"Permanent Income" Inequality

PRELIMINARY AND INCOMPLETE

Brant Abbott
Queen's University
abbottbrant@gmail.com

Giovanni Gallipoli
University of British Columbia
gallipol@mail.ubc.ca

THIS DRAFT: MAY 2, 2017

Abstract. We estimate inequality in permanent income and its evolution. Our notion of permanent income is related to Friedman's (1957) original idea, but does not impose a specific utility function. We account for financial and real wealth, as well as the certainty equivalent value of potential future earnings, thus providing a monetary statistic directly related to economic welfare, which is not true of income or wealth alone. We combine publicly available consumption and income data from the PSID with net worth data from the SCF to produce our estimates. Our method imposes no restrictions on the dynamics of observed income processes and features state-dependent stochastic discounting. We produce nonparametric estimates of stochastic discount factors, and allow for unobserved heterogeneity. We compare these results to a stylized version with calibrated CRRA utility and observed heterogeneity only.[1] We use our estimates of permanent income to study how inequality in the U.S. evolved between 1989 and 2013, and how the human component of wealth varies over the life cycle of different households. Our findings suggest that accounting for human wealth significantly changes the assessment of aggregate inequality and of its evolution. Specifically, we find that: (i) top 10% and top 1% shares of permanent income are substantially smaller (roughly 2/3) than the corresponding shares of net worth; (ii) however, top shares of permanent income have grown much faster over the 1989-2013 period than top shares of net worth, suggesting that inequality has increased more than previously thought. The share of asset wealth owned by the top 10% of the wealth distribution grew over that period by 8 percentage points while the share of permanent income attributable to that same group grew by 14 percentage points. Finally, we find that the share of households who sit at the top of both the net worth and human wealth distributions has actually decreased between 1989 and 2013, indicating that increased concentration of permanent income is not due to a small set of households holding increasing shares of both human and asset wealth. Instead, increasing concentration of permanent income is mostly due to the growing importance of asset wealth as a share of total wealth.

JEL Classification: D3, G1, I24, E21, J01
Keywords: Inequality, Earnings, Wealth, Human Capital, Estimation, Marriage, Households

[1] The current draft has only this version reported. The more flexible version is close to completion.

1 Introduction

A primary objective of research on inequality is to understand the forces shaping differences in the welfare of individuals and households. This is apparent in the optimal policy branch of this literature, where equalization of marginal utilities from consumption is often assumed to be the underlying goal of redistribution.[2] However, this objective has been less apparent in the empirical literature where research has naturally focused on observables, primarily income and wealth.[3]

Economic welfare also depends on unobservable features of life, in particular the value to a person of their potential to earn income in the future. Depending on how they are discounted, potential future earnings might sometimes be the most important determinant of economic welfare, and hence should be considered in empirical inequality research. Appropriate discounting of future earnings effectively accounts for the ease with which consumption can be shifted across time periods, and for how uncertain future earnings and consumption are.[4]

In this paper we estimate a pecuniary statistic that is directly related to economic welfare, and analyze trends in inequality of this statistic over the time period 1989-2013. Our statistic is the annuity value of the sum of current net worth and of the certainty equivalent value

[2]This is a massive literature. The New Dynamic Public Finance part of the literature is surveyed by Golosov, Tsyvinski, Werning, Diamond, and Judd (2006) and Kocherlakota (2010). Examples from the Ramsey planning part of the literature include Conesa, Kitao, and Krueger (2009) and Davila, Hong, Krusell, and Ríos-Rull (2012).

[3]See for example the work of Saez and Kopczuk (2004), Piketty and Saez (2006), Saez and Zucman (2014), Bricker, Henriques, Krimmel, and Sabelhaus (2016), Kaymak and Poschke (2016) and Rios-Rull, Kuhn, et al. (2016). An extensive literature on the distribution of wages and earnings documents the widening inequality in the working population (see for example Levy and Murnane (1992), Gottschalk, Moffitt, Katz, and Dickens (1994), Goldin and Katz (2007) and Autor, Katz, and Kearney (2008)). Studies of the wealth distribution focus on the financial/real wealth held by the wider population, including the unemployed and those who do not participate in the labor market (see Saez and Zucman, 2014; Bricker, Henriques, Krimmel, and Sabelhaus, 2016). More recently, the work of De Nardi, Fella, and Paz-Pardo (2016) carefully illustrates how rich income processes (as those described in Guvenen, Karahan, Ozkan, and Song, 2016) may be reflected in the equilibrium distribution of wealth.

[4]The way future income is discounted is important, and Huggett and Kaplan (2016) convincingly argue that the true value of human capital is far below the value that would be implied by discounting future net earnings at the risk-free interest rate, an approach that is commonly advocated because of its simplicity. For examples, see Becker (1975), Jorgenson and Fraumeni (1989) and R. Haveman and Schwabish (2003). Mechanically discounting income flows to approximate human capital rules out state-dependent changes in the valuation of future earnings.

of potential future earnings, where annuity factors vary in the population (largely with age). This annuity value is equal to the certainty equivalent consumption level, a constant stream of which would generate the same expected lifetime utility as the uncertain stream of actual consumption. This statistic is reminiscent of the "Permanent Income" as defined by Friedman (1957), with the obvious difference that in Friedman's model the annuity value equals actual consumption. The fundamental distinction is that our estimates of the human component of wealth do not simply rely on computing the expected present value of future earnings discounted at the risk free rate, though they would reduce to this if we imposed linear quadratic utility functions. Despite these distinctions, we refer to our statistic as Permanent Income hereafter. We find that the top 10% share of Permanent Income is 2/3 as large as the top 10% share of asset wealth, but that Permanent Income inequality grew about 40% faster than Asset Wealth inequality over the 1989-2013 period.

To estimate our statistic we combine data from the Panel Study of Income Dynamics (PSID) and the Survey of Consumer Finances (SCF). The PSID is useful for its panel data on earnings and consumption, which allow us to identify estimates of certainty equivalent values of future earnings as functions of observables. We apply these estimated functions to the SCF data, where the resulting estimates of human wealth can be added to observed net worth, allowing us to finally compute estimates of Permanent Income. Because we do not make assumptions about the processes that generate risk in the labor market, aggregate risk is present in the data and affects estimates of human wealth. To ensure a long enough sample to identify the aggregate risk process, we impute consumption in the PSID prior to 1999 using the method suggested by Attanasio and Pistaferri (2014). Thus, all PSID data from 1968 to 2013 are utilized when estimating our human wealth functions.

Estimates of certainty equivalent values depend on stochastic discount factors, and therefore on utility functions. An alternative to assuming specific functional forms is to estimate stochastic discount factors nonparametrically. This enables the data to guide the choice of

utility function in a flexible way. The method suggested by Escanciano, Hoderlein, Lewbel, Linton, and Srisuma (2015), which we follow, involves estimating marginal utility functions rather than stochastic discount factors directly. We compare these results to the case where a calibrated constant relative risk aversion utility function is assumed. **(Results based on nonparametric marginal utility estimates are in progress - CRRA results are reported below)**.

Another difficulty is understanding whose consumption – individual or household – to enter into the stochastic discount factors, and whose future income to discount. For married people, how do the future earnings of one's spouse matter? How does the possibility of divorce or marriage in the future affect estimation? To help sort these issues out we develop a dynamic model of individuals. Some individuals are married members of collective households, and there is risk of divorce in the future. Single people face a 'risk' of becoming married. This model allows us to derive an estimatable expression for the human wealth of an individual, even if they are married. A household level measure of human wealth is then the sum of spouses human wealths.

The remainder of this paper is as follows ...

2 Lifetime Wealth

We are interested in estimating the permanent income of individuals and households. Permanent income is usually associated with Friedman's formulation with linear-quadratic utility where the present value of expected future earnings – discounted at the risk free rate – is considered to be the human component of wealth. We focus on a slightly different object. We measure the human component of wealth as the present value of expected future earnings, but we discount future earnings using households' stochastic discount factors, rather than the risk

free rate.[5] Our measures of human wealth explicitly account for the effects of marriage and divorce on stochastic discount factors, and therefore on the valuation of future earnings. In the next section we describe how we go about measuring the human component of wealth.

2.1 Individual and Household Problems

The state of the economy at time t is represented by Ω_t, and the history of states of the world by $\Omega^t = \{\Omega_0, \Omega_1, \ldots, \Omega_t\}$. The state of world includes realizations of all aggregate and idiosyncratic (individual-level) risk. The 'state of the world' variable Ω_t includes risky individual state variables (idiosyncratic wage shocks, as well as the stochastic part of marital status and fertility outcomes) and risky aggregate state variables (the aggregate component of returns to human and non-human wealth, or even aggregate marriage market shocks).

A household's wealth portfolio is a vector containing positions in various assets and debts. For an unmarried household this vector is $\mathbf{a}_{it} = \{a_{it}^{\kappa}\}_{\kappa \in k}$, where a_{it}^{κ} is the individual's position in asset κ. For a married household consisting of an individual i and their spouse j, the wealth portfolio is $\mathbf{a}_{(ij)t}$. Each individual also posses a vector X_{it} of state variables, which includes age, gender, education, number of kids, and so on. In period t an individual i is $m(i,t)$ years old.

An individual enjoys utility from consumption c_{it}, leisure ℓ_{it}, and (possibly) being married to another person j. Utility from consumption and leisure for person i at time t is $u(c_{it}, \ell_{it})$, and if person i is married to person j at time t a marriage utility term $\heartsuit_{it(j)}$ is added. An individual's value function varies with their marital status: V_i^S denotes an individual's value function if they are currently single and V_i^M denotes their value function if they are married. To be clear, the value function V_i^M measures the indirect utility of person i only; the indirect utility of their spouse (person j) will be measured by a different value function V_j^M.

[5]The importance of using stochastic discount factors has been documented by Huggett and Kaplan (2016). However, unlike Huggett and Kaplan (2016), we measure human wealth directly from data, rather through the lens of a simulated model.

An individual may supply h_{it} hours of labour, for which they earn a wage w_{it} per hour. Wages vary with X_{it} (e.g. education), Ω_t (current aggregate and idiosyncratic productivity shocks), and $m(i,t)$ (age). Individuals also have the option to engage in home production by spending $n_{i,t}$ hours on housework. An individual's productiveness in housework varies with X_{it} according to the function $\Psi(n_{it}, X_{it})$. Leisure, ℓ_{it}, depends on work and home production decisions through the individual time budget constraint: $\ell_{it} = 1 - h_{it} - n_{it}$.

