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SAVINGS AND SAVING RATES: UP OR DOWN?

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ABSTRACT

It depends what we want to measure. Most literature has focused on observed flow of savings (per-period savings as fraction of GDP), which has declined persistently since 1980. Even though this decline means that fewer funds are available for investment in each period, it does not follow that the households' actual savings (underlying, not observed, savings determined by dynamic optimization) also go down. We theoretically link these two concepts, discuss the conditions under which they move in opposite directions, and show that indeed the actual savings has sharply increased since 1980.

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1 Introduction

Since 1980, and after several years of apparent stability, the U.S. saving rate measured by the National Accounts experienced a persistent decline, bottoming out at 0% of GDP in 2000. This trend drew attention of academics and policymakers alike, generating a rich literature that seeks to understand why agents' desire to save has declined. We argue that the *observed saving rate* based on income flow may be a misleading measure of *actual saving rate* in the economy.

It is a common mistake to think of *savings as just a flow* – a proportion of income that households want to keep for the future. However, dynamic models of saving and consumption deliver a *prescriptions about the stock* of savings. At any given time, households target a level of financial assets that depends on their total wealth, present and future. When present wealth increases (*capital gains* for instance), or when future wealth increases (*future human capital* increases its value), agents rely less on delaying current consumption to achieve their desired level of savings.

We use a standard macroeconomic model to theoretically link *observed savings* with the implied *actual savings*, and show that observed savings are a good proxy for actual savings only when the price of current assets and the value of future human capital are stable. To quantify the link, we use widely available data on the relative prices of financial assets, realized income and interest rates to compute the implied value of household wealth and uncover actual savings that are consistent with the observed savings in the U.S. since 1980.

Consider a stationary economy where agents save 10% of their income every period. If agents experience an increase in current wealth (capital gains), they have been saving relatively too much, and will react by reducing their per-period savings below 10% for some period of time. Similarly, if agents believe that their future human capital will increase, leading to more income than expected, current savings needs decline reducing again their period-savings below 10%. Thus, there are situations where actual savings increases while the immediate observed savings declines. We show that that a similar pattern has played out in the U.S. since 1980.

We decompose the sources of departure between observed and actual savings,[1] and find that although capital gains were relevant on reducing savings as a fraction of

[1]This accounting exercise is in the spirit of what Farhi and Gourio (2018) has performed to decompose recent macro-finance trends into the evolution of market power, intangibles and risk premia.

income, this happened only over the last 20 years, mostly due to increased stock values. The capital gain component has indeed received some recent attention. Fagereng et al. (2019) and Robbins (2019), for instance, adjust observed saving rates by redefining income to include capital gains. Consistent with our results, they find that adding capital gains explicitly in the measurement of savings helps to adjust observed savings upward. Straub (2019) goes beyond this approach and analyzes the impact of heterogeneity in observed savings through capital gains.

We show, however, that the most relevant factor in explaining why observed and actual saving rates have moved in opposite direction is the sharp increase in the value of human capital, which has been widely overlooked in the literature. Furthermore, we find that the increase in the value of human capital was mainly driven by decreasing interest rates.

Our finding is relevant because several recent economic and demographic changes that imply an increase in saving rates (such as relaxed credit constraints, additional insurance opportunities, and higher life expectancy) have been usually challenged, and sometimes outright discarded, because they are at odds with declining saving rates.[2] Farhi and Gourio (2018) and Eggertsson, Lancastre, and Summers (2019), for instance, seemingly counterfactually argue that savings in the U.S. economy should have sharply increased in the last 30 years. Here we show that indeed saving rates have been increasing when measured consistently with dynamic models. Similarly, higher life expectancy implies larger needs for retirement expenses and medical bills. In a well-known paper, Auerbach, Cai, and Kotlikoff (1991) predicted a sharp increase in savings over the next 30 years, which did not appear to happen based on observed saving rates. Our work shows that their predictions, though seemingly inconsistent with observed savings, are indeed consistent with actual savings.

Related Literature: The first paper noting the fall in observed saving rates was Summers and Carroll (1987), who stressed the relevance of savings for long-term growth and urged the U.S. government to take action to prevent a stagnation.[3] A subsequent rich literature, including Campbell (1987); Attanasio (1994); Nordhaus (1995); Gokhale, Kotlikoff, and Sabelhaus (1996); Attanasio (1998) and Parker (1999), address the economic consequences of declining saving rates and the implied policy

[2]Recently Lusardi, Skinner, and Venti (2001) also suggest that NIPA saving rates may not be useful in judging whether households are preparing for retirement or other contingencies.

[3]See also Hendershott and Peek (1987) for a contemporaneous similar discussion.

responses. We show that the decline in the supply of savings is consistent with an increase in the demand for savings, which has consequences for evaluating potential policy responses.

These papers also sparked a large literature trying to understand the persistent decline in saving rates.[4] A potential solution was to incorporate capital gains into the computation of savings measures. In an influential paper Gale and Sabelhaus (1999) show that, among many potential adjustments to measured saving rates (such as retirement accounts, inflation and taxation) the most relevant was capital gains. Other research involved adjusting for changes in TFP, Chen, Imrohoroglu, and Imrohoroglu (2006), and proposals to reformulate the NIPA calculations, Boskin (2009). We show that there may not be any inconsistency in how we measure saving rates.

