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Saving Rates and Savings Ratios

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Abstract

The flow of savings as a fraction of disposable income (*saving rate*) and the stock of savings as a fraction of total wealth (*savings ratio*) are tightly connected. We use a standard dynamic model to show that they may move in opposite directions when financial and/or human capital change dramatically. Making this link theoretically explicit provides an internally consistent measure of savings ratios based on saving rates and other publicly available data. We implement this measure for the four largest economies: U.S., China, Germany and Japan, and identify periods in which saving rates and savings ratios have moved in opposite directions. We find that those departures are not explained by capital gains, but instead by changes in the value of human capital.

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1 Introduction

In the last 20 years there has been an intense debate about the evolution of individual and aggregate savings. While some countries, such as China, appear to be experiencing saving gluts, large western economies appear to have embarked in dearths of savings. These trends have drawn the attention of academics and policymakers alike, mostly because declining household saving rates seem puzzling when confronted to evidence of substantial contemporaneous increase in household wealth. A clear example is the unprecedented increase in U.S. household's net worth (from five to seven GDPs since the eighties), accompanied by drastic decline in saving rates (from 15% to 5% of GDP since the eighties). Are then households saving more or less? Is this pattern special to the U.S.?

In this paper we clarify that there are two concepts of savings that are closely related, but capture different phenomena and can be moving in opposite directions. One is the propensity to save out of disposable income, or *saving rate*. This rate has been measured for many years in almost all countries using standard national accounting techniques. Thus, it is easily comparable over time and across economies, becoming the main input in the discussions about savings. The other is the propensity to save out of total wealth, which we call *savings ratio*. Despite being tightly linked to fundamental saving motives, this ratio have not been measured consistently over time and across countries, mostly in response to the lack of a common methodology to measure total wealth, human and non-human. We show how its measurement helps to make sense of apparently puzzling observations related to wealth and saving rates, in the U.S. and in other countries.

We use a standard dynamic consumption model to theoretically link these two concepts of savings. We clarify under which conditions they move in opposite directions, so there is neither a puzzle nor reasons to be confused about a joint reduction in saving rates and rising financial wealth. Intuitively, households target a level of financial assets that depends on their total wealth, present and future. When present wealth increases (because of *capital gains* for instance), or when future wealth rises (because *the value of future human capital* improves), agents rely less on delaying current consumption to achieve their desired level of savings. We show that indeed saving rates are a good proxy for the evolution of savings ratios *only* when the price of current assets and the present value of future human capital are stable.

To see this more clearly, consider a stationary economy where agents save 10% of their income every period so to target a level of savings as a fraction of total wealth. If agents experience capital gains, they have been saving relatively too much, and will react by reducing their saving rate below 10% for some time. Similarly, if agents believe that their future human capital will increase, leading to more income than expected, saving so much from current income is not needed, reducing again their saving rate below 10%. Thus, there are situations where savings ratios remain at the same level while standard measures of saving rates decline.

The second benefit of clarifying the theoretical linkage between the two concepts of savings is to highlight how to construct measures of savings ratios that are internally consistent both with saving rates and with the key components of wealth (namely financial and human capital) that affect saving decisions. To implement this theory-based measurement method, we quantify the link for the U.S. economy, which provides rich and abundant publicly available data, and has been the subject of extensive discussions. We show that despite the much debated fall in saving rates in the U.S., Americans have been steadily increasing their savings ratio for the last 40 years. This result is indeed remarkably consistent with alternative, micro-data based, methodologies proposed in the literature.

The third benefit of our exercise is to determine which of the main wealth components, capital gains of human capital present value, was the most relevant in explaining the joint dynamics of saving rates and savings ratios.[1] The capital gain component has received some recent attention. Fagereng et al. (2019) and Robbins (2019), for instance, adjust saving rates by redefining income to include capital gains and find that this explicit change in measurement helps to adjust saving rates upwards, but not dramatically.[2] We also find that capital gains help to explain the decline in saving rates and their departure from savings ratios, but not enough to capture their opposite trend. Indeed, we find that the main driver in the saving rate moving in opposite direction to the savings ratio is the sharp increase in the present value of human capital, primarily determined by the decline in interest rates. These findings are also in line with Lustig, Nieuwerburgh, and Verdelhan (2013), who were the first to point out the sharp increase in the U.S. wealth-consumption ratio and the key role

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

[2]Straub (2019) goes beyond this approach and analyzes the impact of heterogeneity in observed savings through capital gains.

played by human wealth. They do so, however, by appealing to a rich data set of individual behavior. It is reassuring that our estimates are consistent while relying on standardized publicly available aggregate data and a methodology that can be easily extended to many economies so to perform cross-country comparisons.

To show the applicability of our methodology we also compute savings ratios for China, Japan and Germany, which together with the U.S. represent approximately 50% of the world GDP. These measures are then comparable across countries. Unlike the U.S., we find that both measures of savings move in the same direction for Japan (downwards) and Germany (upwards). Thus, although discrepancies can arise between saving rates and savings ratios, that is not necessarily the case. However, when analyzing China, a different pattern emerges: while the saving rate has remained steadily high for the last 20 years, the savings ratio has steadily declined. There is, however, a common pattern across all these countries: *the present value of human capital is the dominant component in determining the evolution of saving rates*. For instance, had human capital maintain its value, U.S. and Germany would have displayed saving rates of around 35%, while China and Japan would have experienced slightly negative saving rates. Hence, in absence of changes in the present value of human capital, driven in western countries by a reduction in interest rates and in eastern countries by a decline in growth rates, the international flow of capital could have been very different, with eastern economies borrowing from western economies.

Related Literature: There is an extensive literature addressing the movements of the aggregate saving rate in the U.S. The first paper noting its fall 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] This observation sparked a rich literature on the causes of declining saving rates. Given the aforementioned inconsistency with the evolution of wealth, one approach was refining the measurement of saving rates.[4] 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 proposed adjusting for changes in TFP, Chen, Imrohoroglu, and Imrohoroglu (2006b), and reformulating NIPA calculations, Boskin (2009). Here we clarify that there may not be any inconsistency in how we measure saving rates, but instead that those mea-

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

[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).

sures capture a different aspect of the increase of savings.

Summers and Carroll (1987)′ observation also sparked a rich literature on the economic consequences of declining saving rates and the implied policy responses, ranging from the impact on growth, such as Campbell (1987); Attanasio (1994); Nordhaus (1995); Gokhale, Kotlikoff, and Sabelhaus (1996); Attanasio (1998) and Parker (1999), to the impact on wealth inequality more recently, such as Gomez (2017), Karabarbounis and Neiman (2019), Fagereng et al. (2019) and Robbins (2019).[5] While our work is silent about the macroeconomic effects of a reduction in saving rates, we clarify that savings may instead have investment implications through valuation effects.