If individual i is single at time t their value function V_i^S will depend on a continuation value at time $t+1$ that includes the possibilities of choosing to get married or remain single in the following year:

$$\begin{aligned} V_i^S(\mathbf{a}_{it}, X_{it}, \Omega^t) = \max_{c_{it},\ell_{it},h_{it},n_{it},\mathbf{a}_{it+1}} \Big\{ & u\left(c_{it}, \ell_{it}\right) \\ & + \beta\left(1-\phi\right) E_{\{\Omega^{t+1}\}}\left[V_i^S(\mathbf{a}_{it+1}, X_{it+1}, \Omega^{t+1})\right] \\ & + \beta\phi E_{\{\Omega^{t+1}, X_{jt+1}, \mathbf{a}_{jt+1}\}}\left[V_i^M(\mathbf{a}_{(ij)t+1}, X_{it+1}, X_{jt+1}, \Omega^{t+1})\right] \Big\}. \end{aligned} \tag{1}$$

The probability $\phi = \phi\left(X_{it}, \Omega^t\right)$ is the conditional probability that i chooses to get married next period, after meeting potential partners. This probability depends on individual characteristics and marriage market conditions. In the event that i chooses to marry, their indirect utility will depend on the wealth and characteristics of their partner $\mathbf{a}_{jt+1}$ and X_{jt+1}, respectively, as well as the state of the world next period. Thus, the expected value of being married is taken over the distribution of these variables among the j's who i might potentially choose to marry. The assets of a newly formed married household will be the sum of the spouses initial individual assets: $\mathbf{a}_{(ij)t+1} = \mathbf{a}_{it+1} + \mathbf{a}_{jt+1}$.

The consumption choice of i is defined over their current budget set

$$\sum_{\kappa\in k} a_{it+1}^{\kappa} + c_{it} \leq w_{it}h_{it} + \Psi(X_{it}, n_{it}) + \sum_{\kappa\in k} R_t^{\kappa} a_{it}^{\kappa} - T_t\left(\mathbf{a}_{it}, w_{it}, h_{it}\right), \tag{2}$$

where R_t^κ is the one-period return on asset κ, and $T(\mathbf{a}_{it}, w_{it}, h_{it})$ is a function summarizing all tax liabilities. The individual's time constraint $\ell_{it} = 1 - h_{it} - n_{it}$ and current borrowing constraint $\sum_{\kappa \in k} a_{it+1}^\kappa \geq \underline{a}_{it}$ also affect these choices.

If individual i is married to individual j at time t their value function V_{it}^M will include a continuation value that allows for the possibilities of choosing to stay married or get divorced in the following year:

$$\begin{aligned} V_i^M(\mathbf{a}_{(ij)t}, X_{it}, X_{jt}, \Omega^t) = u(c_{it}^*, \ell_{it}^*) \\ + \beta \Big\{ (1-\tilde{\phi}) E_{\{\Omega^{t+1}, \mathbf{a}_{it+1}\}} \left[V_i^S(\mathbf{a}_{it+1}, X_{it+1}, \Omega^{t+1}) | \mathbf{a}_{(ij)t+1}^* \right] \\ + \tilde{\phi} E_{\{\Omega^{t+1}\}} \left[V_i^M(\mathbf{a}_{(ij)t+1}^*, X_{it+1}, X_{jt+1}, \Omega^{t+1}) \right] \Big\} + \heartsuit_{it(j)}. \end{aligned} \tag{3}$$

In the above equation the values $\left(\mathbf{a}_{(ij)t+1}^*, c_{it}^*, \ell_{it}^*\right)$ are the values of household savings, as well as consumption and leisure for individual i, that result from the joint household optimization problem, which we describe below. The parameter $\tilde{\phi} = \tilde{\phi}(X_{it}, X_{jt}, \Omega^t)$ is the conditional probability of a household choosing to stay married. If the household divorces before next period their asset portfolio will be split and individual i will receive a part $\mathbf{a}_{it+1}$ of it. Because there may be uncertainty about the divorce settlement, a conditional expectation over possible asset divisions is taken when evaluating the divorce part of the continuation value. While we don't model the choice of getting married explicitly, we assume that the marriage shock $\heartsuit_{it(j)}$ captures the presence of non-pecuniary returns to being married to person j. These returns are assumed to be additively separable and drop out of all marginal calculations.

Married households are assumed to be collective. Therefore, the joint optimization problem of the spouses can be viewed as that of a planner who maximizes a weighted average of the spouses utilities, according to some Pareto weights. We have already used V_i^M to denote the utility of person i when they are provided the allocations that the household planner finds optimal. We need to distinguish this from person i's utility under (possibly) non-optimized

allocations, which we denote by $\tilde{V}_i^M$. The problem of the household planner is:

$$V_{(ij)}^M(\mathbf{a}_{(ij)t}, X_{it}, X_{jt}, \Omega^t) = \max_{\mathbf{z}_{(ij)t}} \Big\{ \lambda_{(ij)} \tilde{V}_i^M(\mathbf{a}_{(ij)t}, X_{it}, X_{jt}, \Omega^t) + (1-\lambda_{(ij)}) \tilde{V}_j^M(\mathbf{a}_{(ij)t}, X_{jt}, X_{it}, \Omega^t) \Big\}, \tag{4}$$

where the decision vector is $\mathbf{z}_{(ij)t} = \left\{ c_{it}, c_{jt}, \ell_{it}, \ell_{jt}, h_{it}, h_{jt}, n_{it}, n_{jt}, \mathbf{a}_{(ij)t+1} \right\}$, and $\lambda_{(ij)}$ is the Pareto weight on individual i in the household planning problem.

The feasible consumption set of the married household is determined by the resource budget constraint

$$\sum_{\kappa \in k} a_{(ij)t+1}^{\kappa} + c_{(ij)t} \leq w_{it} h_{it} + w_{jt} h_{jt} + \Psi(X_{it}, n_{it}) + \Psi(X_{jt}, n_{jt}) + \sum_{\kappa \in k} R_t^{\kappa} a_{(ij)t}^{\kappa} - T_t\left(\mathbf{a}_{(ij)t}, w_{it}, w_{jt}, h_{it}, h_{jt}\right), \tag{5}$$

where $c_{(ij)t}$ is total consumption expenditure of the household. This is related to the consumption resources allocated to each spouse by the constraint $c_{(ij)t} = \vartheta(c_{it} + c_{jt})$, where ϑ is determined by the OECD adult equivalence scale. Individual time allocation constraints $\ell_{it} = 1 - h_{it} - n_{it}$ and $\ell_{jt} = 1 - h_{jt} - n_{jt}$, and a household borrowing limit $\sum_{\kappa \in k} a_{(ij)t+1}^{\kappa} \geq \underline{a}_{(ij)t}$ also constrain the household planner's choices.

2.2 Valuation of Human Wealth

We derive an individual's valuation of his/her own human capital by the amount of wealth he/she would be willing to accept in exchange for own future earnings, under the assumption of *commitment* to state-contingent future labor supply. To accomplish this we introduce a hypothetical asset that pays dividends per share equal to individual i's yearly labor income. We argue that the price at which individual i would be willing to sell this asset is equal to

their valuation of own human capital. Intuitively, the individual would be as well off owning one share of this asset and receiving zero-payment for their (committed) labor as they would be owning zero shares of the asset and receiving full-payment for their labor. Of course, in reality no one would be willing to buy this asset from i because of the inherent commitment problems, so the valuation we derive is a shadow price representing what human capital is worth to its owners.[6,7]

A complication that arises in this setting is that, if and when a person gets married in the future, their current valuation of an asset depends on its effect on their marital bargaining power. If buying the asset were not to increase the individual's utility once married, then it would be worth less to them than otherwise. We will not attempt to estimate the effect of owning more shares of a hypothetical asset on marital bargaining power.[8] Therefore, we make the simple assumption that bargaining between newly married couples can be represented by the symmetric Nash Bargaining solution. In other words, the ex-post Pareto weights of spouses do adjust in response to pre-marital investments, and the do so through the effect of pre-marital investments on the outside options of spouses and on the marital surplus. As we explain carefully below, the only effect of this assumption on human capital valuations is through a single person's continuation value in marriage.

Another complication that arises in this environment relates to how the hypothetical asset is allocated upon divorce. We assume that, in such circumstances, sole ownership of the asset based on individual i's labor income would go to person i, and that other assets, possibly including a claim on alimony, would be allocated to the ex-spouse as compensation. The reason we assume that i takes ownership of the hypothetical asset is that we are trying to value

[6] As discussed at length by Benzoni and Chyruk (2015), it is not normally possible to enforce contracts written against future labor services and ownership of human capital is not transferable (that is, human capital is a non-traded asset).

[7] As noted by Huggett and Kaplan (2016), this approach to valuing non-traded assets was first introduced by Lucas Jr (1978). Huggett and Kaplan (2016) also adopt this approach.

[8] In fact, this is a very interesting question in its own right but would require a much more sophisticated approach to modeling household interactions.

i's human capital, which they would own upon divorce as well.[9] This assumption, along with the one described in the previous paragraph, allows us to derive very tractable formulas for valuing one's own human capital.