The evolution of saving rates has also implications beyond growth, as unspent capital gains appears to be the main driver of wealth inequality (see Gomez (2017), Karabarbounis and Neiman (2019), Fagereng et al. (2019) and Robbins (2019), among others). To further evaluate this mechanism, Straub (2019), building on the seminal work by De Nardi (2004), incorporates distributional effects in an otherwise standard permanent income theory to reconcile the model's predictions with known but elusive empirical observations as in Dynan, Skinner, and Zeldes (2004). Besides these efforts, still there seems to be a disconnect between the observed increase in the wealth-to-income ratio and saving rates, even when adjusting for capital gains.

There is also an evolving literature on savings and financial markets. Carroll, Slacalek, and Sommer (2019) argue that financial liberalization helps to explain the reduction in saving rates (the easier it is to borrow, the less agents need to save). This view has been used, for instance, by Guerrieri and Lorenzoni (2017) to argue that a sudden sharp reversal of the trend of loosening credit played a large role in the recently, and relatively short-lived, saving rate rise. Given that demographics is recognized as an important driver of savings as well, recent efforts combined demographic and financial transitions. Ordonez and Piguillem (2019) and Eggertsson, Mehrotra, and Robbins (2019), for instance, study both forces in the same setting. We show that the valuation of assets and human capital closely follows movements in interest rates through valuation effects, affecting both observed and actual saving rates, which is consistent with the standard theory and with the data.

[4]For the challenges that measurement errors of saving rates impose to the econometric testing of the permanent income hypothesis, for instance, see Stark and Nakamura (2007).

2 Standard Macroeconomics Model

In this section we provide a theoretical framework to interpret the aggregate measures of savings. We consider the simplest model of asset accumulation that allows for a meaningful link between savings flows and stocks, and thus between observed and actual savings. Time is discrete and continues forever. There is no aggregate risk, so average prices are deterministic. Households can save using a risky asset a, subject to *i.i.d.* idiosyncratic risk, and a risk-free asset b. Assuming households have CRRA preferences, their problem is:

$$\max_{\{c_t, a_{t+1}, b_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma}$$

subject to the budget constraint:

$$c_t + a_{t+1}p_t + b_{t+1} \leq (1+\pi_t)\epsilon_i a_t p_t + R_t b_t + w_t,$$

where w_t is labor income (labor supply is fixed and normalized to 1), the risky asset $a_t \geq 0$ can be financial or non-financial (e.g., housing), p_t is the relative price of risky assets (introduced to capture capital gains) and π_t their (dividend) return. As we show in Appendix A, the distribution function of the idiosyncratic shocks ϵ_i is inconsequential to our results as long as it is *i.i.d.* over time. We introduce shocks to generate a non-degenerate portfolio, with both risky and risk-free assets. In what follows we simplify notation to $\pi_t^i = (1+\pi_t)\epsilon_i$.

As is standard in the literature, we solve this problem appealing to the permanent income hypothesis. To that end, we define human wealth, h, as the discounted sum of future wages:

$$h_t = \sum_{j=1}^{\infty} \frac{w_{t+j}}{\prod_{l=1}^{j} R_{t+l}}. \tag{1}$$

Households maximize the present value of utility subject to the budget constraint and the natural debt limit, i.e., $b_t \geq -h_t$. Defining household i's total wealth at t as:

$$W_t^i = \pi_t^i a_t p_t + R_t b_t + w_t + h_t, \tag{2}$$

the solution has the form:

$$c_t^i = (1 - s_t)W_t^i \tag{3}$$

$$p_t a_{t+1}^i = s_t \phi_t W_t^i. \tag{4}$$

The factor s_t *is the actual saving rate out of total wealth*, the focus of this paper, while the factor ϕ_t is the proportion of savings allocated to the risky asset. Notice that both s_t and ϕ_t are independent of the consumer's wealth and current income. This follows from the fact that preferences are homothetic.

These equations make clear that *actual savings* is a linear function of the *current total wealth*. Households are not concerned about the flow of savings, but about the growth rate of total wealth. As we show in the Appendix, an agent who has wealth W_t^i and received a shock i in period t, chooses financial assets such that in period $t+1$, and upon the realization of a future shock i', the total wealth satisfies:

$$W_{t+1}^{i'} = \Big[\underbrace{\phi_t \pi_{t+1}^{i'} \frac{p_{t+1}}{p_t} + (1 - \phi_t) R_{t+1}}_{\equiv r_{t+1}^{i'}} \Big] s_t W_t^i. \tag{5}$$

The choice of s_t ensures that total wealth grows at the optimal rate. This theory, which is the standard out-of-shelf theory of savings, has nothing to say about the flow of savings. It only determines how the household wants its stock of wealth to grow, and agents adjust savings to achieve their target. In particular, the saving rate in this environment satisfies:

$$(1 - s_t)^{-1} = 1 + \beta^{1/\sigma} [\mathbb{E} r_{t+1}^{1-\sigma}]^{1/\sigma} (1 - s_{t+1})^{-1}, \tag{6}$$

which confirms that the *saving rate is independent of wealth and income*. It is affected by the interest rate, exposure to risk and the risk tolerance.[5] If $\sigma = 1$ (log utility) then it is easy to show that $s_t = \beta$, for all t. If instead $\sigma \neq 1$, then the saving rate solves the recursive forward-looking equation (6).