The U.S. case was not an exception. Similar controversies took place in other countries. The high saving rates observed in Japan until 1980 and the subsequent fall also sparked a literature trying to understand the observed patters, as surveyed by Horioka (1990). Given the large differences in economic performance between Japan and the U.S. Hayashi, Ito, and Slemrod (1988) discussed how puzzling it was the similarities in the evolution of saving rates. This inconsistency was finally settled by Chen, Imrohoroglu, and Imrohoroglu (2006a), who show the important role played by TFP. In this paper we also show the relevance of the pattern of grow and convergence to a steady state on shaping the observed saving rates. In China, in contrast, the debate has been about the persistently high observed saving rates. Explanations that range from demographics (Curtis, Lugauer, and Mark (2015)), the one child policy (Choukhmane, Coeurdacier, and Jin (2013)) and insurance motives (Imrohoroglu and Zhao (2018)) have been proposed. This literature is in general puzzled that a fast growing economy as China saves instead of borrow. With our methodology we uncover a decreasing savings ratio in spite of the high saving rate, exactly as predicted by the theory. Moreover, we show that without the implied changes in human capital, China would have indeed borrowed instead of saving.

Reconciling apparently contradicting signals from saving rates and wealth is relevant beyond clarifying their relation. It is also relevant, for instance, to qualify the related discussion about the role of life expectancy on savings. The view that higher life expectancy in the U.S. implies an increase in savings has been usually challenged, and sometimes outright discarded, because they are at odds with declining saving

[5]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).

rates.[6] 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 savings have been increasing when measured as a ratio of total wealth. [7]

There is also an evolving literature studying how the development in financial markets impact savings. 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 on the trend of loosening credit played a large role in the recently, and relatively short-lived, saving rate rise after the Global Financial Crisis. Ordonez and Piguillem (2019) and Eggertsson, Mehrotra, and Robbins (2019) combine the demographic and financial drivers of savings in the same setting, also claiming that savings out of wealth in the U.S. should have increased in recent decades. In this paper we show, indeed, that the valuation of assets and human capital closely follows movements in interest rates and affect both saving rates and savings ratios consistently with standard dynamic macroeconomic theory and with the data.

2 The link between saving rates and savings ratios

In this section we first use a standard dynamic consumption model to derive the theoretical relation between savings out of disposable income, what we call *saving rate* and savings out of total wealth, what we call *savings ratio*. We then exploit this theoretical relation to propose a methodology for their measurement.

2.1 Savings ratios

Time is discrete and continues forever. The economy is populated by households who can save using a risky asset a, subject to *i.i.d.* idiosyncratic risk, and a risk-free asset b.

[6]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.

[7]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 these predictions, though seemingly inconsistent with observed saving rates, are indeed consistent with savings ratios.

There is no aggregate risk, so average prices are deterministic. Assuming households have CRRA preferences, their problem is:

$$\max_{\{c_t, a_{t+1}, b_{t+1}\}t_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma}$$

subject to the per-period budget constraint,

$$c_t + a_{t+1}p_t + b_{t+1} \leq \pi_t^i a_t p_t + R_t b_t + w_t,$$

where c_t is consumption, 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), R_t is the relative price of the risk-free asset, p_t is the relative price of the risky asset (introduced to capture capital gains) and π_t^i their idiosyncratic return (composed by capital plus dividends). The expectation operator is then over these idiosyncratic shocks. We introduce idiosyncratic shocks to generate a non-degenerate portfolio, with both risky and risk-free assets. In what follows we simplify notation by assuming that $\pi_t^i = (1 + \pi_t)\epsilon_i$. We show in Appendix A that the distribution of the stochastic process for ϵ_i is inconsequential to our results as long as it is *i.i.d.* over time.

As standard in the literature, we proceed by solving this problem appealing to the permanent income hypothesis. To that end, we define human wealth, h_t in period t, as the discounted sum of future wages from period t on:

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

Households maximize the present value of utility subject to the budget constraint and the *natural debt limit*, i.e., $b_t \geq -h_t$ in each period, i.e., households can borrow up to the present value of their human capital.

We can define household i's total wealth in period t as

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

In Appendix A we formally prove that the solution has the form:

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

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

The factor s_t is the saving rate out of total wealth, what we call *savings ratio*. We denote the proportion of savings allocated to the risky asset as ϕ_t. Notice that both s_t and ϕ_t are independent of the consumer's wealth and income. This follows from the fact that preferences are homothetic and idiosyncratic shocks are *i.i.d.* These assumptions are useful for tractability, but not fundamental for the results. Relaxing them would maintain the structure of equations (3) and (4), but with the savings ratio potentially depending on shocks and/or wealth.

Intuitively savings are determined by households optimizing by choosing what proportion of total wealth to consume today and which proportion to leave for the future. In this sense, households are not concerned about how much they save out of income in the period, but instead about the growth rate of total wealth. Indeed, as we show formally in Appendix A, a household who has wealth W_t^i in period t, chooses financial assets such that in period $t+1$, and upon the realization of a future shock π'_{t+1}, total wealth satisfies:

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

Hence, the choice of s_t guarantees that **total** wealth grows at the optimal rate, combining the observed growth in financial wealth and the needs to save. Intuitively, if a household experiences at period t an increase in the value of its financial assets (an increase in p_t) or an increase in its human capital (an increase in h_t) that increases its total wealth, the optimal rule (3) implies that the household would consume a fraction $1 - s_t$ of such higher wealth. If the income at period t does not change, there would be a decrease in savings out of income while maintaining constant savings out of wealth. In what follows we show the explicit relation between the *savings ratio* that the theory predicts at the center of households' choices and the commonly measured savings as a fraction of income, or *saving rate*.

What determines savings ratios? We can rewrite s_t recursively

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

where $r_{t+1} = \phi_t \pi_{t+1} \frac{p_{t+1}}{p_t} + (1 - \phi_t) R_{t+1}$ from equation (5). The stationary solution is,

$$s = \beta^{\frac{1}{\sigma}} [\mathbb{E} r^{1-\sigma}]^{1/\sigma}. \tag{6}$$

Stationary savings ratios are determined by the usual suspects: discounting, precautionary motives and intertemporal smoothing. *Discounting* is captured by the discount factor β. If $\sigma = 1$ (log utility), for instance, $s = \beta$ (indeed this is the case even outside the stationary equilibrium). But in general, and regardless of σ, the larger is β (capturing for example an increase in life expectancy) the more households want to save out of total wealth. *Precautionary motives* are captured by Jensen's inequality and determined by the strength of risk aversion σ. Given the variance of r, the larger is σ the more households want to save out of total wealth to smooth consumption across states. Finally, *intertemporal smoothing* is captured both by expected returns and σ, which also determines the intertemporal elasticity of substitution with CRRA preferences.[8] When returns are expected to be high in the future (conditional on $\sigma > 1$), the less households want to save out of total wealth.

When these fundamental drivers of savings change, we can then expect changes in savings out of total wealth, but under what conditions we can assess those changes purely by observing standard measures of savings out of disposable income? In what follows we obtain the theoretical counterpart for saving rates and the explicit linkage with savings ratios.

2.2 Saving rates

Let average income be $y_t = \pi_t a_t p_t + (R_t - 1) b_t + w_t$. Since we are abstracting from taxes, we can think about R_t and w_t as after-tax prices, so that y_t is also disposable income. Using this definition, we can rewrite the budget constraint as:

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

[8]Notice that the returns component can be written as $\left([\mathbb{E} r^{1-\sigma}]^{\frac{1}{1-\sigma}} \right)^{\frac{1-\sigma}{\sigma}}$. Thus, $[\mathbb{E} r^{1-\sigma}]^{\frac{1}{1-\sigma}}$ (certainty equivalent) captures the role of σ affecting risk aversion, and the remaining part the role of σ as the IES's inverse. See Angeletos (2007) for an extension to an environment with Epstein-Zin preferences.