Human Capital Valuations of Married Individuals. We begin with valuation of individual i's human capital when i is married. The number of shares of the hypothetical asset that i's household owns at time t is e_{it}, and the price of this asset is θ_{it}. We could also introduce an asset based on j's human capital, but that is not necessary to value i's human capital, hence we repress that notation for now. When the hypothetical asset e_{it} is introduced, the budget constraint for a married household becomes:

$$\begin{aligned}\sum_{\kappa\in k} a^{\kappa}_{(ij)t+1} + c_{(ij)t} + \theta_{it}e_{it+1} \leq \theta_{it}e_{it} + (1+e_{it})w_{it}h_{it} + w_{jt}h_{jt} \\ + \Psi(X_{it}, n_{it}) + \Psi(X_{jt}, n_{jt}) \\ + \sum_{\kappa\in k} R^{\kappa}_{t} a^{\kappa}_{(ij)t} - T_t\left(\mathbf{a}_{(ij)t}, w_{it}, w_{jt}, h_{it}, h_{jt}\right).\end{aligned} \tag{6}$$

Furthermore, we include e_{it} as an additional state variable in the household planner's problem in equation (4), as well as in the definition of an individual's utility from marriage in (3). After

[9] Of course, one can be ordered to pay alimony out of their returns to human capital in the real world. However, alimony is usually a fixed amount amount of money, so changes in earnings affect the earners' net-income, not their spouses. Thus alimony is better represented as an extra allocation of financial assets to the ex-spouse than an allocation of human capital, which is how we model it.

making these adjustments we re-write the household planner's problem in a recursive manner:

$$
\begin{aligned}
&V^M_{(ij)}(\mathbf{a}_{(ij)t}, e_{it}, X_{it}, X_{jt}, \Omega^t) = \\
&\max_{\mathbf{z}_{(ij)t}} \Big\{ \lambda_{(ij)} u\left(c_{it}, \ell_{it}\right) + (1-\lambda_{(ij)}) u\left(c_{jt}, \ell_{jt}\right) \\
&+ \lambda_{(ij)} \beta (1-\tilde{\phi}) E_{\{\Omega^{t+1}, \mathbf{a}_{it+1}\}} \left[V^S_i(\mathbf{a}_{it+1}, e_{it+1}, X_{it+1}, \Omega^{t+1}) | \mathbf{a}_{(ij)t+1} \right] \\
&+ (1-\lambda_{(ij)}) \beta (1-\tilde{\phi}) E_{\{\Omega^{t+1}, \mathbf{a}_{jt+1}\}} \left[V^S_j(\mathbf{a}_{jt+1}, X_{jt+1}, \Omega^{t+1}) | \mathbf{a}_{(ij)t+1} \right] \\
&+ \beta \tilde{\phi} E_{\{\Omega^{t+1}\}} \left[V^M_{(ij)}(\mathbf{a}_{(ij)t+1}, e_{it+1}, X_{it+1}, X_{jt+1}, \Omega^{t+1}) \right] \Big\},
\end{aligned} \tag{7}
$$

where the decision vector $\mathbf{z}_{(ij)t}$ now includes e_{it+1}. After using the budget constraint in (6) to substitute c_{it} out of the problem in (7), we can easily derive the following first-order condition for the optimal choice of e_{it+1}:

$$
\begin{aligned}
&u_c(c_{it}, \ell_{it}) \vartheta \theta_{it} = \\
&\beta (1-\tilde{\phi}) \frac{\partial}{\partial e_{it+1}} E_{\{\Omega^{t+1}, \mathbf{a}_{it+1}\}} \left[V^S_i(\mathbf{a}_{it+1}, e_{it+1}, X_{it+1}, \Omega^{t+1}) | \mathbf{a}_{(ij)t+1} \right] \\
&+ \frac{1}{\lambda_{(ij)}} \beta \tilde{\phi} \frac{\partial}{\partial e_{it+1}} E_{\{\Omega^{t+1}\}} \left[V^M_{(ij)}(\mathbf{a}_{(ij)t+1}, e_{it+1}, X_{it+1}, X_{jt+1}, \Omega^{t+1}) \right].
\end{aligned} \tag{8}
$$

To proceed we must calculate the derivatives of the married and single continuation values using envelope conditions. For the married continuation value this involves straightforward differentiation of equation 7 with respect to e_{it}, noting that the c_{it} has been replaced by the budget constraint. The result is that

$$
\begin{aligned}
&\frac{\partial}{\partial e_{it+1}} V^M_{(ij)}(\mathbf{a}_{(ij)t+1}, e_{it+1}, X_{it+1}, X_{jt+1}, \Omega^{t+1}) = \\
&\lambda_{(ij)} u_c(c^M_{it+1}, \ell^M_{it+1}) \vartheta \left(\theta^M_{it+1} + w_{it+1} h^M_{it+1} \right),
\end{aligned} \tag{9}
$$

where the superscript M indicates quantities that arise in marriage. To derive the derivative of a single person's value function we must first be explicit about the problem they solve when single. Extending equation (1) to include the hypothetical asset e_{it+1} results in the following problem:

$$\begin{aligned} V_i^S(\mathbf{a}_{it}, e_{it}, X_{it}, \Omega^t) = \max_{c_{it},\ell_{it},h_{it},n_{it},\mathbf{a}_{it+1}} \Big\{ & u\left(c_{it}, \ell_{it}\right) \\ & + \beta\left(1-\phi\right) E_{\{\Omega^{t+1}\}}\left[V_i^S(\mathbf{a}_{it+1}, e_{it+1}, X_{it+1}, \Omega^{t+1})\right] \\ & + \beta\phi E_{\{\Omega^{t+1}, X_{jt+1}, \mathbf{a}_{jt+1}\}}\left[V_i^M(\mathbf{a}_{(ij)t+1}, e_{it+1}, X_{it+1}, X_{jt+1}, \Omega^{t+1})\right] \Big\}. \end{aligned} \tag{10}$$

The maximization in (10) is subject to the usual time allocation and borrowing constraints, as well the extended budget constraint,

$$\begin{aligned} \sum_{\kappa\in k} a_{it+1}^{\kappa} + c_{it} + \theta_{it} e_{it+1} \leq \theta_{it} e_{it} + (1+e_{it}) w_{it} h_{it} + \Psi(X_{it}, n_{it}) \\ + \sum_{\kappa\in k} R_t^{\kappa} a_{it}^{\kappa} - T_t\left(\mathbf{a}_{it}, w_{it}, h_{it}\right). \end{aligned} \tag{11}$$

The derivative of the value function in (10) can thus be derived by replacing c_{it} with the extended budget constraint, resulting in:

$$\frac{\partial}{\partial e_{it+1}} V_i^S(\mathbf{a}_{it+1}, e_{it+1}, X_{it+1}, \Omega^{t+1}) = u_c(c_{it+1}^S, \ell_{it+1}^S)\left(\theta_{it+1}^S + w_{it+1} h_{it+1}^S\right). \tag{12}$$

Finally, using equations (9) and (12), one can re-arrange the first order condition for optimal e_{it+1} chosen by a married household (equation 8) into an expression describing the valuation

of i's human capital θ_{it}^M (the purchase price per share of e_{it+1}):

$$\begin{aligned}\theta_{it}^M =&\beta(1-\tilde{\phi})\frac{1}{\vartheta}E_{\{\Omega^{t+1},\mathbf{a}_{it+1}\}}\left[\frac{u_{it+1}'^S)}{u'(c_{it})}\left(w_{it+1}h_{it+1}^S+\theta_{it+1}^S\right)\right] \\ &+\beta\tilde{\phi}E_{\{\Omega^{t+1}\}}\left[\frac{u_{it+1}'^M)}{u'(c_{it})}\left(w_{it+1}h_{it+1}^M+\theta_{it+1}^M\right)\right].\end{aligned} \tag{13}$$

The result that stochastic discount factors determine the value of human capital in this model is very similar to general asset pricing formulations found in the literature following the seminal work of Lucas (1978). The probability of a change in marital status, and the surplus generated by marriage (through the economies of scale parameter ϑ) also factor into our valuation results.

Human Capital Valuations for Single Individuals. We derive the human capital valuation equations of a single by considering their first-order condition for the optimal choice of e_{it+1} in problem (10):

$$\begin{aligned}&u_c(c_{it},\ell_{it})\theta_{it}= \\ &\beta(1-\phi)\frac{\partial}{\partial e_{it+1}}E_{\{\Omega^{t+1},\mathbf{a}_{it+1}\}}\left[V_i^S(\mathbf{a}_{it+1},e_{it+1},X_{it+1},\Omega^{t+1})|\mathbf{a}_{(ij)t+1}\right] \\ &+\beta\phi\frac{\partial}{\partial e_{it+1}}E_{\{\Omega^{t+1},X_{jt+1},\mathbf{a}_{jt+1}\}}\left[V_i^M(\mathbf{a}_{(ij)t+1},e_{it+1},X_{it+1},X_{jt+1},\Omega^{t+1})\right].\end{aligned} \tag{14}$$

As was the case when deriving valuations for married individuals, we need to substitute out the derivatives of continuation values. For the derivative of $V_i^S(\cdot)$ this is straightforward, and in fact we have the expression in equation (12) already. However, the derivative of $V_i^M(\cdot)$ proves much more difficult because we do not have an envelope condition to utilize. This is the case because $V_i^M(\cdot)$ is *not* an indirect utility function, or in other words is *not* the solution to an individual optimization problem. Rather, $V_i^M(\cdot)$ is a component of the objective of a household planner. To compute the necessary derivative here we will need to understand the effect of pre-marital investments on the utility allocated to the spouse making those investments, which

requires us to make assumptions about how the Pareto weight $\lambda_{(ij)}$ will be decided in the event that i gets married. Indeed, valuation of pre-marital human capital investments is inextricably linked to the household bargaining process upon marriage.

As anticipated above, we assume symmetric Nash Bargaining over the surplus generated by marriage. Under this assumption we can derive a relationship pinning down how the marital utility of person i changes if they make pre-marital investments. Symmetric Nash Bargaining implies that i's utility in marriage will increase by at least as much as their outside option (utility from being single), plus half of any surplus generated by pre-marital investment.

Specifically we assume that a married household's Pareto weight solves

$$\max_{\left\{V_i^M, V_j^M\right\}} \left(V_i^M - V_i^S\right)\left(V_j^M - V_j^S\right), \tag{15}$$

where we have repressed the state variables that the value functions depend on for clarity. Let $G(V_i^M, V_j^M) = 0$ be the Pareto frontier of household allocations, in which case the Nash Bargaining solution will satisfy

$$\left(V_i^M - V_i^S\right) = \frac{G_2}{G_1}\left(V_j^M - V_j^S\right). \tag{16}$$

To translate this condition into something useful within our empirical model, note that an equivalent formulation of the household planning problem in equation (7) is: $\max\left\{\lambda_{(ij)}V_i^M + (1-\lambda_{(ij)})V_j^M\right\}$ subject to $G(V_i^M, V_j^M) = 0$. Combining the first-order conditions from this problem with those from the underlying Nash Bargaining problem results in:

$$\left(V_i^M - V_i^S\right) = \frac{1-\lambda_{(ij)}}{\lambda_{(ij)}}\left(V_j^M - V_j^S\right). \tag{17}$$

The equivalence of equations (16) and (17) is due to the fact that $\lambda_{(ij)}$ is the Pareto weight that implicitly solves the Nash Bargaining problem in equation (15).