The only theoretical prediction of the model is that saving rate that links stocks into stocks. How the flows move depends on the particular values of w_t and a_t. We will characterize its relation to the standard measure of saving rate as a fraction of GDP.

[5] See Angeletos (2007) for an extension to an environment with Epstein-Zin preferences. As it will be clear in Section 3, a generalization of equation 6 is not relevant to our analysis.

Remark 1 ***Idiosyncratic labor income risk:*** *What happens when there is uncertainty? Take the steady version of saving rate, s:*

$$s = \beta^{\frac{1}{\sigma}} [\mathbb{E} r^{1-\sigma}]^{1/\sigma}.$$

If labor income is random (but still idiosyncratic) the saving rate could depend on the level of wealth, but this only happens for those households that are close to the borrowing limit. Since Krusell and Smith (1998), we know that there is approximate aggregation. In fact, we can show that the average saving rates in the economy can be closely approximated by:

$$s = \beta^{\frac{1}{\sigma}} [\mathbb{E} r^{1-\sigma}]^{1/\sigma} e^{(\sigma+1)\sigma_w^2/2},$$

where σ_w is the standard deviation of a log-normal shock to labor income.

Remark 2 ***Determination of optimal portfolio allocation, ϕ:*** *In Appendix A we show that ϕ solves:*

$$\mathbb{E}_{i'} \left[\left(\frac{p_{t+1}}{p_t} \pi_{t+1}^{i'} - R_{t+1} \right) \left(\phi_t \pi_{t+1}^{i'} \frac{p_{t+1}}{p_t} + (1-\phi_t) R_{t+1} \right)^{-\sigma} \right] = 0,$$

which is also independent of wealth.

The takeaway from these results is that savings in a model with homothetic preferences is properly represented by a relationship as in (5) where s_t could be affected by the interest rate, or its expected value, and the household's labor income risk. In any case, actual savings links stocks to stocks, while observed savings are just the flows that make such link operational.

3 Measurement Meets Theory

In this section we show how the *observed flow of saving rate* and the theoretical *actual saving rate based on stocks* are linked. Mapping data with its theoretical counterpart, income is $y_t = \pi_t a_t p_t + (R_t - 1) b_t + w_t$.[6] Since we are abstracting from taxes, we can

[6]Here π_t is the original definition as a dividend, unlike π_t^i which is a gross return.

think about r and w as after-tax prices, so that y is also disposable income. Using this definition, we can rewrite the budget constraint as:

$$c_t + p_t a_{t+1} + b_{t+1} = a_t p_t + b_t + y_t.$$

Thus, the saving rate out of disposable income is measured as:

$$s_t^d = \frac{p_t(a_{t+1} - a_t) + b_{t+1} - b_t}{y_t} = \frac{y_t - c_t}{y_t}. \tag{7}$$

This is the standard measure in NIPA, and is also used for the Flow of Funds financial accounts to compute the personal saving rate. Using the budget constraint, together with equations (2) and (3), the law of motion of assets is:

$$p_t a_{t+1} + b_{t+1} = s_t W_t - h_t,$$

$$p_t a_{t+1} + b_{t+1} = s_t[a_t p_t + b_t + y_t + h_t] - h_t.$$

Reorganizing we obtain:

$$\frac{p_t(a_{t+1} - a_t) + b_{t+1} - b_t}{y_t} = (s_t - 1)\frac{(a_t p_t + b_t + h_t)}{y_t} + s_t. \tag{8}$$

Combining equations (7) and (8) we can see that the standard flow measure of savings (s_t^d) and our stock-based measure of actual savings (s_t) are linked by:

$$s_t^d = (s_t - 1)\frac{(a_t p_t + b_t + h_t)}{y_t} + s_t. \tag{9}$$

Researchers and policymakers sometimes measure the left hand side of (9) and arrive to conclusions which the theory only predicts for s_t in the right hand side. In short there tends to be a confusion between *an implied flow of savings and the actual desired volume of savings*. If $a_t p_t + b_t$ (financial capital) and h_t (human capital) are stable, the implications for s_t^d carry over to s_t. However, if either financial or human capital changes, the mapping is no longer valid and drawing conclusions from the observation of s_t^d could be misleading.

Remark 3 ***Alternative definitions of income:*** *Note that given the right-hand side of the budget constraint, we can define "net savings" as $s_t^d = p_t a_{t+1} + b_{t+1} - p_t a_t - b_t$. Fagereng et al.*

(2019) and Robbins (2019) also define "gross savings," which include expected capital gains, defined as $cg_{t+1} = (p_{t+1} - p_t)a_{t+1}$. *In this way they generate an alternative, and broader, measure of income respect to NIPA, known as "Haig-Simons income." Adding* cg_{t+1} *to both sides of the budget constraint, the gross saving rate can be defined as:*

$$s_t^g = \frac{s_t^d + cg_{t+1}}{y_t + cg_{t+1}}.$$

The difference comes from multiplying a_{t+1} *by* p_{t+1} *rather than* p_t. *The saving rate defined this way directly adds capital gains to the standard flow of savings. In this paper we focus on the net rate because it is the standard measure in National Accounts that, is directly implied by the theory and it is not directly affected by realized capital gains.*