Commonly, the saving rate out of disposable income, s_t^d, is measured as:

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

Using the budget constraint, together with the wealth equation (2) and the consumption equation (3), the law of motion of assets becomes:

$$\begin{aligned} p_t a_{t+1} + b_{t+1} &= s_t W_t - h_t \\ &= s_t[a_t p_t + b_t + y_t + h_t] - h_t. \end{aligned}$$

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 obtain the explicit relation between the saving rate (s_t^d) and the savings ratio (s_t) as:

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

While s_t^d is measured frequently, s_t is not readily available and comparable across countries, which is unfortunate given it provides a more direct link to fundamental saving motives. We can, however, back out s_t by adjusting the measure of s_t^d with information about the evolution of $a_t p_t + b_t$ (households' net worth) and h_t (approximated by the present value of households' future labor income, discounted at the risk-free rate). This adjustment comes from rewriting equation (9) as follows:

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

This equation clearly shows the conditions under which we can use standard saving rates measures to draw conclusions about savings out of total wealth. If $a_t p_t + b_t$ (financial capital) and h_t (human capital) are stable, the dynamic properties of s_t carry over to implications for s_t^d. In this case, both measures provide consistent information about potential drivers of savings. However, if either financial or human capital change over time, the mapping is no longer valid and drawing conclusions from the observation of s_t^d could be misleading about s_t. Agents could be saving more out of wealth even when they are saving less out of disposable income, and viceversa.

Notice that the mapping between savings ratios and saving rates is just an accounting identity. Indeed, if we just define savings ratios as $s_t = 1 - \frac{c_t}{W_t}$ and saving rates as $s_t^d = 1 - \frac{c_t}{y_t}$, then it is clear that:

$$s_t^d = 1 - (1 - s_t)\frac{W_t}{y_t},$$

and that a decline in s_t^d can be generated by a decline of s_t but also by an increase in s_t if accompanied by a strong increase in $\frac{W_t}{y_t}$. Indeed, we can recover this exact identity if, in equation (9), we include y_t in the definition of wealth.[9]

Our theoretical framework, however, is useful for two reasons. First, it allows us to derive an internally consistent factor χ_t that links s_t^d and s_t and that can be easily decomposed into *capital gains* and *human capital* (discounted future labor income). This decomposition reveals that wealth is more than net worth, hence it is not possible to make inferences about saving decisions just by combining the evolution of saving rates and of financial wealth. As the present value of future human capital enters into the definition of wealth, observing a growing net worth ratio is not enough to conclude that households are saving more, as increasing net worth and falling savings ratios are perfectly consistent with a decline in savings out of wealth properly defined. Second, it delivers a theoretical structure to use data commonly available in National Accounts and Flow of Funds to measure s_t without resorting on measuring W_t directly, then being amenable to comparing the evolution of s_t in relation to s_t^d across countries.

In the next two sections we use standard and publicly available data in the U.S. and other large economies to show that savings ratios and saving rates have gone in different directions in some of the largest economies during the recent decades, and we decompose the forces behind that result. But first, we conclude this section with a discussion of the robustness of these results to possible generalizations.

[9] We thank an anonymous referee for proposing this simple expression.

2.3 Robustness considerations

The reader may be concerned that the link we uncovered between savings ratios and saving rates may not be robust to natural generalizations. In this section we address the potential concerns of interpreting this link in the presence of idiosyncratic labor shocks, heterogeneity on optimal saving rates and alternative income definitions.

2.3.1 Idiosyncratic labor income risk

We have considered idiosyncratic risk to financial assets. How does the possibility that human capital is also risky affect savings? Assuming, for instance, that labor income follows a log-normal distribution with standard deviation σ_w, the savings ratio can be closely approximated by:

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

which is closely related to equation (6) and lends itself to analogous interpretations. An increase in labor income risk, for example, leads to more savings out of wealth due to a strengthening of a precautionary saving motive. This is, again, not necessarily reflected in saving rates.[10]

2.3.2 Savings heterogeneity

As equation (6) shows, heterogeneity in discount factors, β, risk aversion, σ, and even permanent differences in returns, could generate heterogeneous savings ratios, s_t. Does this heterogeneity interact with aggregation? To see this, suppose that individuals are indexed by a permanent heterogeneous component j, so that:[11]

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

Then, aggregate savings satisfies

[10]The above approximation is valid only for agents who are not constrained. For agents who are close to borrowing limits (or who are at their borrowing limit), the previously derived savings ratio no longer holds. But, since those agents have little or no wealth, their weight on the aggregate is negligible. This is similar to the findings in Krusell and Smith (1998), who show approximate aggregation.

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

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

Given the correlation $\rho_{s,\chi}$ between savings ratios and wealth components (financial assets and human capital), more dispersion in either of its components should generate larger observed saving rates, with this effect reinforced as the correlation increases.[12]

2.3.3 Alternative income definitions

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 that in National Accounts, 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 measure of savings out of income but does not change any of the insights and the relation between savings ratios and saving rates. In what follows we focus on the net rate because it is the standard measure in National Accounts, it is implied by the theory, and it is not directly affected by details in measuring realized capital gains.

3 Measuring savings ratios and saving rates in the U.S.

While saving rates, s_t^d, is a standard, widely available and uncontroversial measure across countries, we will use equation (10) to back out the implicit savings ratios s_t. The main challenge is to measure the valuation of financial and human capital

[12] The sign and magnitude of this correlation is not without controversy. There seems to be positive correlation between saving rates and total net worth, as shown by Dynan, Skinner, and Zeldes (2004). However, Bach, Calvet, and Sodini (2017), who define savings with respect to financial net worth, found a negative correlation in Swedish data.

embodied in χ_t. In this section we describe in full detail how to perform this task with widely available and well understood data for the U.S. economy. Then, in Section 4 we describe the necessary modifications to make this methodology easily applicable to other countries.

3.1 Measuring capital gains.

Defining net worth as $N_t = a_t p_t + b_t$, as in equation (10), we compute here the component $\frac{N_t}{y_t}$ in χ_t. We obtain N_t from Table B.101, line 40, of the Flow of Funds and y_t from NIPA Table 2.1, line 27. The evolution of this ratio is shown in the first panel of Figure 1. From the evolution of net worth, we can compute the implied capital gains in household balance sheets. Table F6 line 1 of Flow of Funds provides the net acquisitions of financial assets by households in period t, defined as $dN_t = N_{t+1} - N_t$. 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