Next, we examine equation (16) evaluated at the point where person i brings exactly zero units of e_{it} to the marriage, which is the solution we observe in the data. Computing the total differential of this equation with respect to e_{it} results in

$$\frac{\partial V_i^M}{\partial e_{it}} - \frac{\partial V_i^S}{\partial e_{it}} = \left(\frac{G_2}{G_1}\right)\frac{\partial V_j^M}{\partial e_{it}} + \frac{1}{G_1}\left(\frac{\partial G2}{\partial e_{it}}\left(V_j^M - V_j^S\right) - \frac{\partial G1}{\partial e_{it}}\left(V_i^M - V_i^S\right)\right). \tag{18}$$

While this expression may seem intractable, one can easily show that at the optimal solution to the household planner's problem

$$\left(\frac{\partial G2}{\partial e_{it}}/\frac{\partial G1}{\partial e_{it}}\right) = \frac{u_c(c_i t, \ell_{it})}{u_c(c_j t, \ell_{jt})} = \frac{\lambda_{(ij)}}{1-\lambda_{(ij)}}, \tag{19}$$

therefore the last term of equation (18) equals zero when evaluated at the solution to the bargaining problem. Thus, a final simplified relationship between the derivatives of individual utilities, evaluated at the solution to the bargaining problem, is

$$\frac{\partial V_i^M}{\partial e_{it}} - \frac{\partial V_i^S}{\partial e_{it}} = \frac{1-\lambda_{(ij)}}{\lambda_{(ij)}}\frac{\partial V_j^M}{\partial e_{it}}. \tag{20}$$

Intuitively, the extent to which i's utility in marriage will increase in excess of their outside option depends on their ex-post Pareto weight and how valuable the hypothetical asset would be to their spouse.

To utilize equation (20), first note that the definition of the household planner's optimization objective in (4) implies that the envelope condition in (9) can be re-written as:

$$\lambda_{(ij)}\frac{\partial V_{it+1}^M}{\partial e_{it+1}} + (1-\lambda_{(ij)})\frac{\partial V_{jt+1}^M}{\partial e_{it+1}} = \lambda_{(ij)} u_c(c_{it+1}^M, \ell_{it+1}^M)\vartheta\left(\theta_{it+1}^M + w_{it+1}h_{it+1}^M\right). \tag{21}$$

Combining this with the Nash Bargaining implication in (20), we obtain an extremely useful

result characterizing the effect of pre-marital investments on the utility within marriage:

$$\frac{\partial V^M_{it+1}(\cdot)}{\partial e_{it+1}} = \frac{1}{2}u_c(c^M_{it+1}, \ell^M_{it+1})\frac{1}{\vartheta}\left(\theta^M_{it+1} + w_{it+1}h^M_{it+1}\right) + \frac{1}{2}\frac{\partial V^S_{it+1}(\cdot)}{\partial e_{it+1}}. \tag{22}$$

The intuition for this equation relates to how much of the return on the hypothetical asset will be allocated to individual i by the household planner: A lower bound is the change in their utility if they exercise their outside option, which is captured by $\partial V^S_{it+1}/\partial e_{it+1}$. An upper bound is the marginal change in their utility if the entire return on the asset, including surplus due to economies of scale, is allocated to i. With symmetric bargaining exactly one half of the component pertaining to the return that exceeds the effect on i's outside option is paid to i.

Equation (22) is very useful because we now have an expression to substitute into equation (8), which was our objective when we set out to analyze the bargaining problem. Doing this, and substituting the envelope condition for single households in equation (12), allows us to derive the following valuation formula for the human capital of a currently unmarried person i:

$$\begin{aligned}\theta^S_{it} =& \beta(1-\frac{\phi}{2})E_{\{\Omega^{t+1}\}}\left[\frac{u_c(c^S_{it+1}, \ell^S_{it+1})}{u'(c_{it}, \ell_{it})}\left(w_{it+1}h^S_{it+1} + \theta^S_{it+1}\right)\right] \\ &+ \beta\frac{\phi}{2}E_{\{\Omega^{t+1}, X_{jt+1}, \mathbf{a}_{jt+1}\}}\left[\frac{u_c(c^M_{it+1}, \ell^M_{it+1})}{u'(c_{it}, \ell_{it})}\frac{1}{\vartheta}\left(w_{it+1}h^M_{it+1} + \theta^M_{it+1}\right)\right].\end{aligned} \tag{23}$$

While this expression is similar to canonical asset pricing formulations, it makes clear that the correct pricing relationship involves a biased expectation of future returns to human capital, where the bias derives from the implicit extra weight single households place on outcomes in the event of remaining single. The above equation is also informative as to how one would test the robustness of the symmetric bargaining assumption: asymmetric bargaining weights would result in factors other than 1/2 (but still on the unit interval) being used to re-weight single and married outcomes.

We can subsume all sources of uncertainty into a single expectation operator $\tilde{E}_t$, which also accounts for the over-weighting of unmarried future outcomes (as opposed to an unbiased expectation E_t). Having done this we can summarize the value of human capital for any individual as

$$\theta_{it} = \tilde{E}_t \left[\beta \frac{u'(c_{it+1}, \ell_{it+1})}{u'(c_{it}, \ell_{it})} \left(w_{it+1} h_{it+1} + \theta_{it+1} \right) \right], \tag{24}$$

where future variables implicitly depend on marital status. Clearly, valuations of one's own human capital depend on stochastic discount factors. Thus, state-contingent realizations of individual consumption matter for valuing state-contingent human capital payoffs. The last step in our analysis is to evaluate equation (24) at the point $e_{it} = 0$ so that the equation is analogous to real-world valuations where human capital assets are not traded. Then, if one observes state-contingent consumption realizations, and can construct the appropriate weighting of future outcomes, human capital valuations can be computed recursively.

Individual state-contingent consumption is not observable, so we treat variation in the outcomes of ex-ante identical individuals as being the result of realized risk. In what remains of this section we will explain this approach to estimating individual θ_{it} valuations, and then use these estimates to construct estimates of household-level permanent income. To accomplish this we first parameterize several aspects of the model, then estimate data analogues of equation (24) using PSID data.

2.3 Parameterization of Preferences

To parameterize the model we follow three steps. First, we make several assumptions about functional forms of preferences, the mean elasticity of labor supply, and the inter-temporal substitution elasticity. Second, we use observed data on singles estimate all individual utility parameters, which are identified for single households under our assumptions. Third, we re-

cover the Pareto weight of each married household in each year, which we show are identified as long as all married individuals engage in at least some housework or labor supply (given the other parameters are already estimated). In the sample we employ in our main estimation work only 0.2% of individuals do neither housework or formal labor and so have to be excluded.

Individual utility from consumption and leisure is assumed to be

$$u(c_{it}, \ell_{it}) = \frac{c_{it}^{1-\gamma}}{1-\gamma} + \nu \frac{\ell_{it}^{1-\frac{1}{\epsilon}}}{1-\frac{1}{\epsilon}}. \tag{25}$$

Under this preference specification, the Frisch elasticity of labor supply is

$$\epsilon \frac{1-h_{it}-n_{it}}{h_{it}}, \tag{26}$$

and thus varies with hours worked and housework. We estimate the parameter ϵ by choosing that value that ensures the average Frisch elasticity among singles without children who work at least 1000 hours per year is $2/3$. This is in line with the very recent estimate for men by Blundell, Pistaferri, and Saporta-Eksten (2016). This is a larger elasticity than the median estimate in the literature, but well within the range of reasonable estimates (see Keane (2011) for a survey). The value of ϵ that is consistent with this average elasticity is 0.225. We assume an inter-temporal substitution elasticity of 0.75 in accord with the estimates of Blundell, Browning, and Meghir (1994) and Attanasio and Weber (1993), which implies $\gamma = 1.33$. Finally, the parameter ν is estimated using the intra-temporal optimality condition of singles who work:

$$\nu = E\left[\frac{w_{it} c_{it}^{-\gamma}}{\ell_{it}^{-\frac{1}{\epsilon}}}\right]. \tag{27}$$

The expectation in equation 27 is taken again over all singles without children who work at least 1000 hours per year. The estimated value of ν is 0.105.

Home production $\Psi(X_{it}, n_{it})$ is modelled as a linear-quadratic function

$$\Psi(X_{it}, n_{it}) = \psi(X_{it}) \left(n_{it} - \frac{1}{2} n_{it}^2 \right), \tag{28}$$

where home sector productivity $\psi(X_{it})$ depends on individual characteristics. Notice that the marginal product of housework time will always be positive, except at the corner solution $n_{it} = 1$. To estimate the home sector productivity function we use the sub-sample of individuals that do both housework and formal labor, and so for whom the following time-allocation optimality condition holds:

$$\psi(X_{it}) = \frac{w_{it}}{1 - n_{it}}. \tag{29}$$

For each applicable single-person household we compute the right hand side of equation 29, and regress the resulting variable on a full set of age, education and gender dummy variables. The fitted regression equation is our estimate of the function $\psi(X_{it})$. Importantly, we can apply this function to any individual even if equation 29 does not hold.

The value of adopting such a stylized model of home production is that is will allow us to identify the Pareto weight $\lambda_{(ij)t}$ for each married household in our sample. This is because the time allocation of each married household will satisfy at least one of the following optimality conditions:

$$\begin{array}{rcll}
\frac{\lambda_{(ij)t}}{1-\lambda_{(ij)t}} & = & \frac{w_{it}}{w_{jt}} \left(\frac{\ell_{jt}}{\ell_{it}} \right)^{-\frac{1}{\epsilon}} & \text{if } i \text{ and } j \text{ both work,} \\
\frac{\lambda_{(ij)t}}{1-\lambda_{(ij)t}} & = & \frac{\psi(X_{it})}{\psi(X_{jt})} \frac{1-n_{it}}{1-n_{jt}} \left(\frac{\ell_{jt}}{\ell_{it}} \right)^{-\frac{1}{\epsilon}} & \text{if } i \text{ and } j \text{ both do housework,} \\
\frac{\lambda_{(ij)t}}{1-\lambda_{(ij)t}} & = & \frac{\psi(X_{it})(1-n_{it})}{w_{jt}} \left(\frac{\ell_{jt}}{\ell_{it}} \right)^{-\frac{1}{\epsilon}} & \text{if } j \text{ works and } i \text{ does housework,} \\
\frac{\lambda_{(ij)t}}{1-\lambda_{(ij)t}} & = & \frac{w_{it}}{\psi(X_{jt})(1-n_{jt})} \left(\frac{\ell_{jt}}{\ell_{it}} \right)^{-\frac{1}{\epsilon}} & \text{if } i \text{ works and } j \text{ does housework.}
\end{array} \tag{30}$$

To construct $\lambda_{(ij)t}$ we follow the hierarchy of equation 30, meaning that we use the first equa-

tion that applied to the household out of the four possibilities. If both spouses work we use the first equation of 30, otherwise we check whether both do housework, and so on. While we can identify time varying Pareto weights, we can also work with constant weights that we estimate as:

$$\overline{\lambda}_{(ij)} = \frac{1}{T_{(ij)}} \sum_{t=1}^{T_{(ij)}} \lambda_{(ij)t}, \tag{31}$$

where $T_{(ij)}$ is the number of periods that household (ij) is observed for. Figure 1 illustrates the density of ole.