Remark 4 ***The role of heterogeneity:*** *One may be concerned that the standard model does not consider the implications of saving rate heterogeneity on aggregate measures. As equation* (6) *shows, heterogeneity in* β, σ, *and even permanent differences in returns, could generate heterogeneous saving rates that interact with aggregation. Suppose that individuals are indexed by a permanent heterogeneous component* j, *so that:*[7]

$$s_t^{d,j} = (s_t^j - 1)\chi_t^i + s_t^j.$$

Then, aggregate savings satisfies:

$$s_t^d = (s_t - 1)\chi_t + s_t + \rho_{s,\chi}\sigma_{s_t}\sigma_{\chi_t}.$$

Given the correlation $\rho_{s,\chi}$ *between saving rates and total wealth, more dispersion in either of its components should generate larger observed flows of savings, not lower. This effect is reinforced if the correlation increases.*[8]

While s_t^d is measured frequently, s_t is not observable. We can, however, back out s_t by adjusting the measure of s_t^d with information about the evolution of $a_t p_t + b_t$ (household net worth) and h_t (approximated by the present value of future labor income,

[7] Aguiar, Bils, and Boar (2020) show that most of the savings heterogeneity in the U.S. is explained by a permanent component.

[8] There seems to be positive correlation between saving rates and net worth, as shown by Dynan, Skinner, and Zeldes (2004). However, Bach, Calvet, and Sodini (2017), who define savings respect to financial net worth, found a negative correlation in Swedish data.

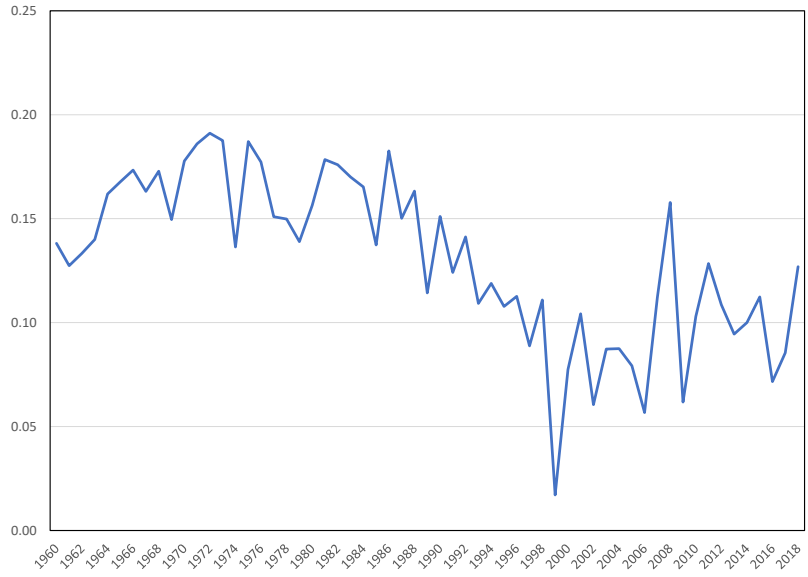
discounted at the risk-free rate). This adjustment comes from rewriting equation (9):

$$s_t = \frac{s_t^d + \chi_t}{1 + \chi_t} \qquad \texttt{where} \qquad \chi_t = \frac{a_t p_t + b_t + h_t}{y_t}. \tag{10}$$

Thus, using NIPA and the Flow of Fund tables we can compute the implied theoretical actual saving rate and compare it with the observed saving rate. The relationship would depend on how χ_t moves over time, due to either *capital gains* or *human capital* (discounted future labor income).

Figure 1 shows the standard measure of saving rates as a fraction of output, s^d. As we can see it continuously declined from 1970 until the Great Recession.

Figure 1: Observed saving rate



3.1 Measuring Capital Gains.

As a first step toward measuring capital gains, we compute net worth over income. This is, defining net worth $N_t = a_t p_t + b_t$ we compute the component $\frac{N_t}{y_t}$ in χ_t. The Flow of Funds provides information about the aggregate holdings of households. Using Table B.101 to obtain the net worth and NIPA Table 2.1 to compute personal income we can construct the first panel of Figure 2. Comparing it with Figure 1 we can see that both seem to be providing opposite (inconsistent) signals. The sharp fall

in s^d happens simultaneously with a steep increase in net worth, which increased by around 30% from 1980 to 2018. How is it possible that net worth increases while savings decline? The answer may be found by considering capital gains.