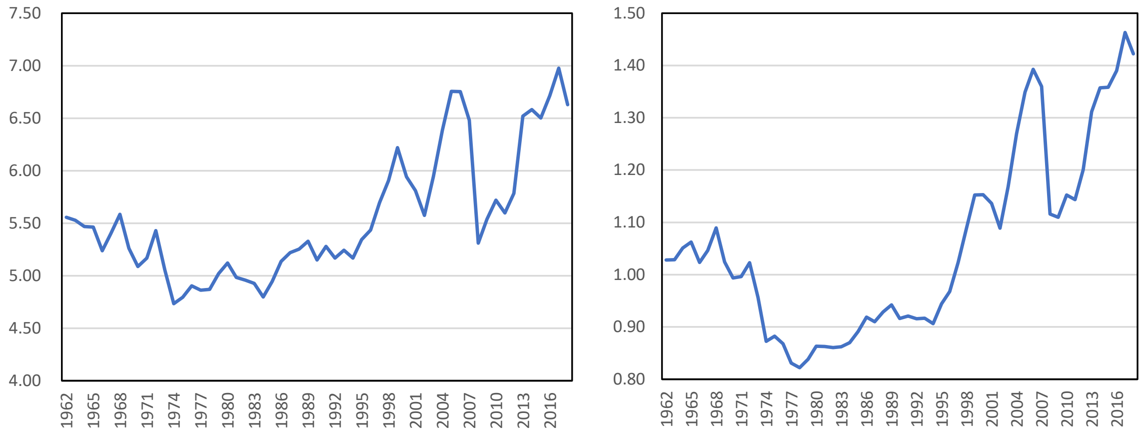
$$p_t = \frac{N_{t+1}}{\tilde{N}_{t+1}} = \frac{N_{t+1}}{dN_t + N_t}.$$

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 1. From 1980 to 2018 there was an estimated capital gain of around 65%. We will evaluate later the extent to which observed saving rates can be accounted for by these capital gains.

3.2 Measuring human capital.

To recover the savings ratio s_t, we also need to compute the second component of χ_t for each t, which corresponds to human capital, h_t. Calculating it requires two elements: the expected future income and a risk-free rate. As our model is based on

Figure 1: U.S. net worth and capital gains



(a) *Net Worth* (b) *Capital Gains*

real variables in a stationary environment, let $\tilde{R}$ be the gross nominal interest rate and ρ the inflation rate, so real rates are $R = \tilde{R} - \rho$. 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 $\widehat{h} = h/y$ is:

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

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

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

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, $(1 - \alpha_t)$, a risk-free nominal gross rate, $\tilde{R}_t$, and the growth rate of nominal per-capita disposable income, $\tilde{g}^y_t$. 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 27 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.[13]

Regarding the nominal interest rate $\tilde{R}$, a natural candidate is the return on Treasuries. The problem with using the gross return on government bonds is that on average $\tilde{R} - \tilde{g}^y < 1$. This generates confusion as it would imply infinite human capital. This problem also hints to the fact that the return on Treasuries probably do not accurately reflect the true household's intertemporal opportunity cost of human capital, which is riskier and less liquid than government bonds. Hence, in what follows, and as a benchmark, we use instead the corporate bond rate Baa from FRED, which are riskier and less liquid than Treasuries (replicating better the accumulation of human capital) and which ensures that in most periods $\tilde{R} - \tilde{g}^y > 1$. While this return has the benefit of being a standard measure available since 1960, one potential concern is that may not be risky enough to capture the risk embedded in human capital. For this reason, in Figure 7 of Appendix B we present alternative measures of human capital using *30-year mortgage fixed rate* (available since 1971 and captures one of the main saving instruments, and then source of aggregate risk, for U.S. households) and the *BofAML High Yield* (available since 1986, and much riskier than Baa corporate bonds). These alternative specifications make clear that the specific interest rates we use to discount just affect the level of the savings ratio, not its evolution.

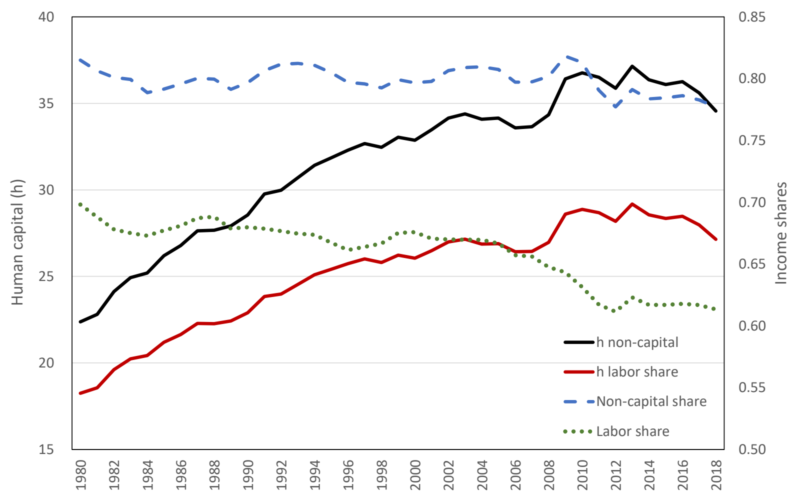
Finally, to make equation (11) operational we would need infinite periods. To overcome this issue, we assume a final value for $\widehat{h}$ using a steady state approximation. In steady state, it should be true that $\widehat{h} = \frac{(1-\alpha)}{\tilde{R}-1-\tilde{g}^y}$. We use data up to 2018, and thus assume that in 2019 the final value for $\widehat{h}$ is the steady state formula $\widehat{h} = \frac{(1-\alpha)}{\tilde{R}-1-\tilde{g}^y}$, where all variables are computed as the average of the last ten years (the average in the period 2008-2018). Using (11) we can compute the implied values for $\widehat{h}_t$ 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 human capital as a fraction of income, $\widehat{h}$, is depicted as a continuous black line in Figure 2. The most important insight is that it experienced a steep increase. As the underlying "labor share" (blue dashed line in Figure 2) is stable and around 80% this increase is mostly explained by the fall in interest rates experienced in this period, which increases the present value of labor income. Intuitively,

[13]NIPA only provides information about the total taxes paid by households, without separating the sources of taxable income.

when interest rates fall, households can borrow the value of its future labor income proceedings at a cheaper rate, increasing their current wealth.

Figure 2: U.S. labor shares and human capital



Comparing our estimations of financial and human capital sheds light on the appropriateness of the discount rate. If all sources of income are discounted at the same rate, the ratio of human to physical capital should be around $\frac{1-\alpha}{\alpha} \approx 5$. A simple comparison of the scales in figures 1 a) and 2 shows that indeed the computed human capital is around five times the measured net worth. This measure is a preliminary hint that focusing purely on the evolution of financial net worth to make sense of decline in saving rates misses the largest component of wealth, which is the present value of human capital. We will delve more formally into this decomposition later.

