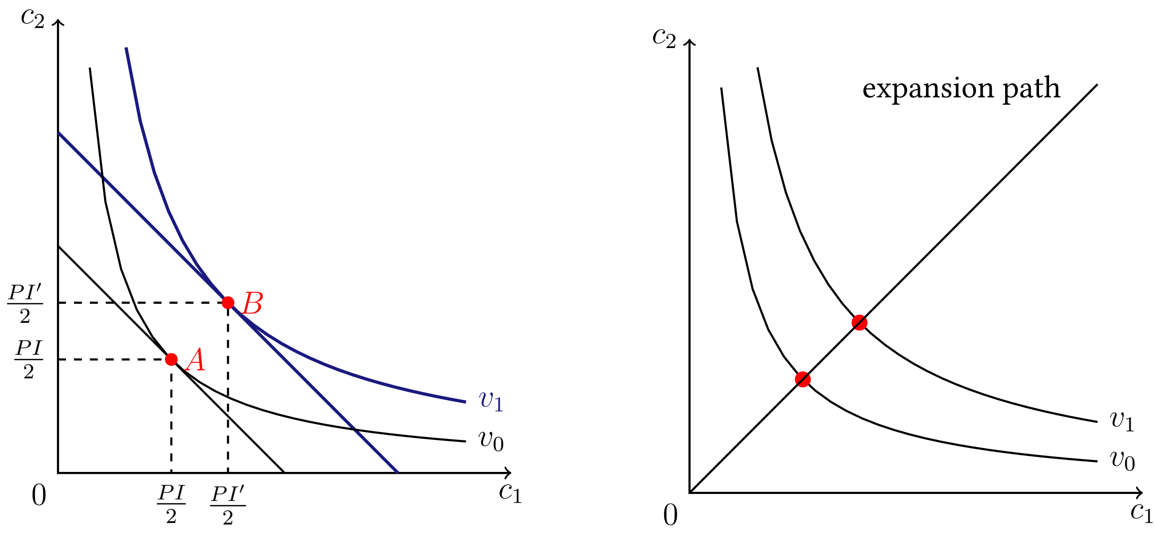
In this simplified problem, all goods' optimal allocations are a linear function of total wealth, $y_1 + y_2$. Permanent income is defined as the annuity value of total wealth, which is equal to half the total wealth in this model, $PI = \frac{1}{2}(y_1 + y_2)$. Therefore, in each period, consumption is a linear function of permanent income, which implies a consumption elasticity with respect to permanent income of 1, $\mathcal{E}_{C,PI} = 1$.[3]

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

2.2 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 5, 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.

[3]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



(a) Optimal Allocation

(b) Expansion Path

Figure 1: Model without Friction

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

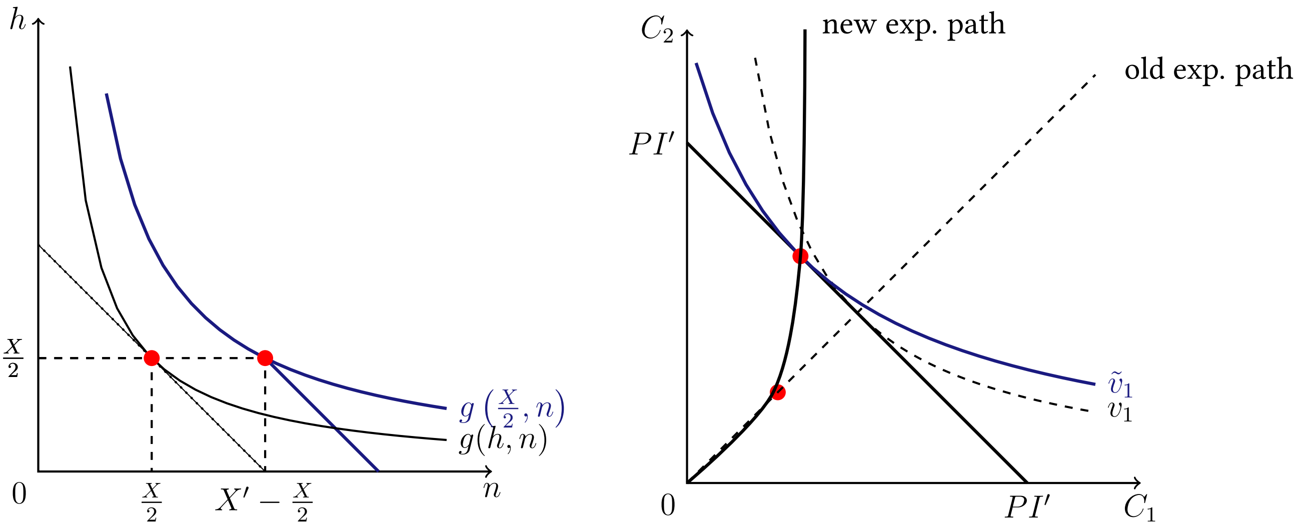
$$
\begin{aligned}
\tilde{v}_1(h_1) = \max u(c_1) + u(c_2) \quad \text{s.t. } & u(c) = c^{1-\sigma}/1-\sigma \\
& c = h^{\nu} n^{1-\nu} \\
& h_1 + n_1 + s = y_1 \\
& h_2 + n_2 = y_2 + s \\
& h_1 \text{ is given.}
\end{aligned}
$$

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.[4]

Panel 2a of Figure 2 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 pre-determined 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.

[4]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.

The consumption elasticity to permanent income is no longer 1.[5] Panel 2b of Figure 2 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 2: 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 2. 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 2b. Second, for the household whose permanent income grew faster, its consumption bundle skews toward more adjustable goods as in Panel 2a. 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.