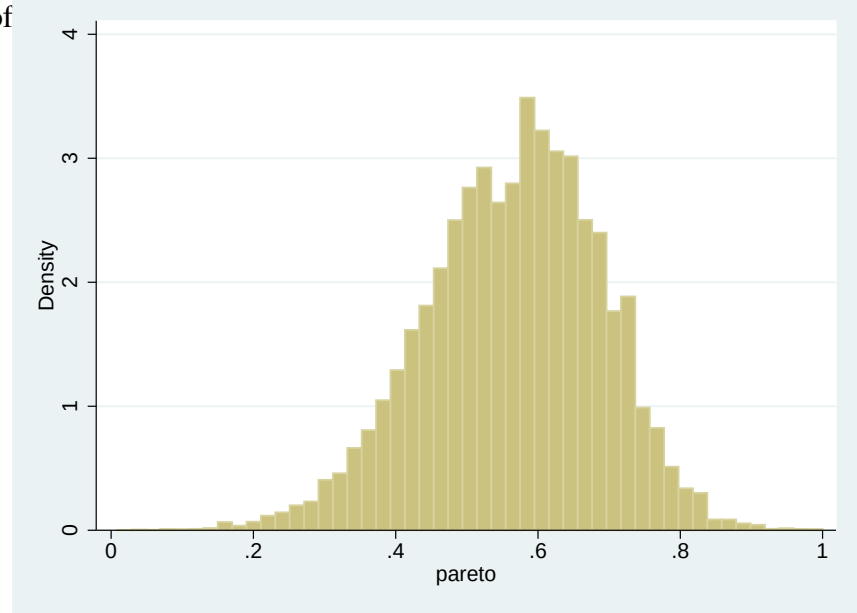


Figure 1: Estimated Pareto weights.

3 Estimating Human Wealth over the Life Cycle

To estimate the value of human capital stocks for different households we need longitudinal panel information about household characteristics, earnings, labor supply, home-production and consumption expenditure. Much of this information is directly obtained from different files of the Panel Study of Income Dynamics. However, the availability of consumption expenditure data is limited by the fact that a larger set of measurements only started in 1999 and

was further extended in the early 2000s; hence, we build on the approach originally proposed by Attanasio and Pistaferri (2014) to quantify the evolution of consumption inequality. Their method relies exactly on the ever larger availability of consumption expenditures in the PSID since 1999.[10] In essence, the procedure imputes consumption to PSID families observed in the years before 1999 (until that date only food expenditures were measured) by using the detailed consumption data available from 1999 onward. There are four clear advantages to this approach: (i) the procedure only relies on information from a unique data set, making variable linkages easier and more obvious; (ii) one can test how closely trends in consumption inequality are replicated by the imputation procedure using the period during which detailed expenditure data is available (in-sample verification); (iii) given that the PSID stretches all the way back to the late 1960s, this procedure delivers the longest possible longitudinal consumption data base currently available for the US; (iv) last but not least, expenditure categories in the PSID appear to match NIPA aggregates well.

Having gathered a longitudinal data set containing both income and consumption measures, the challenge is to find a way to account for the distribution of all possible earnings paths that lie ahead of any given individual in our sample. One simplistic approach would be to discount the realized path of earnings. However, this presents two major problems. First, simply discounting the realized income path for any given worker would not obviously be a satisfactory approximation of the ex-ante value of that worker's human capital. Such naive approach would not capture the valuation associated to all unrealized future outcomes, whether good or bad. Second, even if one was willing to use this simplistic discounting of realized earnings, the PSID sample only allows to sample relatively incomplete histories of the working life of each household. As we explain below, we use a synthetic panel approach to deal with both of these issues.

[10] A large literature on consumption inequality makes extensive use of the Consumer Expenditure Survey (CEX), the only micro-level dataset containing information on most consumption categories going back to the early 1980s.

Obtaining longitudinal measures of household consumption. As mentioned before, we use a slightly modified version of the Attanasio-Pistaferri method. This allows to approximate the variance of log consumption in different years, a statistic that is invariant to any rescaling of the consumption levels. Given this scale invariance, this method is not concerned with matching average household expenditure in each given year: to guarantee that we match both levels and proportional dispersion of the cross-sectional distribution of consumption, we perform an extra step in which the average expenditure level is re-scaled to reproduce the yearly average household expenditure reported in NIPA data. This adjustment does not, by construction, affect the value of the dispersion measures but guarantees that the approximation can reproduce both the magnitudes and the proportional variation of consumption expenditures. More details are available in the Appendix.

Constructing synthetic work histories. Valuing the yet-to-be realized values of hypothetical earnings requires the full consideration of all possible earning paths that have as a starting point the current individual state. Unfortunately, one can not sample alternative realizations of an individual's earnings history. One way to get around this problem is to use a well-parameterized model and generate many simulated income histories. In this way one can capture the unobservable variability implicit in the income process. In this paper we take a different approach and use micro-level data about each individual work history. More specifically, at any sample date, we group sample members in different 'bins', populated by individuals who are very similar in terms of observable characteristics including their current earnings. Then, we track the earning trajectories of all individuals in each such bin and use them as an approximate sample of the distribution of possible labor market outcomes given similar initial condition (that is, keeping the initial state variables fixed). After these trajectories are realized, we proceed to group individuals again based on their updated observables. In this way we generate conditional labor market histories that: (i) feature a full set of alternative earnings' realizations for any given vector of state variables; (ii) span the entire working life of

individuals, and allows for the probability of retirement, unemployment (or non-participation) associated to any initial state. This latter aspect is key because in most cases we can only observe limited snapshots of the working life of any given individual.

Implementing this approach in practice requires some fairly detailed data analysis, which we describe in Section 3.1.

3.1 Empirical Approach

Recall from equation (24) that measuring lifetime wealth requires one to estimate the θ_{it} price obtained through the following human wealth valuation formula[11]:

$$\theta_{it} = \tilde{E}_t \left[\beta \frac{u'(c_{it+1})}{u'(c_{it})} \left(w_{it+1} h_{it+1} + \theta_{it+1} \right) \right]. \tag{32}$$

For the moment ignore the fact that $\tilde{E}_t$ entails a biased expectation for unmarried individuals, which we will address shortly, and consider instead the exercise of estimating an unbiased expectation on the right-hand side. Furthermore, suppose that i will be retired with certainty at time $t+2$ so that $\theta_{it+1} = 0$ (this is only for illustration, we explain our approach to endogenous retirement below). Although we observe all of c_{it+1}, w_{it+1} and h_{it+1} for a given individual, we only observe them for a particular realization of the state of the world. Because the expectation we are interested in will be an average over all possible future states of the world, we will need to estimate the distribution of the statistic on the right-hand side of equation (32), whose expectation we are computing. If, as mentioned before, we want to rely on the idea of synthetic work histories, we need to assume that the expectations of individuals who are ex-ante identical (in terms of observables) share the same distribution of ex-post outcomes, and therefore the expectation we seek is an average over the observed outcomes for

[11] Under our preference specification leisure can be suppressed. In sensitivity analysis we will bring it back into the valuation formula.

such individuals. More formally, this identifying assumption can be written as,

$$\tilde{E}_t\left[\beta\frac{u'(c_{it+1})}{u'(c_{it})}\left(w_{it+1}h_{it+1}\right)\right]=\tilde{E}\left[\beta\frac{u'(c_{it+1})}{u'(c_{it})}\left(w_{it+1}h_{it+1}\right)\Big|X_{it},y_{it},m_{it},Y_t\right], \tag{33}$$

where X_{it} are observable individual characteristics, $y_{it}=w_{it}h_{it}$ is current labor earnings, Y_t is the current aggregate state of the world (business cycle stage), and m_{it} is the age of i at time t. That is, we treat all ex-post variation that cannot be predicted using current earnings, age, individual characteristics (and the current aggregate state of the world) as the result of either aggregate or idiosyncratic shocks. Later in this section we will explain how we use maximum likelihood to estimate the conditional expectation on the right-hand-side of equation (33).

This approach also allows for the fact that many people do not retire at exactly age 65. However, we are still forced to assume that the value of human capital decays to zero after some arbitrary age, which we choose to be age 80.[12] Thus, we can estimate the human capital valuation of an individual i who is 79 years old at time t by

$$\hat{\theta}_{79}(X_{it},y_{it},Y_t)=\tilde{E}\left[\beta\frac{u'(c_{it+1})}{u'(c_{it})}\left(w_{it+1}h_{it+1}\right)\Big|X_{it},y_{it},79,Y_t\right]. \tag{34}$$

After computing this conditional expectation function, we proceed recursively and estimate the human capital valuation of an individual who is 78 years old by

$$\begin{aligned}&\hat{\theta}_{78}(X_{it},y_{it},Y_t)= \\ &\quad\tilde{E}\left[\beta\frac{u'(c_{it+1})}{u'(c_{it})}\left(w_{it+1}h_{it+1}+\hat{\theta}_{79}(X_{it+1},y_{it+1},Y_{t+1})\right)\Big|X_{it},y_{it},78,Y_t\right].\end{aligned} \tag{35}$$

The estimated conditional expectation function $\hat{\theta}_{78}(X_{it},y_{it},Y_t)$ can then be used to estimate the valuation of an individual who is 77 years old, and so on.