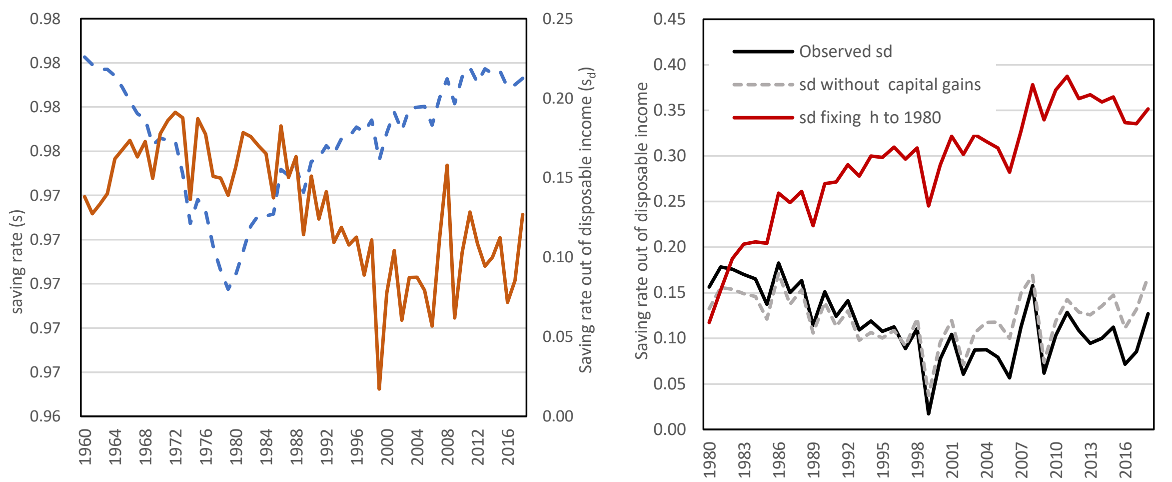
Remark on the measure of labor share: We obtain a large increase in human capital, so one may wonder whether this is partly due to the stable pattern of labor share that we measure using the non-capital share. This may be a concern considering that Karabarbounis and Neiman (2014), among others, have documented a steady decline in the labor share using instead compensation to employees directly. This alternative is shown by the green dashed line in Figure 2, with a sharp decline from almost 70% in 1960 to almost 60% in 2010. The evolution of human capital computed under this alternative labor share is depicted by the red solid line in Figure 2. Even though the alternative tames somewhat the growth of the present value of human capital, it does not revert its strong increase. As in Lustig, Nieuwerburgh, and Verdelhan (2013), *the large increase in human capital is driven by the interest rate, not the labor share.*

We maintain here our benchmark computation because most, if not all, government transfers that we allocate to labor are returns to human capital.[14]

3.3 Comparing savings ratios and saving rates in the U.S.

Now using standard measures of saving rates, s_t^d and the two components of χ_t that we have obtained above, we can compute savings ratios, s_t, from equation (10). The comparison between savings ratios and saving rates can be seen in Figure 3 (a). The orange curve is the standard measure of saving rates and the blue line is our theory-based measure of savings ratios considering both financial and human capital gains. It is clear from it that the savings ratio has been increasing since 1980, while the saving rate has been continuously falling. This figure shows that, despite an extensive literature trying to explain why U.S. households are saving less, in fact they have been saving more out of their total wealth.

Figure 3: Saving rates and savings ratios



(a) Measured Savings (b) Counterfactual saving rates

To understand the roots of the opposite behavior between savings ratios and saving rates we perform a series of counterfactual exercises that consists in asking what saving rates s_t^d we would have observed absent financial and human capital gains, while

[14]As stressed by Karabarbounis and Neiman (2019) the presence of "factorless income" generates some complications when defining income shares. Oftentimes it is not clear what is the appropriate treatment. In our case, since these government transfers are not originated in previous financial investments, the imputation to human capital seems quite natural.

maintaining savings ratios, s_t fixed. From equation (10), s_t^d is related to s_t by

$$s_t^d = (s_t - 1)\chi_t + s_t. \tag{12}$$

Thus, given s_t, alternative measures of χ_t would have generated a saving rate different than the one depicted in the blue line of Figure 3.(a).

In scenario 1) we eliminate financial capital gains when computing χ_t. The counterfactual s_t^d is plotted in Figure 3 (b) with the grey dashed line. Without capital gains, the U.S. saving rate would have behaved very similar to the realized one (the black line that replicates the orange line in Figure 3 (a)). In the last two decades, however, saving rates would have been three percentage points higher (reaching 15% instead of 12% in 2018). Intuitively, without capital gains households would have needed to save more to reach their desired savings ratios.

In scenario 2) we eliminate human capital gains (fixing $\widehat{h} = \widehat{h}_{1980}$) in the computation of χ_t. The counterfactual s_t^d is plotted in Figure 3 (b) with the continuous red line. Without an increase in the present value of human capital, much more savings out of income would have needed to reach the desired savings ratios, increasing sharply over time, from around 12% to 35% in 2018.[15] Intuitively, without the large increase in the value of human capital, households would have needed to save substantially more income to reach their desired levels of savings. But since the human capital sharply increased, that was not necessary and saving rates indeed declined.

4 Global savings ratios and saving rates.

Our theory-based method to measure and decompose the difference between savings ratios and saving rates use information that can be obtained from most countries' official and public datasets. Hence, we can now apply it to understand saving patterns, and their determinants, in the other three largest developed economies in the world: China, Germany and Japan, which together with the U.S. account for 50% of the world GDP.

Even though our methodology does not require sophisticated data, still some complications arise due to the idiosyncrasies of each country. For Japan and Germany the

[15] 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%.

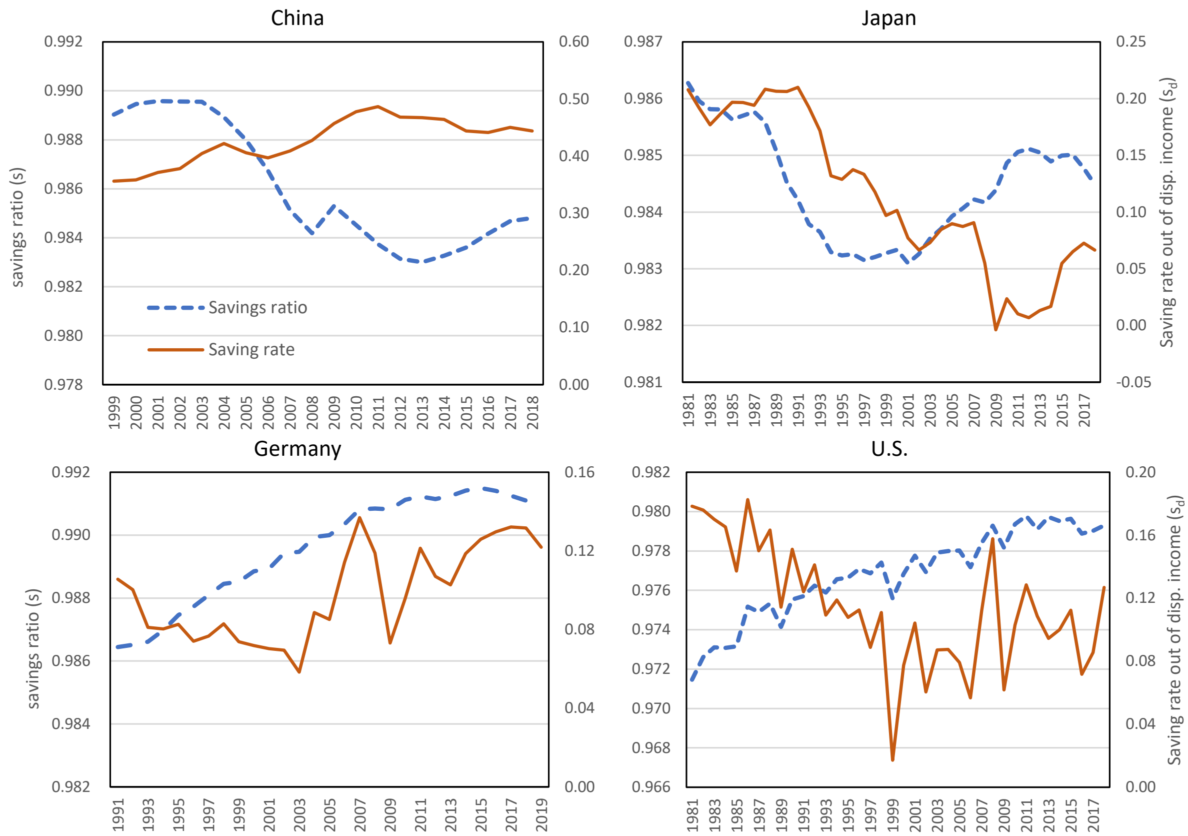
application of the methodology is straightforward, even though for Germany we can only obtain consistent results since its 1991 unification. For China, instead, there are some additional complications. First, our approach requires the valuation of household's net worth, which is not officially computed by the Chinese official statistics offices. Second, China has just recently emerged from a long phase of financial repression, which implies that data for interest rates and returns are either scarce or not necessarily reflecting market valuations. To deal we the first issue we use the net worth estimates in the "Chinas National Balance Sheet 2020" published by the National Institution for Finance & Development.[16] Regarding interest rates, there is no analogous to the Baa use in Section 3 for China. WIND provides the "*Chinese Corporation BBB+*," but only for the period 2009-2020. To extend the series further back in time we use, also from WIND, the average mortgage rate plus a spread of 5%, which was the spread observed in the period with both series available. Since before 1998 mortgages were illegal in China, we could only construct the series from that year onwards. We summarize all datasets in detail in Appendix C.