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

3 Data and Empirical Strategy

In the previous section, I illustrated how consumption commitments could generate non-homothetic behavior in the consumption response to permanent income. I also highlighted testable implications from the model. In this section, I explain my empirical strategy to test those. In Subsection 3.1, I describe the Panel Study of Income Dynamics (PSID) data. In Subsection 3.2, I introduce my empirical strategy. Finally, in Subsection 3.3, I present my econometric approach.

3.1 Data

In the analysis, I use data from the 1999 – 2019 waves of the Panel Study of Income Dynamics (PSID), which are the ones that have broad consumption, income, and wealth measures. This unique feature of the data allows analyses focusing on the long-run path of consumption, income, and wealth within a household lifecycle. In addition, I use data from the 1980 - 2019 PSID waves to estimate the income process used to compute expected income growth.[6] Finally, I use the CPI to express all monetary values in 2017 US dollars.

Expenditures Following Kaplan, Violante, and Weidner (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.

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

[6] The PSID was conducted annually until 1996 and biennially since 1997. From waves before 1999, I use only odd survey years for consistency.

payments, lease payments, loan payments, and additional vehicle costs.[7] 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, Bils, and Boar (2020) compute the same averages and find 58.3 and 73.2 percent, respectively.

Earnings I construct two measures of income. First, household after-tax labor income 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 social security benefits. My measure of payroll taxes comes from the NBER's TAXSIM.[8]

My second measure of household income is 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.[9] Again, I compute the taxes using the NBER's TAXSIM (payroll and federal and state income taxes).

Wealth Following Kaplan et al. (2014) and Aguiar et al. (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

[7] Since the 2019 wave, the PSID staff created two aggregated consumption variables. Both sum all the subcategories into a total household consumption quantity, differing only on how to compute expenditure on shelter. The first variable, Total Consumption, considers shelter expenditure as the sum of rent for renters and implicit rent for homeowners. The second variable, Total Expenditure, considers shelter expenditure as the sum of rent for renters, mortgage payments, and property taxes. The first measure differs from my baseline only in how I treat vehicle expenditure. I explore the second measure as a robustness exercise.

[8] 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.

[9] Because I explore two ways of accounting for expenditure on shelter, I also 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.

other pensions. Net worth is the sum of net illiquid and net liquid wealth.

To better understand a household's lifecycle wealth dynamics, I also clean questions available in the Wealth Module of each PSID wave to construct a measure of active saving. These sequences measure money flows into and out of different assets and, combined with changes in the measured wealth, allow for distinguishing between active savings and capital gains. Following Hurst, Luoh, and Stafford (1998), active savings is the sum of net inflows into the stock market, change in vehicle equity, net change in transaction account balances, net inflows to business, net inflows to annuities, home improvements, and net inflows into real estate other than main home minus increases in uncollateralized debt. Active saving calculation includes only changes in home equity classified as home improvements. Capital gains are defined as changes in wealth minus active savings.

Sample Selection To construct my panel in the PSID, 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 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. Appendix B.1 presents some sample descriptions.

3.2 Estimating Permanent Income

I now describe the measure of permanent income for household i at time t. Permanent income is defined as the sum of household's current assets, $A_{i,t}$, plus its discounted future expected path of income, $Y_{i,t}$:

$$\mathrm{PI}_{i,t} = A_{i,t} + \mathbb{E}_{i,t}\left[\sum_{j=1}^{J_i} \frac{Y_{i,t+j}}{R^j}\right]. \tag{1}$$

The expectation is computed using all available information for the household i at time t, such that $\mathbb{E}_{i,t}[\cdot] = \mathbb{E}[\cdot|I_{i,t}]$ with $I_{i,t}$ denoting the information set. J_i is the household's expected death period. R is a discount rate.

Crucial to compute permanent income is the necessity of having an estimate of the expected path of income for each household. I proceed by making a set of assumptions that allows me to recover it. First, I assume lagged income and some demographic characteristics describe the information set. Second, I assume the household and the econometrician have the same information set. Let $g(\mathbf{Y}_i^{t-1}, \mathbf{X}_{i,t})$ be the function that approximates the expectation process formation, where $\mathbf{Y}_i^{t-1}$ is a vector with past income realizations, and $\mathbf{X}_{i,t}$ is a vector with some demographic characteristics. For the exposition, let $g(\cdot)$ be the same for every household, but I later allow it to be industry- or occupation-specific. Third, I restrict $g(\cdot)$ to linear autoregressive processes, which are the best linear approximation (under quadratic loss) to the conditional mean $E(Y_t|\mathbf{Y}_i^{t-1}, \mathbf{X}_{i,t})$. I estimate all equations by OLS. In other words, I use the "linear least squares forecast."

When estimating the process parameters to construct future expected income in period t, I restrict the sample to observations collected before t. This deal 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 the same number of sample years when estimating the income process.

As a benchmark, I use an 1-st order autoregressive process. For $\tau \in \{t-x, \cdots, t\}$, the log income follows

$$\ln Y_{i,\tau} = \theta_0^t + \rho_1^t \ln Y_{i,\tau-1} + \mathbf{X}_{i,\tau}\theta_1^t + \epsilon_{i,\tau} \ , \tag{2}$$

in which log income is a function of lagged income, demographic characteristics, $\mathbf{X}_{i,\tau}$, and an error term, $\epsilon_{i,\tau}$. The latter captures in-sample forecast error, $\ln Y_{i,\tau} - \mathbb{E}_{i,t}[\ln Y_{i,\tau}]$, and approximation error, $\mathbb{E}_{i,t}[Y_{i,\tau}] - g(\ln Y_{i,\tau-1}, \mathbf{X}_{i,\tau}; \theta^t)$. Subsection 4.5 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.