[12] Although some individuals still report positive earnings past this age, both their number and the size of their earnings are small. We do not extend the cutoff to a later age because this makes the estimated conditional expectations rather volatile.

Importantly, the expectation functions in equations (34) and (35) (and their counterparts for any other age) directly account for time varying aggregate shocks. This is because all individuals who are of a given age m in a given survey year are included when estimating the function $\hat{\theta}_m(X_{it}, y_{it}, Y_t)$. Thus, some of the variation in individual outcomes arises from the realization of aggregate shocks that could not be forecast based on the aggregate or individual income of the previous period. Indeed, our estimates are not based on (and do not impose any) assumed form for wage risk processes. The risk due to the aggregate component is identified by estimating over 45 years of aggregate shock realizations.

Estimation. One cannot simply apply OLS in order to estimate the conditional expectation functions developed above because the statistic whose expectation we wish to compute is non-negative. Nor can one use OLS to estimate the conditional expectation of the log of that statistic[13] because zeros do occur, particularly after retirement. Therefore, we follow the suggestion by Wooldridge (1992) to estimate the conditional expectation functions using Poisson QMLE regressions. We estimate separate Poisson regressions for each combination of age, gender and marital status observed in the PSID. Marital status is a binary variable in which cohabitation is considered marriage. The independent (right-hand-side) variables of each of these regressions are dummy variables for education attainment levels (less than high-school, high-school degree, some college, and college degree or more), the presence of children in the household, current labor earnings, average real earnings in the economy (to capture information about aggregate conditions), and a dummy variable for zero current earnings. We include the dummy for zero earnings to capture the human wealth of individuals who are temporarily out of the labor force. The specific set of conditioning variables was chosen because they are observed in both the PSID and the SCF. Therefore, the conditional expectation functions $\hat{\theta}_m$ that we estimate in the PSID can be used to recover estimates of the human wealth of households in the SCF. One caveat is that the SCF provides household

[13] After taking the expectation of the log we would need to correct estimates and multiply them by the expectation of the exponential of the error term.

data in which we only observe these characteristics for the head, whereas our PSID estimates are for individuals. To address this we first estimate human wealth for each individual in the PSID as described above. Next, we sum together head's and wife's human wealth for married households in the PSID to form household level estimates of human wealth. The value of human wealth for unmarried households in the PSID remains the head's human wealth. We then estimate a final poisson regression with household human wealth as the dependent variable and a full set of age, marital status, and gender dummies are interacted with the variables included in the original Poisson regressions. Estimated conditional expectations from this final Poisson regression are what we use in the SCF data.

Finally, one has to consider that, as we discussed above, the correct expectation function to apply to unmarried individuals is biased towards their outcomes in the event that they remain single. As suggested by our model, we address this point by applying a weight equal to one-half on each observed transition into marriage, and redistributing the other 1/2 of the weight equally to all observations in which no transition to marriage occurs.

3.2 Constructing Permanent Income

So far we have described how we estimate the Human Wealth of an household. An important step is to now use these estimates to construct Lifetime Wealth and Permanent Income. Lifetime Wealth is simply the sum of Human Wealth and Asset Wealth, but constructing Permanent Income requires more structure. In an infinite horizon model households consume the 'annuity value' of their lifetime wealth, where the annuity being referenced is really a perpetuity. As a simple way to augment this to be consistent with a life-cycle model we assume that all households plan to live for 100 years, and those who die early will leave a bequest consisting of their unused resources. Given this approximation of decisions we can estimate

Permanent Income as:

$$\hat{\pi}_{it} = \frac{r}{1-(1+r)^{-(100-m_{it})}} \left(\sum_{\kappa \in k} a_{it}^{\kappa} + \hat{\theta}_{it} + \hat{\theta}_{jt} \right). \tag{36}$$

That is, we model permanent income as a finite annuity value of lifetime wealth. Note that we use the age of the head of household (individual i) to compute the annuity factor, as we do not observe the spouses age in the SCF.

4 Estimation Results

Using the mthods described in the previous sections we obtain a set of estimates for the overall lifetime wealth of each household in our SCF sample, as well as a detailed decomposition of the relative components of each household's wealth portfolio at any given point in time.

Figure 2: The value of human wealth, net worth and the sum of the two (total wealth) over the lifecycle. Values expressed in dollars are averages across all households.

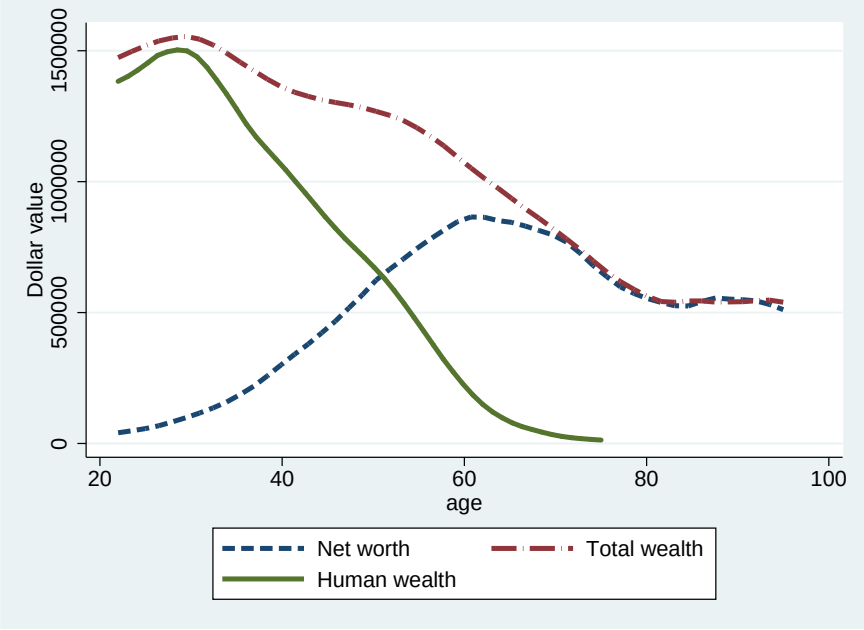


Figure 2 reports the estimated human and non-human wealth components, as well as the

total wealth, averaged across households in our sample. It is immediate to see that young households tend to have most of their wealth concentrated in human wealth, which makes any shocks impacting labor supply or health extremely costly. In addition, shocks to human wealth are poorly insured because the stock of net worth (non-human wealth) is typically very low among young adults.

The value of human wealth peaks very early in the life cycle, between age 25 and 30, well before the age at which earnings typically peak. This can be explained by considering two aspects: first, the expected length of remaining working life is important when putting a price tag on a stream of labor earnings; second, earlier investments in human capital tend to carry a much higher return while effective human capital depreciation may become more severe with age.

The contrast between human and non-human wealth is quite striking: as is well known, net worth peaks after age 60 after accounting for a relatively small fraction of total wealth until age 40. However, its decline is much more gradual as it effectively accounts for all wealth after age 70. Given these patterns, total wealth appears to peak quyite early (around age 30) and, while declining to roughly 1/3 of its peak value by age 80, it exhibits less extreme proportional changes over the course of the life cycle.

In the two panels of Figure 3 we report the share of, respectively, net worth (real/financial wealth), permanent income and human wealth held by the top 1% (left panel) and the top 10% (right panel) of households in the distributions of the respective variables. Importantly, the households in the top of the distribution of one of these variables may be different than the households in the top of the distribution of another of these variables.

Including human wealth when doing inequality accounting changes both the static and dynamic view of inequality over the past few decades. First, one can see that permanent income is much less concentrated than real/financial wealth: the total share of wealth held by the top 1% is a little over 15% and roughly half of their share of net worth which is well

Figure 3: Concentration of net worth (real/financial assets), permanent income, and human wealth wealth. Each plot reports the share in the hands of the households at the top of the respective distribution.



(a) Shares held by households in the top 1% of the respective distribution

(b) Shares held by households in the top 10% of the respective distribution

over 30%. This means that overall well-being, measured by permanent income, is much *less concentrated* than net worth. Given the fact that human wealth peaks very early in the life cycle, this is consistent with the fact that total wealth inequality is especially driven by later life discrepancies in net worth (late in life the distribution of human wealth becomes close to a degenerate with the first moment converging towards zero). Similar patterns can be observed for the richest top 10% of households. The share of permanent income held by the richest 10% of households is roughly half the share of real/financial wealth held by the same households, indicating that well-being is more evenly distributed overall.

This narrative, however, becomes much less reassuring when we consider the evolution of permanent income concentration over time. While both human wealth and net worth have become significantly more concentrated between 1989 and 2013, it is apparent that the growth in permanent income concentration has far outpaced the growth in net worth concentration. This is especially striking if one considers the extreme attention and concern that has accompanied the growth of net worth. In fact, our analysis suggests that since 1989 the speed at which permanent income has concentrated in the hands of the richest households is almost twice as

large as the increase in their share of real/financial wealth.

5 The Mechanics of Increasing Inequality

While the preceding analysis provides a rich portrayal of the historical patterns of US inequality over the past quarter century, it does leave some questions unanswered. How did such a steep increase in permanent income concentration come about? Have households in the top of the distribution of one variable (say, net worth) been adding to their share of other variables (say, human wealth)? How do young (and old) households in 2013 compare to their counterparts in 1989?

While it is clear that households in the top of the real/financial wealth distribution have been steadily increasing their share of real/financial wealth, this might in principle be offset by rising concentration of human wealth if a different set of households were at the top of the human wealth distribution. In contrast, if the same subset of households sit at the top of both distributions, this would compound and exacerbate the concentration of permanent income. Hence, a more subtle question is: how has the joint probability of being near the top of both the human and real/financial wealth distributions changed over time?

To answer these questions we proceed in two steps: (i) first, we characterize the changes in the empirical (marginal) distributions, and highlight the remarkable differences between the concentration of human wealth and that of the associated income/earning flows; (ii) next, we provide a way to account for the joint evolution of the distribution of real/financial wealth and human wealth.

5.1 Contrasting Measures of Concentration: Stocks versus Flows

To provide an overview of the changing concentration of economic resources, we report in tables 1 and 2 the values of the shares held by the top 10% of households. In particular, Table

1 reports the share of each variable held by the top 10% of households in the distribution *of that variable*, while Table 2 reports the share of each variable held by the top 10% of households *for real/financial wealth*.