In Figure 4 we present the results, together with the previous U.S. computations focusing on the years after 1980. The first obvious pattern to notice is that in Germany and Japan both savings ratios and saving rates move in the same direction in most of the sample period, both increasing in Germany towards the second part of the sample and both decreasing in Japan towards the first part of the sample. This result illustrates that, even though both measures could deliver different patterns, as in the U.S., that is not necessarily the case. China exhibits a pattern, although in a shorter period, that is more in line with the U.S. but also in the opposite direction: an increase in saving rates but a reduction of savings ratios, just with a recent slight reversal.

There is also an interesting contrast in terms of our estimated evolution of savings ratios between the two western countries (the U.S. and Germany) and the two eastern countries (China and Japan). While savings ratios steadily increase in the western countries, until they stalled in the last decade, in the eastern countries the savings ratios declined initially in the respective sample period, and reverted during the last decades. This evolution is consistent with the U.S. and Germany being in a stationary path in the considered period, while China and Japan experiencing a transition with high initial economic growth in the sample to less stark growth levels.

[16] These are only printed publications, thus the data is not available on digital format, so we have manually collected it.

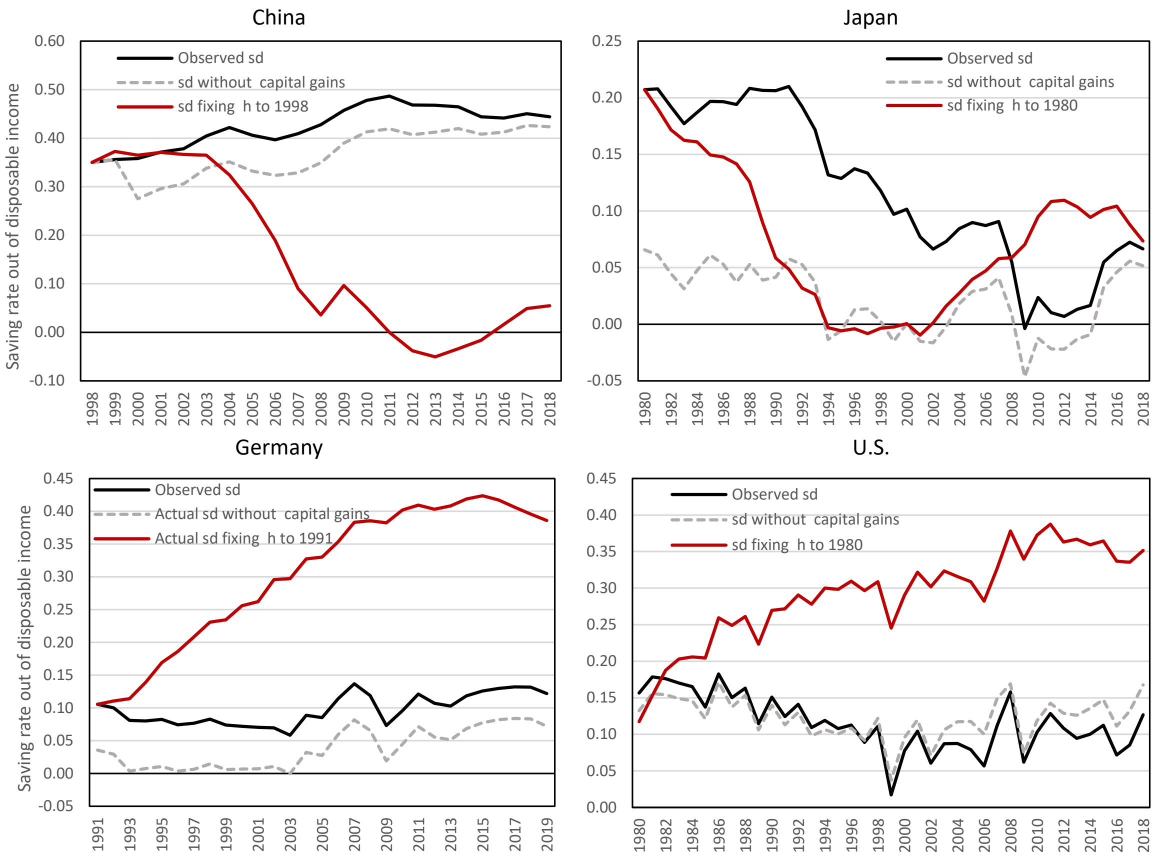
Figure 4: Savings in the largest economies



Explaining why the savings ratios in the U.S. and Germany are increasing is beyond the scope of this paper, but we can find hints in equation (6). An important reason to save is retirement: the risk of living a long life together with the associated potential health care cost would drive agents to save more out of total wealth during their working lifetime. This effect could be thought as captured by an increase in the discount factor β, which should drive savings up in economies with stationary growth, such the U.S. and Germany in the considered period. On the flip side, China and Japan exhibit mostly decreasing savings ratios in the periods coinciding with fast growth. This pattern is consistent with a transition towards higher development stages and expectations of future higher returns, as is also clear from the smoothing-motive component in equation (6). In fact, both eastern countries experienced a reversion of savings ratios when growth rates drop, immediately after the 1989 crisis in Japan and after the 2011 crisis in China.

Shortly, our methodology allows us to conjecture that, while *discounting* forces (related to life expectancy) that induce more savings are quite relevant in western countries with steady growth, they were temporarily overcome by *intertemporal smoothing* forces given by unprecedented growth rates in eastern countries transitioning towards higher development stages.