Using the estimated income process, I construct the expected income path for each household:

$$\begin{aligned} \mathbb{E}\Big[\ln Y_{i,t+1}\Big|I_t\Big] &= \mathbb{E}\Big[\ln Y_{i,t+1}\Big|\ln Y_{i,t}, \ln Y_{i,t-1}, \mathbf{X}_{i,t}\Big] \\ \ln \widehat{Y}_{i,t+1}^t &= \widehat{\theta}_0^t + \widehat{\rho}_1^t \ln Y_{i,t} + \mathbf{X}_{i,t}\widehat{\theta}_1^t \ , \end{aligned} \tag{3}$$

in which $\ln \widehat{Y}_{i,t+1}^t$ is the expected log income in period $t+1$ using the information set in t. Then, to forecast log income in periods after $t+1$, I iterate forward equation 3, updating income and age but keeping other variables constant at their period t realization.[10]

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

$$\begin{aligned} \ln \widehat{Y}_{i,t+2}^t &= \widehat{\theta}_0^t + \widehat{\rho}_1^t \ln \widehat{Y}_{i,t+1} + \mathbf{X}_{i,t}\widehat{\theta}_1^t \\ \ln \widehat{Y}_{i,t+3}^t &= \widehat{\theta}_0^t + \widehat{\rho}_1^t \ln \widehat{Y}_{i,t+2} + \mathbf{X}_{i,t}\widehat{\theta}_1^t \ . \end{aligned}$$

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.[11] 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.

I express expected future income in present value terms using a constant interest rate and age-specific survival probabilities. First, I set the interest rate R to 5%[12]. Second, I obtain death probability from the US Life Tables computed by the National Vital Statistics System. For example, for a household aged 30 in 2020, I discount the expected income at age 65 by $\frac{0.79}{(1.05)^{30}}$, the survival probability divided by the compounded discount rate. I further assume that individuals die with certainty after 100 years old.

Lastly, I use net worth (the value of assets net of the debt value) as my empirical measure of assets. Combining all the elements, the empirical implementation of permanent income for household i in period t, $\text{PI}_{i,t}$, is:

$$\widehat{\text{PI}}_{i,t} = \text{net worth}_{i,t} + \sum_{j=1}^{age_i(t+j)=100} \frac{\psi\Big(age_i(t), age_i(t+j)\Big)}{(1.05)^j} \widehat{Y}^t_{i,t+j}.$$

$age_i(t)$ 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.

Mapping to the data The PSID runs biannually after 1999. So 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. I use the data from the past 16 years to estimate the income process. As robustness, I allow the parameters of the income process to vary by occupation or industry.

Measurement error Survey data is subject to measurement error, which 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

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.

[11] 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.

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

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.[13]

3.3 Econometric approach

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

$$\log c_{i,t} = \beta_0 + \beta_1 \log \widehat{\mathrm{PI}}_{i,t} + \boldsymbol{X}_{i,t}\beta_3 + \epsilon_{i,t} \ , \tag{4}$$

in which $\boldsymbol{X}_{i,t}$ 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.

My identification strategy 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.

Aguiar and Bils (2015) find evidence of non-classical measurement error in the Consumer Expenditure Survey (CE). In particular, they found that wealthier households tend to underreport their spending. This type of measurement error should not be a concern to my exercise. First, I use data from the PSID, which has been shown not to display evidence of a downward trend in the coverage expenditure data (Blundell et al., 2016). Second, my analysis focuses on the relationship between average consumption and average permanent income in the cross-section rather than how it changes over the years or across the permanent income distribution. Third, I recover a similar elasticity using different consumption measures. However, if non-classical measurement errors were important in my exercise, the estimated elasticity would be different for these different consumption measures. I discuss the implications of non-classical measurement error in more detail when discussing the results.

[13]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).

4 Empirical 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 4.2 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 4.3 provides evidence that high past expenditures are associated with less easy-to-adjust goods consumption and higher hard-to-adjust goods consumption. Subsection 4.4 studies how the previous results change when a household adjusts its consumption bundle. Subsection 4.5 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 1 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 1 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 4.5. Lastly, the F statistic is sufficiently high, so it does not raise any concerns about weak instruments.

Table 1: 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 2 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 2: 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

Path Dependence

In Table 3, 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 3 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 2 and illustrated in Panel 2b that the consumption response in period t is a function of the expected permanent income in previous periods.

Table 3: 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 remaining columns of Table 3 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 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).

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 10 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 11 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 3.1 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 12 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 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[14] 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.[15] It is worth remembering that my total income already includes asset income, such as business income, farm

[14] In Subsection 3.1, 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.

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

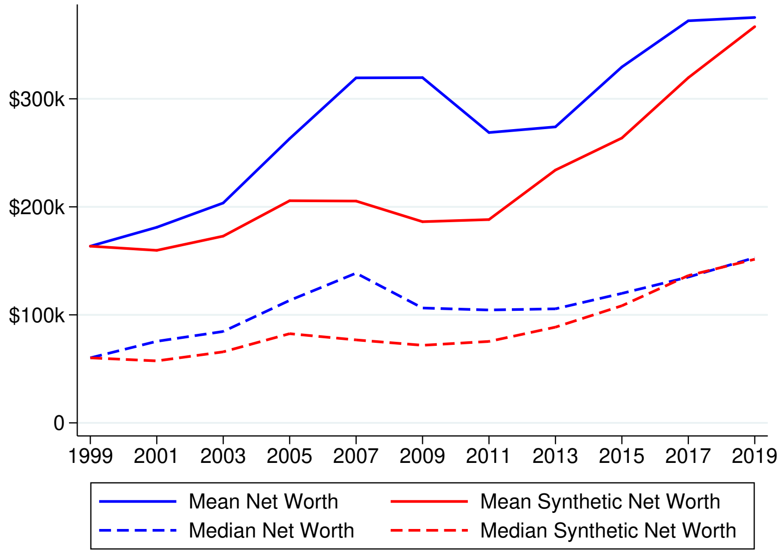
income, dividends, interest, rents, trust funds, and royalties from the head and spouse. So, only one more assumption is needed to compute capital gains for each asset class. I aggregate home equity, other real estate's net worth, and farm and business net worth into a broad category and assume that 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 3 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 3 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.