From the evolution of net worth, we can compute the implied capital gains in household balance sheets. Table F6 of Flow of Funds provides the net acquisitions of financial assets by households. Define $dN_t = N_{t+1} - N_t$ as the net acquisitions in period t. Absent capital gains, it must be the case that

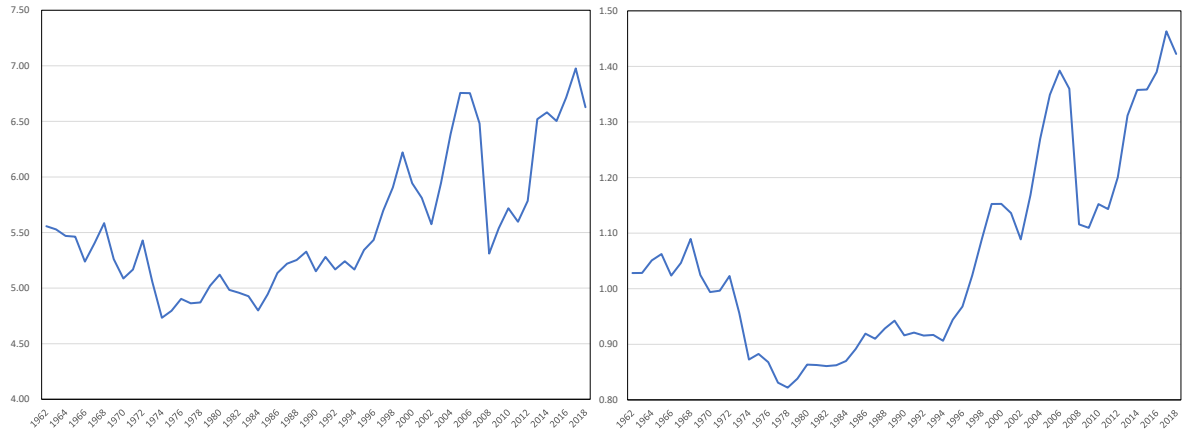
$$N_{t+1} = \tilde{N}_{t+1} \equiv dN_t + N_t.$$

If in period t the computed value is N_{t+1}, we can estimate the capital gain between period t and $t+1$ as the ratio

$$p_t = \frac{N_{t+1}}{\tilde{N}_{t+1}} = \frac{N_{t+1}}{dN_t + N_t}.$$

Since these calculations use nominal variables, we divide p_t by the consumer price index to estimate real capital gains. The resulting series is depicted in the second panel of Figure 2. From 1980 to 2018 there was an estimated capital gain of around 65%. We evaluate later the extent to which observed saving rates can be accounted for by capital gains.

Figure 2: Evolution of net worth and capital gains



(a) Net Worth

(b) Capital Gains

3.2 Measuring Human Capital.

To recover the theoretical actual savings s_t, we also need to compute the second component of χ_t for each t, which corresponds to human capital, h_t. This component relates to the permanent-income hypothesis – both consumption and savings are determined by the present value of the future expected income. Calculating it requires two elements: the expected future income and a risk-free rate. As our model is based on real variables in a stationary environment, let $\tilde{R}$ be the nominal interest rate and ρ the inflation rate, so that $\tilde{R} = R + \rho$. Denoting by $\tilde{g}^y$ the growth rate of nominal income per capita, real income growth is $g^y = \tilde{g}^y - \rho$. Writing human capital from equation (1) recursively, $h_t = \frac{w_{t+1}+h_{t+1}}{R_{t+1}}$, the ratio $\tilde{h} = h/y$ is:

$$\tilde{h}_t \equiv \frac{h_t}{y_t} = \frac{w_{t+1} + h_{t+1}}{y_t R_{t+1}},$$

$$\tilde{h}_t = \frac{y_{t+1}}{y_t}\left[\frac{1 - \alpha_{t+1} + \tilde{h}_{t+1}}{\tilde{R}_{t+1} - \rho_{t+1}}\right],$$

where α is the capital income share. As $\frac{y_{t+1}}{y_t} = 1 + g^y_{t+1}$, then:

$$\tilde{h}_t = \frac{1 - \alpha_{t+1} + \tilde{h}_{t+1}}{\frac{\tilde{R}_{t+1}-\rho_{t+1}}{1+g^y_{t+1}}} \simeq \frac{1 - \alpha_{t+1} + \tilde{h}_{t+1}}{\tilde{R}_{t+1} - \tilde{g}^y_{t+1}}, \tag{11}$$

since $\frac{\tilde{R}_{t+1}-\rho_{t+1}}{1+g^y_{t+1}} \simeq \tilde{R}_{t+1} - \rho_{t+1} - (\tilde{g}^y_{t+1} - \rho_{t+1})$.

To measure equation (11) we need a measure of capital income share, a risk-free nominal interest rate and the growth rate of nominal per-capita disposable income. The last measure is the simplest; we define $\tilde{g}^y$ as the growth rate of nominal per-capita disposable income (using NIPA Table 2.1 Line 26 dividing disposable income by total population). For $1 - \alpha$ we define total "labor share" (or non-capital income) as compensation to employees (Table 2.1 Line 2) plus government transfers (Table 2.1 Line 17) which includes social security payments, Medicaid and unemployment insurance. We divide this total by personal income (Table 2.1 Line 1). This is the equivalent to w in the model in the sense that it is income that did not result from past financial investments. Notice that this calculation of α uses gross income, so it is correct only if all sources of income are taxed at the same rate.[9]