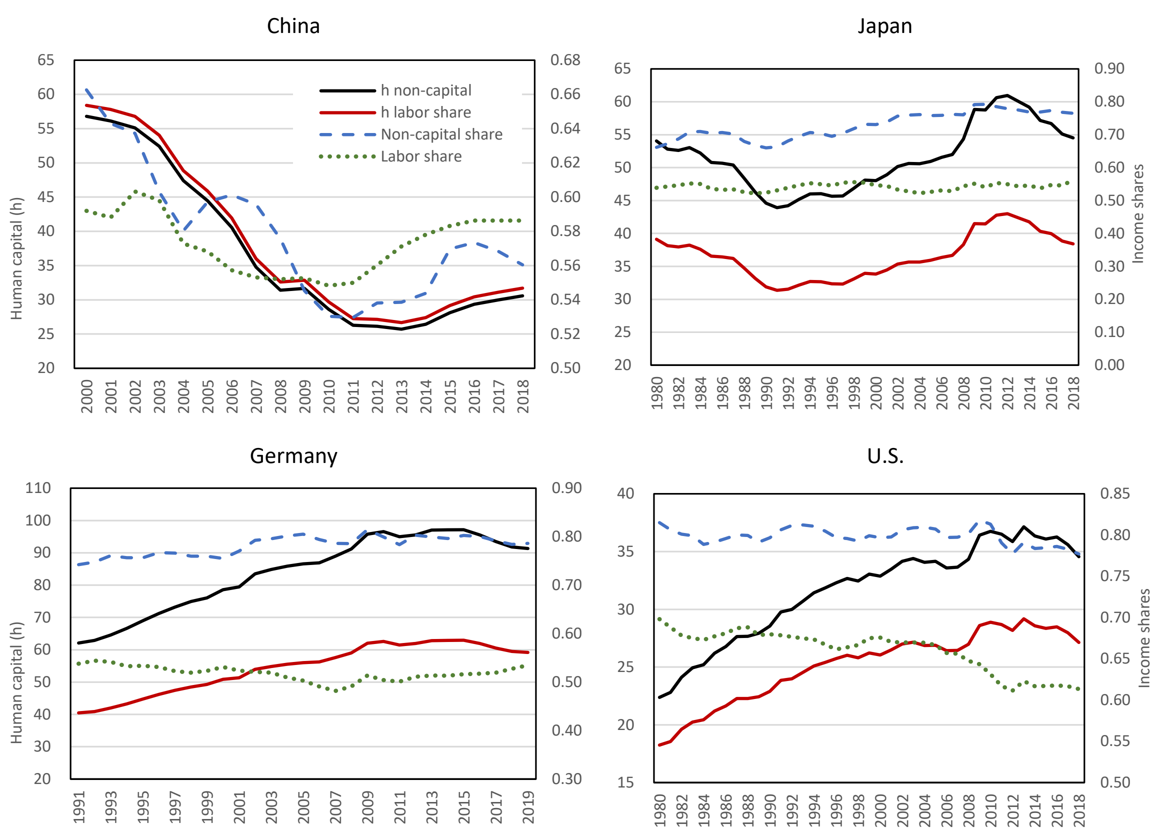
Figure 5: Counterfactual saving rates in the largest economies



As in Section 3.3, we can also perform counterfactual exercises using the relation in equation (12) to understand the relevance of human and financial wealth on the relation between savings ratios and saving rates. Figure 5 makes clear that the critical role played by the present value of human capital in the behavior of savings is not an exception for the U.S. economy, but just a realization of a more general pattern. In all four economies had human capital remained constant, all saving rates would have behaved very differently. Our two western economies would have shown significantly higher saving rates (similar to the high saving rates observed in China), while the two eastern economies would have experienced periods of negative saving rates, borrowing and consuming above output. In few words, without changes in the wealth assigned to human capital, western economies would have used much more of their disposable income to save, while eastern economies would have used more of their income to consume, potentially changing the observed direction and magnitude of international financial flows, from western to eastern economies.

While the uncovered pattern in the German economy follows closely the intuition in Section 3.3 regarding the U.S, the cases of China and Japan deserve further discussion. As we show in Figure 6, in China and Japan the present value of human capital has gone down rather than up. To understand the differences is useful to refer back to the equation of human capital in steady state, $\widehat{h} = \frac{(1-\alpha)}{\tilde{R}-1-\tilde{g}^y}$, implied by equation (11). In a nutshell, the value of human capital increases when labor becomes more important in production, the share $1-\alpha$ increases, or when its return *net of growth*, $\tilde{R}-\tilde{g}^y$, drops and agents can borrow more from future wages.

Figure 6: Value of human capital in the largest economies



The increase in the value of human capital, both in the U.S. and Germany, is explained almost completely by the fall in interest rates during the nineties and early

2000s, which stabilized at low levels after 2010. In this sample period both western economies were stationary, with small changes in labor shares and growth rates. Japan followed a similar pattern with the exception of the eighties, when the country suffered a slow down in economic growth, and then an increase in interest rates net of growth that led to a decline in the present value of human capital in that period. To explain the large decline in the value of human capital for China, however, is more challenging as the three elements we identified as critical, labor share, interest rates and growth, declined. During the sample period we consider, however, labor shares only declined by around 10%, while growth rates declined more than interest rates, exhibiting rates net of growth that increased by almost 100%.

The takeaway from this sample is that changes in the present value of human capital have a dominant impact on the relation between saving rates and savings ratios. Since human wealth represents more than 80% of total wealth, and since its present value gets determined both by changes in interest rates and in expectations of future economic growth, how it evolves have important quantitative consequences for the international flow of capital and large implications on how we interpret saving rates to draw conclusions about the needs and demand for savings.

5 Conclusions

Using standard measures of saving rates (i.e., savings out of income flows) to infer savings ratios (i.e., savings out of wealth stocks) is misleading. The main reason is that households adjust their savings each period to accommodate capital gains and the present value of future expected changes in human capital. We have made the relation between saving rates and savings ratios theoretically explicit and used this theoretical link to propose an internally consistent measure of savings ratios using publicly available data about saving rates.

By clarifying these relations formally, our results highlight two important caveats when making inferences about savings in an economy. First, and perhaps well-understood intuitively, it is important to consider the joint evolution of saving rates and wealth. Second, the evolution of wealth should account for both financial wealth (net worth) as well as the present value of future human capital wealth. This second component is the largest for the determination of total wealth, but usually disregarded given the lack of an immediate data counterpart. Our paper provides a simple way to relate and compute all these elements.

We have applied this theory-based measure to compute savings ratios in the four largest economies: U.S., China, Germany and Japan. Our measure shows that saving rates and savings ratios can move in opposite directions when capital gains and human capital values change dramatically. We use our construct to decompose the forces behind the evolution of this linkage, and show that, absent capital gains, standard measures of saving rates would have been slightly higher in the last two decades, but absent changes in the present value of human capital (partly induced by valuation at lower rates) saving rates would have increased sharply since 1980 in the two western economies and declined in the two eastern economies until recently.