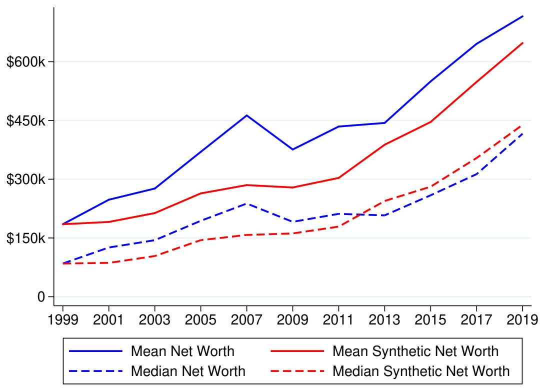
Figure 4 replicates the prior analysis, dividing the sample into two groups. Panel 4a plots those households that experienced positive permanent income growth, and Panel 4b plots those that did not. Similar to the previous graph, the median reported net worth is displayed as the dashed blue line and 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. Importantly, both groups begin from similar starting points. Figure 4 also displays the median reported net worth (solid blue line) and the median synthetic net worth (solid red line). Both

Figure 3: Asset Path Implied by Expenditure and Income

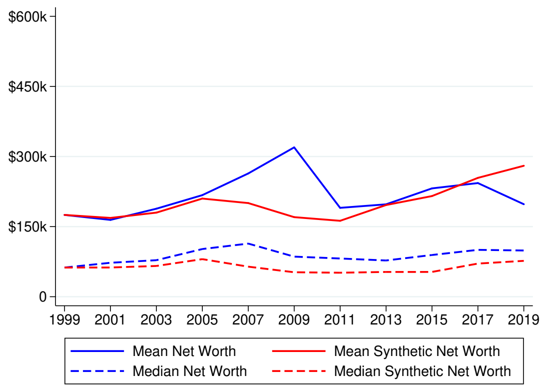


panels of Figure 4 reinforce the observation that households that experienced positive permanent income growth accumulated more wealth than those that did not.

Figure 4: 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 et al. (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 4 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 4 is the mirror image of Table 3. However, it is important to notice two things. First, lagged permanent income enters negatively in Table 4, while it enters positively in Table 3. 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 2 and illustrated in Panel 2b, the consumption response in period t is concave in permanent income growth. Table 4 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.

Table 4: 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

4.3 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 goods as in Panel 2a.

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 5 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.

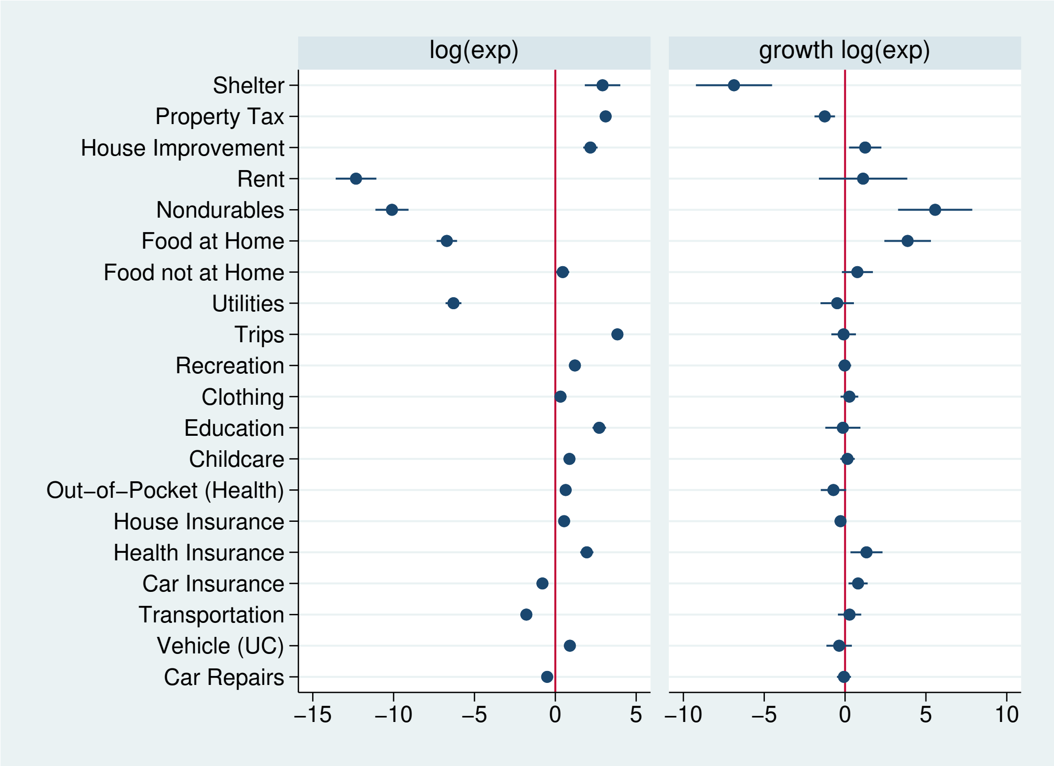
The second row of Table 5 shows the impact of past expenditure growth on the allocation of expenditure between different consumption goods. This result confirms the implication of Panel 2a that, for the household whose permanent income grew faster, its consumption bundle skews toward more adjustable 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 5: 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 5 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 nondurables, food, and insurance. On the other side, those with lower expenditure growth consume more shelter services, utilities, and out-of-pocket health expenditures.