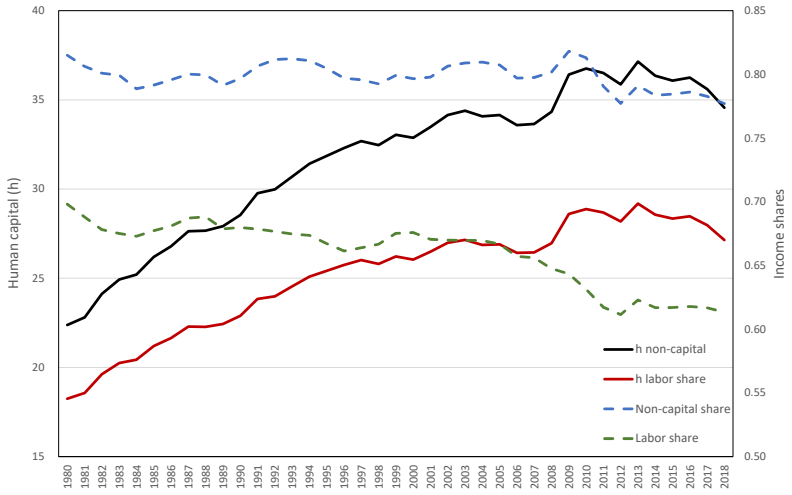
[9]NIPA only provides information about the total taxes paid by households, without separating the

Regarding the nominal interest rate $\tilde{R}$, a natural candidate is the return on treasuries. The problem with this choice is that in general $\tilde{R} - \tilde{g}^y < 0$, which generates confusion as to how to interpret h. Since in average $\tilde{R} - \tilde{g}^y < 0$ implies that $h < 0$, which should be interpreted as infinite human capital. To avoid this problem, we use the corporate bond rate Baa from Fred, which ensures that in most periods $\tilde{R} - \tilde{g}^y > 0$, and it is not deeply affected by the liquidity premium embodied in treasuries.

Finally, to make equation (11) operational we would need infinite periods. To overcome this issue, we assume a final value for $\tilde{h}$ using a steady state approximation. In steady state, it should be true that $\tilde{h} = \frac{(1-\alpha)}{\tilde{R}-\tilde{g}^y}$. We have data up to 2018, and thus assume that in 2019 the final value for $\tilde{h}$ is the steady state formula $\tilde{h} = \frac{(1-\alpha)}{\tilde{R}-\tilde{g}^y}$, where all variables are computed as the average of the last ten years. Using (11) we can compute the implied values for $\tilde{h}_t$ using the actual realizations of α_{t+1}, $\tilde{R}_{t+1}$ and $\tilde{g}^y_{t+1}$. As a result, the further back in time we go, the more accurate the calculation becomes.

The resulting value for $\tilde{h}$ is depicted as a continuous red line in Figure 3. The most important fact is the steep increase in the value of human capital to income ratio, mostly explained by the fall in interest rates. This calculation of human capital uses labor share (green dashed line in Figure 3), which shows a sharp decline from almost 70% in 1960 to almost 60% in 2010, a fact documented by Karabarbounis and Neiman (2014), among others.

Figure 3: Human capital and labor share



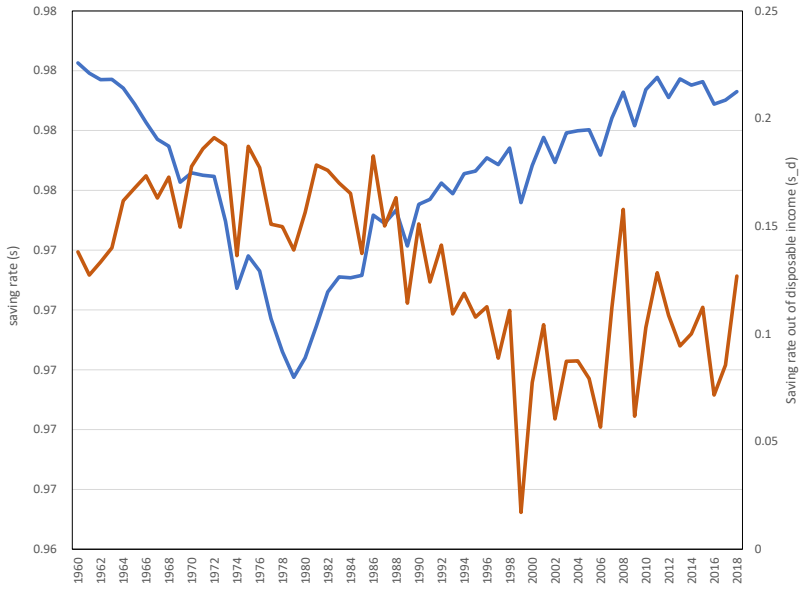
sources of taxable income.

An alternative is to add government transfers to labor income. When we include the expected transfers from the government the non-capital share remains stable around 80% (blue dashed line in Figure 3). Human capital with this alternative labor share is the black solid line in Figure 3). Even though levels are different, the feature of an increase of human capital remains.

3.3 Comparing Observed Savings and Actual Savings.

Using standard observed savings s_t^d and the two components of χ_t, we can compute theoretical actual savings s_t from equation (10). The comparison between observed and actual savings can be seen in Figure 4. The blue line is the actual savings of households considering capital gains and future labor income, while the orange curve is the observed saving rate out of the flow of income. It is clear from Figure 4 that the actual saving rate has been increasing since 1980 after a long and sharp decline.

Figure 4: Comparing Observed and Actual Savings Rates



To understand the roots of the opposite behavior between observed and actual saving rates we perform a series of counterfactual exercises that consists in asking what saving rates we would have observed s_t^d absent capital gains and human capital, if maintaining the computed actual saving rates s_t.