Year	Asset Wealth	Human Wealth	Earnings	Lifetime Wealth	Perm. Income
1989	0.668	0.305	0.408	0.337	0.360
1992	0.667	0.304	0.400	0.327	0.344
1995	0.677	0.310	0.407	0.338	0.359
1998	0.683	0.303	0.389	0.359	0.379
2001	0.694	0.321	0.434	0.385	0.411
2004	0.692	0.328	0.419	0.391	0.423
2007	0.712	0.330	0.443	0.423	0.457
2010	0.741	0.344	0.464	0.416	0.456
2013	0.748	0.350	0.462	0.431	0.471

Table 1: This table reports the share of variable "X" in the hands of the households in the top 10% of the distribution of that same variable "X". For example, the share of earnings held by the households in the top 10% of the distribution of earnings.

One immediately noticeable finding from this analysis is that human wealth clearly exhibits the lowest concentration at the top among all variables. In particular, when comparing earnings inequality and human wealth inequality we find that, while human wealth is a function of potential future earnings, it tends to exhibit significantly lower concentration shares than earnings at the top. This suggests that (i) a non-trivial component of earnings concentration is due to transitory shocks; (ii) human wealth concentration may be mitigated by the fact that working lives can be relatively short and may suffer from setbacks that depreciate human capital and limit the excess-returns associated to skills.

It is worth stressing that, although the overall top 10% shares of both variables in Table 1 have risen, the top 10% share of earnings appears to have risen by more. Moreover, when looking at the top 10% of households in the financial/real wealth distribution (Table 2) only the share of earnings exhibits some growth. This discrepancy indicates that either the age of

Year	Asset Wealth	Human Wealth	Earnings	Lifetime Wealth	Perm. Income
1989	0.668	0.101	0.224	0.283	0.330
1992	0.667	0.093	0.222	0.262	0.307
1995	0.677	0.098	0.239	0.276	0.325
1998	0.683	0.104	0.237	0.311	0.355
2001	0.694	0.107	0.280	0.348	0.396
2004	0.692	0.099	0.273	0.356	0.409
2007	0.712	0.101	0.291	0.389	0.441
2010	0.741	0.100	0.304	0.385	0.445
2013	0.748	0.105	0.306	0.395	0.455

Table 2: This table reports the share of variable "X" in the hands of the households in the top 10% of the distribution of Net Worth. For example, the share of earnings held by the households in the top 10% of the distribution of net worth.

those in the top 10% of net worth has increased (hence higher earnings), or that there is a growing correlation between transitory shocks to earnings and real/financial wealth.

A simple comparison also reveals a great deal of information about the composition of households at the top of different wealth distributions. Even though human wealth has become more concentrated, as shown in Table 1, the share of human wealth attributable to the top 10% of the net worth distribution has not changed, as seen in Table 2. Thus, the large increases in the top 10% share of permanent income imply that the importance of net worth in household portfolios must have risen over time. Put simply, it appears that households who are in the top 10% or finanacial/real wealth have not become more likely to also be at the top of the human wealth distribution. Rather, this evidence suggests that human wealth has become a less important determinant of inequality in permanent income. Taken together, these observations illustrate how considering only earning flows (rather than human wealth stocks) would be misleading, whether studying levels or time trends.

Next, in tables 3 and 4, we overview the changes in concentration among the top 1% of households. This analysis broadly confirms the findings for the top 10% of households. The

year	Net Worth	Human Wealth	Earnings	Income	Permanent Income
1989	0.299	0.061	0.108	0.252	0.104
1992	0.300	0.059	0.109	0.156	0.097
1995	0.347	0.072	0.121	0.190	0.116
1998	0.336	0.068	0.114	0.230	0.130
2001	0.321	0.083	0.157	0.287	0.140
2004	0.331	0.091	0.137	0.245	0.151
2007	0.334	0.076	0.159	0.333	0.165
2010	0.340	0.088	0.160	0.256	0.158
2013	0.353	0.083	0.152	0.316	0.167

Table 3: This table reports the share of variable "X" in the hands of the households in the top 1% of the distribution of that same variable "X". For example, the share of earnings held by the households in the top 1% of the distribution of earnings.

year	Net Worth	Human Wealth	Earnings	Income	Permanent Income
1989	0.299	0.011	0.045	0.205	0.104
1992	0.300	0.010	0.048	0.113	0.096
1995	0.347	0.011	0.061	0.153	0.115
1998	0.336	0.013	0.061	0.169	0.129
2001	0.321	0.012	0.072	0.203	0.139
2004	0.331	0.013	0.078	0.197	0.151
2007	0.334	0.013	0.077	0.256	0.164
2010	0.340	0.011	0.068	0.184	0.157
2013	0.353	0.012	0.069	0.241	0.166

Table 4: This table reports the share of variable "X" in the hands of the households in the top 1% of the distribution of net worth. For example, the share of earnings held by the households in the top 1% of the distribution of net worth.

top shares of all variables are rising; however, when we focus only on households in the top 1% of net worth things look different. The top 1% share of human wealth does not rise, but their share of permanent income increases more than their share of real/financial wealth. Again, this can only occur because real/financial wealth has become a more important determinant of permanent income (as opposed to a larger probability of being in the top of both human wealth and real/financial wealth distributions).

Finally, we stress that all these results are static, and one must consider the possibility that rising human wealth concentration early in life will generate rising real/financial wealth inequality later in life. In the following section we revisit some of these issues more formally.

5.2 The Role of Demographic Change

One striking feature of Human Wealth is how much it varies with age, as illustrated in Figure 2. Given this, one might hypothesize that the well-known trend towards an older population could be responsible for some of the observed changes in Human Wealth Inequality, and therefore also Permanent Income Inequality. To this end we carry out a re-weighting exercise in the spirit of Denardo, Fortin and Lemieux (1986) that allows us to consider how inequality in the variables we observe would have changed had the age distribution not changed since 1989. In particular, we fit probit regressions with a full set of age dummy variables as the independent variables, and then use the predicted probabilities to transform the SCF sample weights into a new set of weights that forces the age distribution to be constant. Figure 4 illustrates how the age distribution actually changed between 1989 and 2013, and how our counterfactual weights reshape the 2013 age distribution.

Given the above re-weightings we can produce counterfactual versions of the tables in the subsection above. In particular, Table 5 reproduces the top 10% shares of each variable

Figure 4: Actual age distributions in 1989 and 2013 (left) and re-weighted counterfactual age distribution in 2013 with actual age distribution in 1989 (right).



under the counterfactual re-weighting. The first interesting thing to notice in Table 5 is that there is almost no change in Human Wealth Inequality, as opposed to the five percentage point increase we observe in the actual data. This tells us that the rising Human Wealth top 10% share is due to the fact that a much smaller segment of the population is currently at their peak human wealth age, and so fewer individuals outside the top 10% have large Human Wealth stocks in 2013 than in 1989. Next we observe the effect that this has on Lifetime Wealth and Permanent Income. Lifetime Wealth and Permanent Income Inequality do not rise as much under the counterfactual weights, but they do still rise a great deal. This indicates that asset wealth is increasingly important as a component of Lifetime Wealth inequality, and possibly more important than rising Human Wealth inequality.

5.3 Who Got Richer? Inequality Accounting

While describing the changes is the marginal distributions of net worth and human wealth is instructive, it is not sufficient to understand observed changes in permanent income. As mentioned above, increasing concentration of permanent income may be due to an increasing overlap of the households sitting at the top of the marginal distributions of net worth and hu-

Year	Asset Wealth	Human Wealth	Earnings	Lifetime Wealth	Perm. Income
1989	0.668	0.305	0.408	0.337	0.360
1992	0.669	0.298	0.397	0.322	0.339
1995	0.683	0.303	0.404	0.335	0.355
1998	0.690	0.299	0.405	0.353	0.375
2001	0.706	0.313	0.424	0.378	0.407
2004	0.703	0.314	0.415	0.378	0.411
2007	0.720	0.316	0.437	0.404	0.441
2010	0.759	0.306	0.444	0.379	0.419
2013	0.764	0.307	0.441	0.393	0.433

Table 5: This table reports the counterfactual share of variable "X" in the hands of the households in the top 10% of the distribution of that same variable "X". For example, the share of earnings held by the households in the top 10% of the distribution of earnings. These counterfactuals hold that age distribution constant as it was in 1989.

man wealth, but it might also be due to a progressive shift towards real/financial wealth in the composition of permanent income. In this section we address the question of which features of the data are most important in accounting for the increasing concentration of permanent income (PI). To answer this question we explicitly quantify the extent to which the same set of households may be responsible for the increased concentration of PI.

For this accounting exercise we account for the joint evolution of net worth and human wealth. By definition, the share of PI held by the households in the top 10% of the PI distribution in period t can be written as

$$s_{PI}^{10}(t) = \frac{PI^{10}(t)}{PI^{10}(t) + PI^{90}(t)},$$

where $PI^{x}(t)$ is the aggregate value of permanent income held by households in the top $x\%$ of the distrbution of PI in year t. Of course, the share $s_{PI}^{10}(t)$ can be split between the net

worth component and the human wealth component, as follows

$$s_{PI}^{10}(t) = \frac{NW^{10}(t) + HW^{10}(t)}{NW^{10}(t) + NW^{90}(t) + HW^{10}(t) + HW^{90}(t)}.$$

Here NW^n denotes the aggregate net worth value held by the top $n\%$ of the PI distrbution of households, while HW^n denotes the aggregate human wealth held by the same set of households.

Next, we define the wedge $\delta_x(t)$ as the value of variable x that, if redistributed from the top 10% to the bottom 90% of households, would make their relative shares of x in year t identical to those observed in year 1989. That is, we define $\delta_x(t)$ as the value such that

$$\frac{x^{10}(t) - \delta_x(t)}{x^{90}(t) + \delta_x(t)} = \frac{x^{10}(1989)}{x^{90}(1989)}.$$

The wedge $\delta_x(t)$ allows one to compute counterfactual inequality values for the distribution of a variable x, which can be used to account for changes in the concentration of x over time.[14]

For instance, if the relative distribution of real/financial net worth had not changed between 1989 and year t, the counterfactual share of permanent income (PI) held by households in the top 10% of the PI distribution in period t would be

$$\widetilde{s}_{PI}^{10}(t, \delta_{NW}) = \frac{NW^{10}(t) + HW^{10}(t) - \delta_{NW}(t)}{NW^{10}(t) + NW^{90}(t) + HW^{10}(t) + HW^{90}(t)},$$

an expression that features the net worth wedge $\delta_{NW}(t)$ only at the numerator.