Figure 5: Consumption Categories



4.4 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.[16] The argument is that households that have moved should have a

[16] In Appendix B.3, I show that permanent income growth is positively associated with the likelihood of having

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 6 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 economic intuition.

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moved at least once in the past.

Table 6: Heterogeneous Effect by Moved or Not

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

4.5 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 16 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

To further investigate the consumption commitments mechanism, I examine the bequests that parents leave for their offspring in Table 17. I start by merging households with their death year

Table 7: 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

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 18 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 19 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 20 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 21 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 21 is consistent with the results of intervivos transfers.

5 A Life-Cycle Model with Consumption Commitments

In the previous sections, I documented how consumption response to permanent income shocks depends on past consumption commitments, mainly through housing choices made in the past. In this section, I use a quantitative model to draw some lessons from these finds. In particular, I investigate the role of consumption commitments in explaining the under-response of consumption to permanent income. In the next section, I explore the consumption commitments implications for wealth inequality and the intergenerational transmission of wealth.

I revisit the canonical incomplete markets model that has been the benchmark model for studying consumption data (Deaton, 1991; Carroll, 1997). To this end, I write a life-cycle model in which households must insure idiosyncratic labor risk using a single risk-free bond, subject to a borrowing constraint. In addition, they choose two consumption commodities, housing, which is subject to nonconvex adjustment cost, and nondurable, which is freely adjustable. The model also has other sources of intergeneration wealth persistence.

5.1 Environment

I consider the problem of a continuum of households. Each period corresponds to one year in the model, such that j index the age of the household. Households are "born" at age $j = 0$, corresponding to a biological age of 25, retire at model age $R = 40$ (biological age 65), and die with certainty at model age $J = 65$ (biological age 90). After retiring, households face a positive mortality rate from age j to $j + 1$, ψ_j. They discount flow utility at the rate β.

Preferences Households have preferences over an aggregated consumption bundle composed of two consumption commodities, housing flow and nondurable. Specifically, agents have flow utility over the consumption bundle c, which uses as inputs housing consumption rh and nondurable consumption n. r is the return on the housing stock h. I assume a Cobb-Douglas aggregator following Berger and Vavra (2015), which implies that the elasticity of substitution between consumption inputs is 1. Estimates of the elasticity of substitution tend to be slightly above one.

$$c = g(rh, n) = (rh)^{\nu} \, n^{1-\nu}$$

Dynan et al. (2004), Straub (2019), and others have identified in the data that households with higher lifetime incomes save more than predicted by simple homothetic preference 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, preference for a household at age j is given by

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

where $\sigma_j > 0$ is an age-dependent elasticity. As Straub (2019), the age profile in consumption elasticities follows a simple exponential decay, $\sigma_{j+1}/\sigma_j = \sigma_{slope}$ during one's working life and flat thereafter. The model is parameterized such that σ_j is lower for higher ages, which implies that consumption when older has high-income elasticity. In other words, high-income households have a back-loaded consumption profile.

Preferences over bequests are given by

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

in which a is a risk-free bond. I assume that both are perfectly substitute in the bequest function, implying that households are indifferent between leaving bonds or housing stock to their children.

Idiosyncratic Earnings Households are subject to idiosyncratic labor income risk. The labor productivity process follows a Markov process plus a common deterministic, age-related component. In particular, for household i at age j, the process is

$$\begin{aligned} z_j^i &= b_1 j + b_2 j^2 + \bar{z}^i + \alpha_j^i + \epsilon_j^i \\ \alpha_j^i &= \rho \alpha_{j-1}^i + \xi_j^i \end{aligned}$$

where b_1 and b_2 define the age-specific deterministic component, $\bar{z}^i$ is an individual-specific fixed effect, α_j^i is a persistent component of productivity that follows an AR1 process, and ϵ_t^i is a transitory independent and identically distributed iid component. The fixed effect $\bar{z}^i$ is a function of the agent's parent household fixed effect, and the shocks ν_j^i and ϵ_j^i are independent of each other iid across i and j. Each shock follows a Normal distribution with respective variance $\sigma_i^2, i = \bar{z}, \epsilon, \xi$. The total labor income is given by $w \times exp(z)$, where w denotes the aggregate market wage per efficiency unit of labor. Labor income in the model is mapped to earnings after taxes and transfers, as in the PSID sample.

Assets Households invest in a risk-free asset, which carries a risk-free rate r, and in housing stock, which provides utility flow and depreciates at a rate δ each period. To adjust the latter (and, consequently, the housing consumption), households must pay nonconvex adjustment costs (Grossman and Laroque, 1990; Berger and Vavra, 2015),

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

However, they can adjust their nondurable consumption freely. For last, households are subject to a borrowing constraint, which is a function of their housing stock, $a > -\mu h$. Households start their working lives with an given quantity of assets and housing drawn from a initial distribution.

Once retired, household i lives off of financial wealth a, housing wealth h, and social security benefits, p. The benefits are calibrated as a fraction of the fixed effect.

5.2 Recursive Formulation

I use a recursive formulation of the problem. Let s_j denote the state variables vector for a household at age j: $s = \{a, h_{-1}, \bar{z}, \alpha, \epsilon\}$. The value function for this household is

$$V_j(s_j) = \max\{V_j^{adjust}(s_j), V_j^{noadjust}(s_j)\} .$$

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

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

$$V_j^{noadjust}(s_j) = \max_{n,a^+} u_j\Big(g(n, h_{-1})\Big) + (1-\psi_j)\beta\mathcal{B}\Big(a^+, h_{-1}\Big) + \psi_j\beta\mathbb{E}\Big\{V(s^+)|s_j\Big\} \tag{7}$$

subject to

$$\begin{aligned}
a^+ &= p_j + w * \exp(z) + (1+r)a - n \\
n &> 0, \quad a^+ \geq -\mu h \\
z_j^i &= b_1 j + b_2 j^2 + \bar{z} + \alpha_j + \epsilon_j \text{ with } \epsilon \sim N(0, \sigma_\epsilon^2) \\
\alpha_j &= \rho\alpha_{j-1} + \xi_j \text{ with } \xi \sim N(0, \sigma_\xi^2) \\
p_j &= \begin{cases} 0 & \text{if } j \geq R \\ \lambda(b_1 R + b_2 R^2 + \bar{z}) & \text{otherwise} \end{cases}
\end{aligned}$$