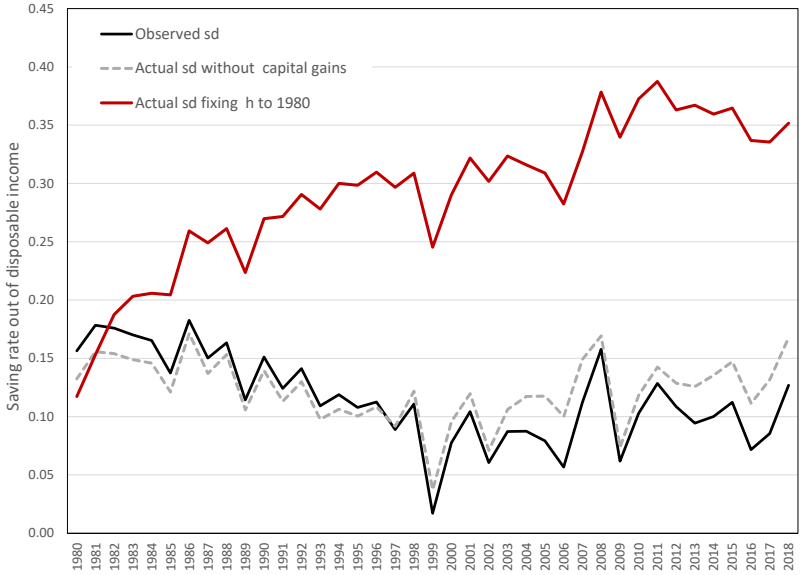
From equation (9), the measured s_t^d is related to actual savings s_t by:

$$s_t^d = (s_t - 1)\chi_t + s_t.$$

Thus, given s_t, alternative measures of χ_t would have generated flow of savings different than the one depicted in Figure 1.

In scenario 1) we eliminate capital gains in the computation of χ_t. The counterfactual s_t^d is plotted in Figure 5 with the grey dashed line. Without capital gains, standard measures of saving rates would have been very similar to the observed ones, which also declined until 2000. In the last two decades, however, standard measures of saving rates would have been three percentage points higher. Intuitively, without capital gains households would have needed to save more to reach their desired savings levels.

Figure 5: Counterfactual observed saving rates



In scenario 2) we eliminate human capital (fixing $\tilde{h} = \tilde{h}_{1980}$) in the computation of χ_t. The counterfactual s_t^d is plotted in Figure 5 with the continuous red line. Without an increase in expected human capital, standard measures of saving rates would have increased sharply over time from around 12% to 35%.[10] Intuitively, without large expected increases in human capital households would have needed to save much

[10]This last measure is strikingly similar to the prediction of Auerbach, Cai, and Kotlikoff (1991), who forecasted that changes in demographics should have induced an increase in savings of around 30%.

more of their income to reach their desired savings levels. But since the human capital sharply increased, that wasn't necessary and thus the observed measured rate declined.

4 Conclusions

Using standard measures of saving rates as a fraction of output to infer the actual saving rates intended by households is misleading. The main reason is that households adjust their savings each period to accommodate capital gains and future expected changes in human capital.

We have made this relation between observed and actual saving rates explicit theoretically, and have used the result to compute actual saving rates, showing that in contrast to observed standard measures of saving rates, U.S. households have actually increased savings since 1980. We were able to measure the role of capital gains and human capital in driving this apparent inconsistency. We show that, absent capital gains, standard measures of saving rates would have been slightly higher in the last two decades, but absent discounted human capital (partly induced by valuation at lower rates) observed flow-based saving rates would have increased since 1980.

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Appendix

A Model's solution

The first order condition generates:

$$p_t u'(c_t^i) = \beta p_{t+1} \mathbb{E}_{i'} \pi_{t+1}^{i'} u'(c_{t+1}^{i'})$$
$$u'(c_t^i) = \beta R_{t+1} \mathbb{E}_{i'} u'(c_{t+1}^{i'})$$

$$p_t (c_t^i)^{-\sigma} = \beta p_{t+1} \mathbb{E}_{i'} \pi_{t+1}^{i} (c_{t+1}^{i'})^{-\sigma} \quad (12)$$
$$(c_t^i)^{-\sigma} = \beta R_{t+1} \mathbb{E}_{i'} (c_{t+1}^{i'})^{-\sigma} \quad (13)$$

As shown in equations (3) and (4), we guess and verify that:

$$c_t^i = (1 - s_t)(\pi_t^i a_t p_t + R_t b_t + w_t + h_t)$$
$$p_t a_{t+1}^i = s_t \phi_t (\pi_t^i a_t p_t + R_t b_t + w_t + h_t)$$

Using the budget constraint and the consumption function we can recover the implicit law of motion of the risk-free asset:

$$b_{t+1}^i = \pi_t^i a_t^i p_t + R_t b_t + w_t - p_t a_{t+1}^i - c_t^i$$
$$b_{t+1}^i = W_t^i - h_t - \phi_t s_t W_t^i - (1 - s_t) W_t^i$$
$$b_{t+1}^i = (1 - \phi_t) s_t W_t^i - h_t$$