Similar reasoning suggests that, absent any changes in the distribution of human wealth after 1989, the counterfactual share of permanent income held by the the top 10% of househlds

[14] It can be shown that

$$\delta_x(t) = x^{10}(t) \cdot \left[\frac{x^{90}(1989)}{x^{10}(1989) + x^{90}(1989)}\right] - x^{90}(t) \cdot \left[\frac{x^{10}(1989)}{x^{10}(1989) + x^{90}(1989)}\right].$$

in the PI distribution would be

$$\widetilde{s_{PI}}^{10}(t, \delta_{HW}) = \frac{NW^{10}(t) + HW^{10}(t) - \delta_{HW}(t)}{NW^{10}(t) + NW^{90}(t) + HW^{10}(t) + HW^{90}(t)}.$$

Of course, any change in the observed value of the share s_{PI}^{10} (between 1989 and t) that is not accounted for by δ_{NW} and δ_{HW} must be due to changes in the relative importance of net worth and human capital in the composition of permanent income.

In practice, the difference $\Delta_{NW} = s_{PI}^{10}(t) - \widetilde{s}_{PI}^{10}(t, \delta_{NW})$ measures how much of the increased concentration of PI is due to additional concentration of net worth in the hands of the top 10% of households. Similarly, the difference $\Delta_{HW} = s_{PI}^{10}(t) - \widetilde{s}_{PI}^{10}(t, \delta_{HW})$ quantifies the role of more human wealth hoarding by the top households. Finally, the difference $\Delta_{resid} = (s_{PI}^{10}(t) - s_{PI}^{10}(1989) - \Delta_{NW} - \Delta_{HW})$ identifies how much of the change in PI concentration is due to a shift in the composition of PI towards NW or HW, rather a change in the marginal distributions of NW or HW.

We use this decomposition to make sense of the changes in the concentration of permanent income between 1989 and 2013. As shown in Table 2 the share of permanent income in the hands of the top 10% of households (ranked according to their net worth) went up from 0.283 to .395, meaning that in 2013 the share of permanent income held by the top 10% of households was larger by more than 11 basis points (that is, they managed to lay claims on an extra 11% of total resources in the economy). Out of this 11% gain, roughly 3.6% was due to higher concentration in the marginal distribution of net worth, while only 0.2% can be attributed to more concentration in the marginal distribution of human wealth. The remaining change (roughly 7.4%) can only be attributed to (i) a change in the composition of permanent income that puts more weight on net worth and less on human wealth, and/or (ii) to an increase in the share of households that sit at the top of both the net worth and human wealth distribution. However, we verify that the share of households who belong to the top 10% of

both marginal distributions (of net worth and human wealth) has actually decreased slightly from 16.6% in 1989 to 15.1% in 2013. This slightly lower share of households who are both rich in human and real/financial wealth implies that the higher concentration of permanent income is mostly due to the increasing importance of real/financial net worth as a component of permanent income.

While different families populate the top of the distributions of net worth and human wealth, the role of real/financial wealth has a driver of permanent income appears to have increased significantly between 1989 and 2013, and this largely explains the higher concentration of permanent income in the hand of high net worth households.

6 Conclusions

Accounting for heterogeneity in wealth composition is important to provide a general assessment of cross-sectional inequality, and of its evolution. In this paper we develop an approach that allows to quantify the amount of human wealth held by different households. Our analysis brings together different data sources and allows to obtain estimates of total household wealth, and of its composition. We show that these estimates contain new and valuable information about the way individuals and families hold wealth. This information is especially useful when accounting for the changing patterns of wealth inequality over the past three decades.

We show that human wealth is less concentrated than net worth. This suggests that inequality in permanent income is actually lower than inferred from popular measures of inequality based on real/financial wealth. However, it is also apparent that richer households have a growing share of permanent income. In fact, concentration of permanent income has grown much faster than concentration of real/financial net worth. As a consequence, effective wealth inequality has been growing much faster than previously thought, albeit from a lower initial level.

Through simple accounting exercises we show that the increasing concentration of permanent income is, to a large extent, due to the increasing importance of real/financial wealth as a share of total wealth. Changes in the marginal distributions of net worth and human wealth only account for a small part of the increase in permanent income inequality. Moreover, we find that the share of households who sit at the top of *both* net worth and human wealth distributions has actually decreased between 1989 and 2013, indicating that increased concentration of permanent income is not explained by a small set of households hoarding all types of wealth. Instead, we find that the key driver of permanent income concentration in the past decades seems to be the expansive growth of real/financial assets as share of the wealth portfolio of rich households. High net worth households, rather than high human wealth households, account for a larger share of total permanent income in 2013 than they did in 1989, suggesting that changes in wealth composition may be key to understand recent inequality patterns.

References

ATTANASIO, O., AND L. PISTAFERRI (2014): "Consumption Inequality over the Last Half Century: Some Evidence Using the New PSID Consumption Measure," *The American Economic Review, P P*, 104(5), 122–126.

ATTANASIO, O., AND G. WEBER (1993): "Consumption Growth, the Interest Rate and Aggregation," *The Review of Economic Studies*, 60(3), 631–649.

AUTOR, D. H., L. F. KATZ, AND M. S. KEARNEY (2008): "Trends in US Wage Inequality: Revising the Revisionists," *The Review of Economics and Statistics*, 90(2), 300–323.

BECKER, G. S. (1975): *Human Capital*. Second Edition, National Bureau of Economic Research, New York, NY.

BENZONI, L., AND O. CHYRUK (2015): "The Value and Risk of Human Capital," Working paper, Chicago Fed.

BLUNDELL, R., M. BROWNING, AND C. MEGHIR (1994): "Consumer Demand and the Life-Cycle Allocation of Household Expenditure," *Review of Economic Studies*, 61(1), 57–80.

BLUNDELL, R., L. PISTAFERRI, AND I. SAPORTA-EKSTEN (2016): "Consumption inequality and family labor supply," *The American Economic Review*, 106(2), 387–435.

BRICKER, J., A. HENRIQUES, J. KRIMMEL, AND J. SABELHAUS (2016): "Measuring Income and Wealth at the Top using Administrative and Survey Data," *Brookings Papers on economic Activity*.

CONESA, J. C., S. KITAO, AND D. KRUEGER (2009): "Taxing capital? Not a bad idea after all!," *The American economic review*, 99(1), 25–48.

DAVILA, J., J. H. HONG, P. KRUSELL, AND J.-V. RÍOS-RULL (2012): "Constrained efficiency in the neoclassical growth model with uninsurable idiosyncratic shocks," *Econometrica*, 80(6), 2431–2467.

DE NARDI, M., G. FELLA, AND G. PAZ-PARDO (2016): "The Implications of Richer Earnings Dynamics for Consumption and Wealth," NBER working paper no. 21917.

ESCANCIANO, J. C., S. HODERLEIN, A. LEWBEL, O. LINTON, AND S. SRISUMA (2015): "Nonparametric Euler Equation Identification andEstimation," .

FRIEDMAN, M. (1957): "The permanent income hypothesis," in *A theory of the consumption function*, pp. 20–37. Princeton University Press.

GOLDIN, C., AND L. F. KATZ (2007): "The Race between Education and Technology: The Evolution of U.S. Educational Wage Differentials, 1890 to 2005," NBER Working Paper 12984.

GOLOSOV, M., A. TSYVINSKI, I. WERNING, P. DIAMOND, AND K. L. JUDD (2006): "New Dynamic Public Finance: A User's Guide [with Comments and Discussion]," *NBER macroeconomics annual*, 21, 317–387.

GOTTSCHALK, P., R. MOFFITT, L. F. KATZ, AND W. T. DICKENS (1994): "The growth of earnings instability in the US labor market," *Brookings Papers on Economic Activity*, 1994(2), 217–272.

GUVENEN, F., F. KARAHAN, S. OZKAN, AND J. SONG (2016): "What Do Data on Millions of U.S. Workers Reveal about Life-Cycle Earnings Dynamics?," Working Paper, University of Minnesota.

HUGGETT, M., AND G. KAPLAN (2016): "How large is the Stock Component of Human Capital?," *Review of Economic Dynamics*, 22, 2151.

JORGENSON, D., AND B. FRAUMENI (1989): "The Accumulation of Human and Non-Human Capital, 1948-1984," in *The Measurement of Saving, Investment and Wealth*, ed. by R. Lipsey, and H. Tice. NBER Studies in income and Wealth.

KAYMAK, B., AND M. POSCHKE (2016): "The evolution of wealth inequality over half a century: The role of taxes, transfers and technology," *Journal of Monetary Economics*, 77, 1–25.

KEANE, M. P. (2011): "Labor supply and taxes: A survey," *Journal of Economic Literature*, 49(4), 961–1075.

KOCHERLAKOTA, N. R. (2010): *The new dynamic public finance*. Princeton University Press.

LEVY, F., AND R. J. MURNANE (1992): "US Earnings Levels and Earnings Inequality: A Review of Recent Trends and Proposed Explanations," *Journal of Economic Literature*, 30(3), 1333–1381.

LUCAS JR, R. E. (1978): "Asset prices in an exchange economy," *Econometrica: Journal of the Econometric Society*, pp. 1429–1445.

PIKETTY, T., AND E. SAEZ (2006): "The evolution of top incomes: a historical and international perspectives," in *American Economic Review Papers and Proceedings*, pp. 200–205. Volume 96, number 2.

R. HAVEMAN, R. BERSHADKER, A., AND J. SCHWABISH (2003): "Human Capital in the United States from 1975 to 2000: Patterns of Growth and Utilization," Upjohn Institute.

RIOS-RULL, J.-V., M. KUHN, ET AL. (2016): "2013 Update on the US Earnings, Income, and Wealth Distributional Facts: A View from Macroeconomics," *Quarterly Review*, pp. 1–75, April.

SAEZ, E., AND W. KOPCZUK (2004): "Top Wealth Shares in the United States: 1916-2000: Evidence from Estate Tax Returns," NBER Working Paper 10399.

SAEZ, E., AND G. ZUCMAN (2014): "Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data," NBER working paper 20625.

WOOLDRIDGE, J. M. (1992): "Some alternatives to the Box-Cox regression model," *International Economic Review*, pp. 935–955.