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:

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

subject to

$$
\begin{aligned}
a^{+} &= p_j + w * \exp(z) + (1+r)a - n - h - \kappa h_{-1} \\
n, h > 0,& \quad a^{+} \geq -\mu h \\
z_j^i &= b_1 j + b_2 j^2 + \bar{z} + \alpha_j + \epsilon_j \text{ with } \epsilon \sim N(0, \sigma_\epsilon^2) \\
\alpha_j &= \rho \alpha_{j-1} + \xi_j \text{ with } \xi \sim N(0, \sigma_\xi^2) \\
p_j &= \begin{cases} 0 & \text{if } j \geq R \\ \lambda(b_1 R + b_2 R^2 + \bar{z}) & \text{otherwise} \end{cases}
\end{aligned}
$$

Following Kaplan and Violante (2014), I solve the method using first-order conditions. As the problem is non-convex, first-order conditions are necessary but not sufficient. I proceed by examining all solutions to each set of first-order conditions, then determine the optimal solution by evaluating the value functions at each candidate solution. Appendix C describes the computational algorithm used to solve the problem.

5.3 Calibration

The goal of my quantitative exercise is to understand the implications of consumption commitments to the under-response of consumption to permanent income. I calibrate the model parameters to reproduce features of the PSID data and of the aggregated US economy. My parametrization is standard for this class of models. Table 8 summarizes the calibration.

Demographics and Initial Asset Positions Decisions in the model take place at a yearly frequency. Households begin their working economic life at age 25 ($j = 0$) and retire at age 65 ($j = R = 40$). The retirement period lasts 35 years until the household's certain death at age 100 ($j = J = 75$). Besides the certain death, households face mortality risk, which I calibrate with data from the Life Tables computed by the Center for Disease Control for 2011. I use the observed wealth portfolios observed PSID households aged 23 to 27 to calibrate the age $j = 0$ asset positions in the model.

Preferences I calibrate the discount factor β to replicate median wealth as a fraction of average income in the PSID. The value of β is 0.95. Second, following Straub (2019), I choose an exponential decay for the non-homothetic preference, $\sigma_{j+1}/\sigma_j = \sigma^{slope} > 0$. The preference parameter decay during one's working life and is flat during retirement. I set the median coefficient of risk aversion $\bar{\sigma}$ to 2. Third, I use the bequest parameters, ϕ_1 and ϕ_2, of De Nardi (2004). Finally, I set $\nu = 0.85$ to match the ratio of shelter expenditures to total expenditures in the PSID, which is around 15 percent on average from 1999–2009.

Adjustment Cost I calibrate the adjustment cost to the housing adjustment cost parameter of Yang (2009).

Income Process I use the PSID sample to estimate a second-order polynomial in age to extract the common life-cycle earnings profile, b1 and b2, 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.

Credit Limit I set the collateral parameter to 0.0 for simplicity.

Table 8: Calibrated 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		PSID
R	Retirament age	65	
T	Death age	100	
	Preferences		
β	Discount factor	0.95	PSID
σ	CRRA	2.00	Literature
σ^{slope}	Ratio of elasticities σ^{k+1}/σ^k	0.94	Straub (2019)
θ	Consumption aggregator	0.88	PSID
ϕ_1	Bequest preference (weight)	-9.50	De Nardi (2004)
ϕ_2	Bequest preference (luxury)	11.60	De Nardi (2004)
	Income Process		
b_1	Linear trend	0.03	PSID
b_2	Quadratic trend	-0.0007	PSID
$\sigma_{\bar{z}}$	Fixed-effect variance	0.17	PSID
σ_ϵ	Transitory variance	0.12	PSID
σ_ν	Persistant variance	0.02	PSID
ρ	Persistance parameter	0.98	PSID
	Other		
κ	Adjustment cost	0.10	
$\underline{a}$	borrowing constrant	0.00	

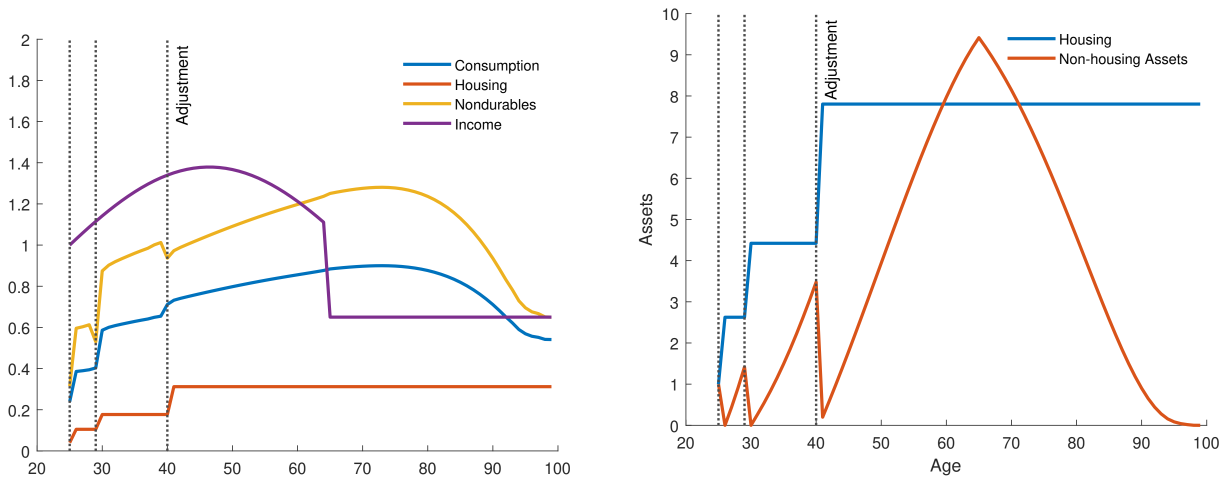
5.4 Calibration Results

Moments

Table X presents the moments meatched during calibration. Table Y presents the moments not-target moments.