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Appendix

A Model's solution

The first order condition generates:

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

$$p_t (c_t^i)^{-\sigma} = \beta p_{t+1} \mathbb{E}_{i'} \pi_{t+1}^i (c_{t+1}^{i'})^{-\sigma} \tag{13}$$
$$(c_t^i)^{-\sigma} = \beta R_{t+1} \mathbb{E}_{i'} (c_{t+1}^{i'})^{-\sigma} \tag{14}$$

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

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

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

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

Therefore the law of motion of wealth is:

$$\begin{aligned} W_{t+1}^{i'} &= \pi_{t+1}^{i'} a_{t+1}^i p_{t+1} + R_{t+1} b_{t+1}^i + w_{t+1} + h_{t+1} \\ W_{t+1}^{i'} &= \pi_{t+1}^{j} \frac{p_{t+1}}{p_t} \phi_t s_t W_t^i + R_{t+1}[(1-\phi_t) s_t W_t^i - h_t] + w_{t+1} + h_{t+1} \\ W_{t+1}^{i'} &= [\phi_t \pi_{t+1}^{i'} \frac{p_{t+1}}{p_t} + (1-\phi_t) R_{t+1}] s_t W_t^i - R_{t+1} h_t + w_{t+1} + h_{t+1} \end{aligned} \tag{15}$$

Notice that:

$$h_t = \sum_{j=1}^{\infty} \frac{w_{t+j}}{\prod_{l=1}^{j} R_{t+l}} \quad \Rightarrow \quad h_t = \frac{w_{t+1} + h_{t+1}}{R_{t+1}} \tag{16}$$

Using this recursive representation of h_t in equation (15) we obtain:

$$W_{t+1}^{i'} = [\phi_t \pi_{t+1}^{i'} \frac{p_{t+1}}{p_t} + (1-\phi_t) R_{t+1}] s_t W_t^i \tag{17}$$

which is equation (5) in Section 2.1. 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 (14) 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:

$$(1-s_t)^{-1} = 1 + [\beta R_{t+1}]^{1/\sigma}[\mathbb{E}r_{t+1}^{-\sigma}]^{1/\sigma}(1-s_{t+1})^{-1} \tag{18}$$

Alternative approach. Multiplying (13) by ϕ_t and (14) 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 (2.1) in Section 2.1:

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

For completeness one can solve for the optimal portfolio allocation ϕ. Combining equations (13) and (14) 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 also independent of wealth. As a result, we have:

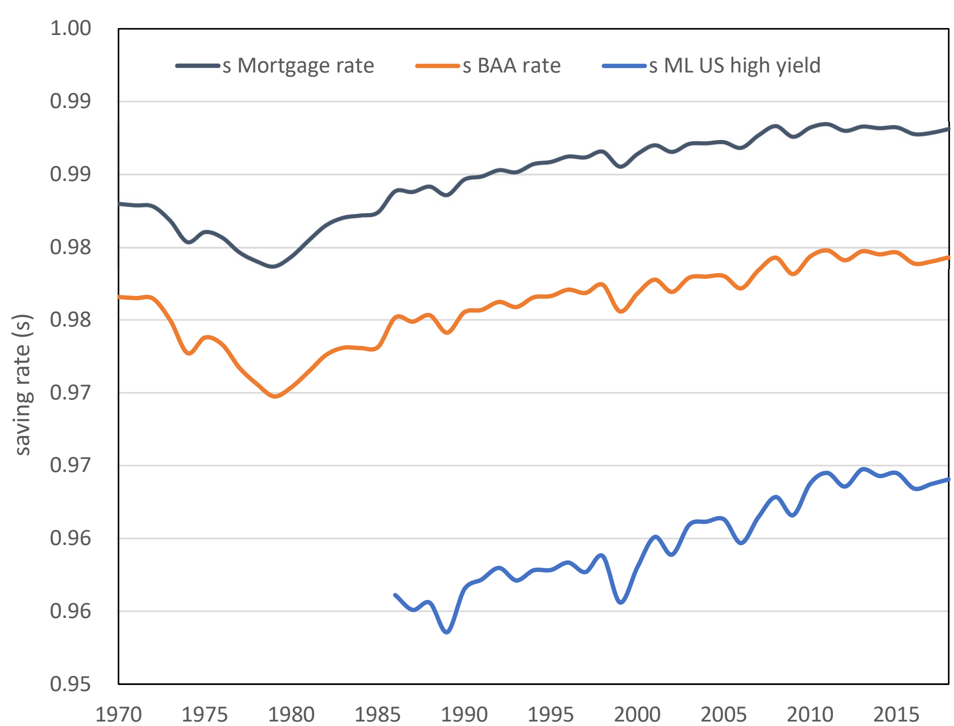
Remark 1 ***Determination of optimal portfolio allocation,*** ϕ***:***

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

which is also independent of wealth.

B U.S. Human Capital with Alternative Discounting

Figure 7: Savings ratios with alternative discounting



C Data Sources

The data sources for the computation of U.S. saving rates have been specified in detail in the main text. Here we provide more details on data sources for the other three countries.

C.1 Japan

Saving Rate: *ESRI Cabinet Office, Government of Japan.*
Total Income: *European Commission's Directorate-General - ECFIN.*
Disposable Income: *European Commission's Directorate-General - ECFIN.*
Total Population: *Statistical Bureau of Japan.*
Inflation: *World Bank.*
Net Worth: *ESRI Cabinet Office, Government of Japan.*
Non-capital Share: *World Bank.*
Labor Share: *FRED, Federal Reserve Economic Data–St. Louis Fed.*
Compensation of Employees: *ESRI Cabinet Office, Government of Japan.*
Risk-free Assets(Treasury Bill Rate): *Bank of Japan.*
Mortgage Interest rate[a]: *Landslide Related. Japan Housing Finance Agency.*
Risky Assets (BBB Corporate Bond effective Yield)[a]: *Wind.*

a. The mortgage interest rate is available from 1980 onwards, while the BBB rate only from 1998. Thus, in the main text we use the computations with the mortgage rate. Nevertheless, with the supporting material we provide calculations concatenating both rates. The patterns remain the same.

C.2 Germany

Saving Rate: *Federal Statistics Office Germany.*
Total Income: *World Bank.*
Disposable Income: *Deutsche Bundesbank Eurosystem. BBNZ1.Q.DE.N.G.0325.A*
Net worth ratio[b]: *OECD, doi: 10.1787/2cc2469a-en.*
Total Population: *Federal Statistics Office Germany.*
Inflation: *World Bank.*
Financial Net Worth: *Deutsche Bundesbank Eurosystem.*
Non-capital Share: *World Bank.*
Labor Share: *Computed using compensation of employees.*
Compensation of Employees: *Eurostat.*
Risk-free Assets(Treasury Bill Rate): *International Monetary Fund.*
Risky Assets(BBB Corporate Bond effective Yield): *Deutsche Bundesbank Eurosystem.*

b. The OECD provides a direct standard measure for the net worth to disposable income ratio for the period 1995 onwards. We use this measure directly in our computations, complemented with an extrapolation to the period 1991-94 using the Financial Net Worth to disposable income ratio.

C.3 China

Saving Rate: *National Bureau of Statistics of China.*
Total Income: *National Bureau of Statistics of China.*
Disposable Income: *National Bureau of Statistics of China.*
Total Population: *National Bureau of Statistics of China.*
Inflation: *World Bank.*
Net Worth: *Li Yang, Zhang Xiaojing, Chang Xin, et al., (2018 and 2020) "China's National Balance Sheet", National Institution for Finance & Development.*
Non-capital Share: *National Bureau of Statistics of China.*
Labor Share: *FRED, Federal Reserve Economic Data–St. Louis Fed.*
Compensation of Employees: *National Bureau of Statistics of China.*
Risk-free Assets(Treasury Bill Rate): *Almanac of China's Finance and Banking (1993, 1997, 2004, 2012, 2020).*
Risky Assets 1999-2008 (Mortgage Rates): *Wind.*
Risky Assets 2009-2020 (BBB+ Chinese Corporation): *Wind.*