Therefore the law of motion of wealth is:

$$W_{t+1}^{i'} = \pi_{t+1}^{i'} a_{t+1}^i p_{t+1} + R_{t+1} b_{t+1}^i + w_{t+1} + h_{t+1}$$
$$W_{t+1}^{i'} = \pi_{t+1}^{j} \frac{p_{t+1}}{p_t} \phi_t s_t W_t^i + R_{t+1}[(1 - \phi_t) s_t W_t^i - h_t] + w_{t+1} + h_{t+1}$$
$$W_{t+1}^{i'} = [\phi_t \pi_{t+1}^{i'} \frac{p_{t+1}}{p_t} + (1 - \phi_t) R_{t+1}] s_t W_t^i - R_{t+1} h_t + w_{t+1} + h_{t+1} \quad (14)$$

Notice that:

$$h_t = \sum_{j=1}^{\infty} \frac{w_{t+j}}{\prod_{l=1}^{j} R_{t+l}} \quad \Rightarrow \quad h_t = \frac{w_{t+1} + h_{t+1}}{R_{t+1}} \quad (15)$$

Using this recursive representation of h_t in equation (14) we obtain:

$$W_{t+1}^{i'} = [\phi_t \pi_{t+1}^{i'} \frac{p_{t+1}}{p_t} + (1 - \phi_t) R_{t+1}] s_t W_t^i \quad (16)$$

which is equation (5) in Section 2. To show that the guess is correct, notice that we can replace the guessed consumption function $c_t = (1 - s_t)W_t$ in the Euler equation (13) to get:

$$[(1 - s_t)W_t^i]^{-\sigma} = \beta R_{t+1} \mathbb{E}_{i'}[(1 - s_{t+1})W_{t+1}^{i'}]^{-\sigma}$$

Now using equation (5) and reorganizing:

$$[(1 - s_t)W_t^i]^{-\sigma} = \beta R_{t+1} \mathbb{E}_{i'}[(1 - s_{t+1})r_{t+1}^{i'} s_t W_t^i]^{-\sigma}$$

$$(1 - s_t) = [\beta R_{t+1} \mathbb{E} r_{t+1}^{-\sigma}]^{-1/\sigma}(1 - s_{t+1})s_t$$

After some simple math:

$$(1 - s_t)^{-1} = 1 + [\beta R_{t+1}]^{1/\sigma}[\mathbb{E} r_{t+1}^{-\sigma}]^{1/\sigma}(1 - s_{t+1})^{-1} \tag{17}$$

Alternative approach. Multiplying (12) by ϕ_t and (13) by $1 - \phi_t$ and adding up:

$$(c_t^i)^{-\sigma} = \beta \mathbb{E}_{i'} \left[\phi_t \frac{p_{t+1}}{p_t} \pi_{t+1}^{i'} (c_{t+1}^{i'})^{-\sigma} + (1 - \phi_t) R_{t+1} (c_{t+1}^{i'})^{-\sigma} \right]$$

$$[(1 - s_t)W_t^i]^{-\sigma} = \beta \mathbb{E}_{i'} \left[\phi_t \frac{p_{t+1}}{p_t} \pi_{t+1}^{i'} + (1 - \phi_t) R_{t+1} \right] [(1 - s_{t+1})W_{t+1}^{i'}]^{-\sigma}$$

Now using equation (5) and reorganizing:

$$[(1 - s_t)W_t^i]^{-\sigma} = \beta \mathbb{E}_{i'} (r_{t+1}^{i'})^{1-\sigma} [(1 - s_{t+1}) s_t W_t^i]^{-\sigma}$$

$$(1 - s_t) = [\beta \mathbb{E} r_{t+1}^{1-\sigma}]^{-1/\sigma}(1 - s_{t+1})s_t$$

After some simple reorganization of the last equation we obtain (6) in Section 2:

$$(1 - s_t)^{-1} = 1 + \beta^{1/\sigma}[\mathbb{E} r_{t+1}^{1-\sigma}]^{1/\sigma}(1 - s_{t+1})^{-1}$$

For completeness one can solve for the optimal portfolio allocation ϕ. Combining equations (12) and (13) we have:

$$\mathbb{E}_{i'} \left[\left(\frac{p_{t+1}}{p_t} \pi_{t+1}^{i'} - R_{t+1} \right) (c_{t+1}^{i'})^{-\sigma} \right] = 0$$

$$\mathbb{E}_{i'} \left[\left(\frac{p_{t+1}}{p_t} \pi_{t+1}^{i'} - R_{t+1} \right) [(1 - s_{t+1})W_{t+1}^{i'}]^{-\sigma} \right] = 0$$

$$\mathbb{E}_{i'}\left[\left(\frac{p_{t+1}}{p_t}\pi^{i'}_{t+1} - R_{t+1}\right)[r^{i'}_{t+1}s_t W^i_t]^{-\sigma}\right] = 0$$

As a result the optimal portfolio allocation ϕ_t solves:

$$\mathbb{E}_{i'}\left[\left(\frac{p_{t+1}}{p_t}\pi^{i'}_{t+1} - R_{t+1}\right)\left(\phi_t\pi^{i'}_{t+1}\frac{p_{t+1}}{p_t} + (1-\phi_t)R_{t+1}\right)^{-\sigma}\right] = 0$$

Which is equation (2) in Section 2 and it is also independent of wealth.