Life-Cycle Profiles

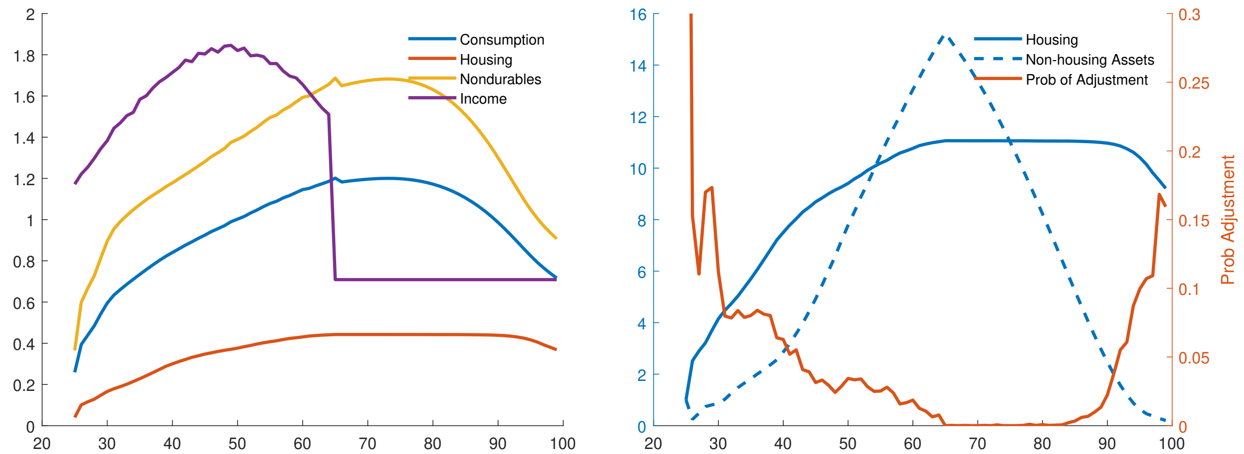
To illustrate the interaction between consumption commitments and the life-cycle profiles, Panel 6a of Figure 6 plots consumption and income profiles as well as housing and nondurable expenditures for a particular household. Meanwhile, Panel 6b plots housing and non-housing asset profiles. I assume that 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.



(a) Consumption (b) Assets

Figure 6: Example of Life-Cycle

Figure 7 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 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 7: Mean Life-Cycle Profiles

Estimating Consumption Response to Permanent Income in Simulated Data

Table 9 shows the results of two methods that examine the consumption response to permanent income but run on simulated data. The first method is the one of Section 4, which measures permanent income by estimating an expected consumption path for each household. The second method is the one proposed by Straub (2019), which employs an instrumental variable approach to recover the consumption response to the income-fixed effect. The table compares the benchmark model, a model with only consumption commitments, and a model with only non-homothetic preferences. It also presents the result estimated in my PSID sample.

Table 9: Consumption Response to Permanent Income

	Data		Model		
			Benchmark	Cons. Commit.	Non-hom. Pref.
Section 4 Regression					
	0.00	0.00	0.00	0.00	0.00
Educ. dummies	N	Y	N	N	N
Straub's IV Method					
	0.00	0.00	0.00	0.00	0.00
Intrument	$\rho = 0.95$	Initial Income	$\rho = 0.95$	$\rho = 0.95$	$\rho = 0.95$

6 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?

7 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

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

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.[17] For example, y_{-1} is a good instrument, which is the one that I used in this paper.

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

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

B Additional Tables and Figures

B.1 Sample Description

B.2 Alternative Definitions

Table 10: 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 1 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 11: 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 12: 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 13: Prob of Adjustment

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

Table 13 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 8: Probability of Moving

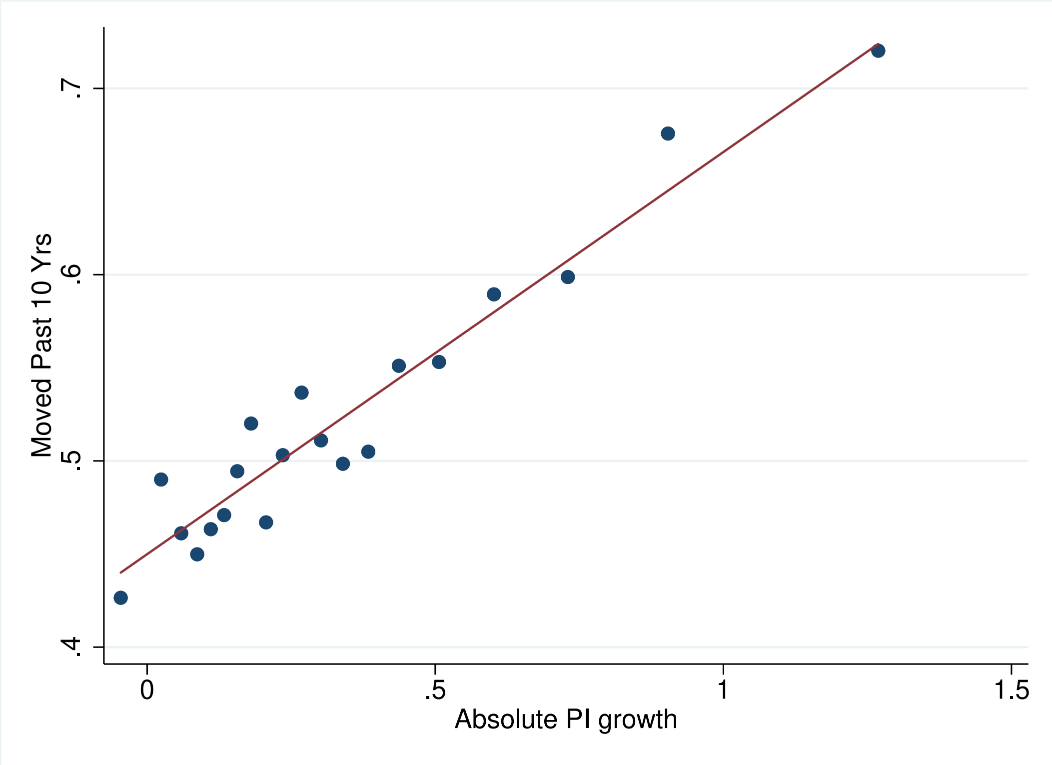

Figure 8 is the graphic representation of Table 13, and it presents the likelihood of households having moved at least once in the past 10 years as a function of the past permanent income growth. It is a binned scatterplot, which divides the past permanent income growth into equal-sized bins, computes 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 14: Heterogeneous Effect by Own or Not

	(1) log(expenditure)	(2) Savings Rate
log(PI)	0.48	0.21
	(0.08)	(0.07)
$\log(\text{PI}_{t-10})$	0.41	-0.08
	(0.10)	(0.09)
Own $\times$ log(PI)	0.01	0.04
	(0.11)	(0.09)
Own $\times$ $\log(\text{PI}_{t-10})$	-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 14 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 15: 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 16: 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 et al. (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 16 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.

B.6 Bequest

Table 17: 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 17 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 18: 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 18, 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 19: 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 19 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 20: 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 20 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 21: 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 21 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 21 is consistent with the results of intervivos transfers.

C Computational Appendix

I solve the method using first-order conditions, as previously done by Kaplan and Violante (2014). As the problem is non-convex, first-order conditions are necessary but not sufficient. I proceed by examining all solutions to each set of first-order conditions, then determine the optimal solution by evaluating the value functions at each candidate solution. I do it at each point in the state space. This includes considering solutions at all corners and evaluating the value functions at these points. I solve the model recursively from the last period of life to $j = J$.

Last-period problem: For a household in its last period of life $j = J$, the optimal decision of not adjusting their housing satisfies:

$$-(1-\nu)(c)^{-\sigma}(rh_{-1})^{\nu}(x-a')^{-\nu} + (1-\psi)\beta\frac{\theta_1}{\theta_2}\left(1+\frac{a+h_{-1}}{\theta_2}\right)^{-\sigma} = 0$$

where $x = w + (1+r)a$ is the cash-on-hand. For those that adjust their housing, their optimal decision satisfies:

$$-\nu(c)^{-\sigma}(rh)^{\nu-1}(x-a'-h)^{1-\nu} + (1-\psi)\beta\frac{\theta_1}{\theta_2}\left(1+\frac{a+h}{\theta_2}\right)^{-\sigma} = 0$$
$$\frac{\nu}{1-\nu}\frac{x-a'-h}{rh} = 1$$

where $x = w + (1+r)a + (1-\kappa)h_{-1}$.

Retirement-period problem: For a household during its retirement period $R \leq j < J$, the optimal decision of not adjusting their housing satisfies:

$$\begin{aligned}-(1-\nu)(c)^{-\sigma}(rh_{-1})^{\nu}(x-a_+)^{-\nu} + (1-\psi)\beta\frac{\theta_1}{\theta_2}\left(1+\frac{a+h_{-1}}{\theta_2}\right)^{-\sigma}\\ + \psi\beta(1-\nu)(c_+)^{-\sigma}(rh)^{\nu}(n_+)^{-\nu} = 0\end{aligned}$$

where $x = w + (1+r)a$ is the cash-on-hand. For those that adjust their housing, their optimal decision satisfies:

$$\begin{aligned}-(1-\nu)(c)^{-\sigma}(rh_{-1})^{\nu}(x-a_+)^{-\nu} + (1-\psi)\beta\frac{\theta_1}{\theta_2}\left(1+\frac{a+h_{-1}}{\theta_2}\right)^{-\sigma}\\ + \psi\beta(1-\nu)(c_+)^{-\sigma}(rh)^{\nu}(n_+)^{-\nu} = 0\end{aligned}$$
$$\frac{\nu}{1-\nu}\frac{x-a'-h}{rh} = 1$$

where $x = w + (1+r)a + (1-\kappa)h_{-1}$.

Working-period problem: 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:

$$-(1-\nu)(c)^{-\sigma}(rh_{-1})^{\nu}(x-a_{+})^{-\nu}+\beta(1-\nu)\mathbb{E}_t\Big[(c_{+})^{-\sigma}(rh)^{\nu}(n_{+})^{-\nu}\Big]=0$$

where $x=w+(1+r)a$ is the cash-on-hand. For those that adjust their housing, their optimal decision satisfies:

$$\begin{aligned}-(1-\nu)(c)^{-\sigma}(rh_{-1})^{\nu}(x-a_{+})^{-\nu}+\beta(1-\nu)\mathbb{E}_t\Big[(c_{+})^{-\sigma}(rh)^{\nu}(n_{+})^{-\nu}\Big]&=0\\ \frac{\nu}{1-\nu}\frac{x-a'-h}{rh}&=1\end{aligned}$$

where $x=w+(1+r)a+(1-\kappa)h_{-1}$.