What explains the decline in r*? Rising income inequality versus demographic shifts[†]

Atif Mian, Ludwig Straub and Amir Sufi

Abstract

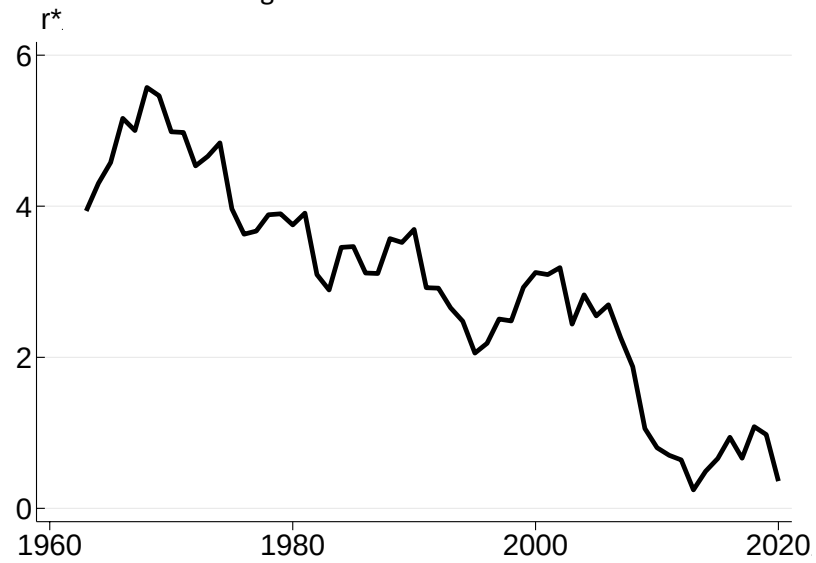
Downward pressure on the natural rate of interest (r^*) is often attributed to an increase in saving. This study uses microeconomic data from the SCF+ to explore the relative importance of demo- graphic shifts versus rising income inequality on the evolution of saving behavior in the United States from 1950 to 2019. The evidence suggests that rising income inequality is more important than the aging of the baby boom generation in explaining the decline in r^*. Saving rates are significantly higher for high income households within a given birth cohort relative to other households in the same birth cohort, and there has been a large rise in income shares for high income households since the 1980s. The result has been a large rise in saving by high income earners since the 1980s, which is the exact same time period during which r^* has fallen. Differences in saving rates across the working age distribution are smaller, and there has not been a consistent monotonic shift in income toward any given age group. Both findings challenge the view that demographic shifts due to the aging of the baby boom generation explain the decline in r^*.

[†] This study was prepared for the 2021 Jackson Hole Economic Symposium hosted by the Federal Reserve Bank of Kansas City. We are grateful to Fatih Guvenen in particular for a fantastic discussion. We also thank Adrien Auclert, Jason Furman, Pierre-Olivier Gourinchas, Markus Poschke, Jim Poterba, John Sabelhaus, Moritz Schularick, Larry Summers, and Ivan Werning for great comments. Laurenz De Rosa provided excellent research assistance. The replication kit for this study can be obtained by clicking here.
Contact info: Mian: (609) 258 6718, atif@princeton.edu; Straub: (617) 496 9188, ludwigstraub@fas.harvard.edu; Sufi: (773) 702 6148, amir.sufi@chicagobooth.edu

I. Introduction

The natural rate of interest has fallen to extremely low levels over the past 40 years, presenting serious challenges to policy-makers. The historically low natural rate of interest (r^*) raises concerns about secular stagnation, threatens asset price bubbles, and complicates monetary policy given proximity to the zero lower bound on nominal interest rates. It comes as no surprise, therefore, that a large body of recent research investigates the reasons behind the decline in r^*.

Figure 1: The decline in r*



Note: An estimate of the natural rate of interest (r^*) following Laubach and Williams (2003).

And yet, there remains much uncertainty on the causes. A central difficulty is that the decline in r^* from 1980 through 2019 (shown in Figure 1) has occurred simultaneously with a number of aggregate trends, such as rising income inequality, an aging of the population, shifting patterns in global saving, and changes in how businesses invest. Given these simultaneous aggregate patterns, techniques using macroeconomic data alone cannot easily tease out the most important factors. We believe that microeconomic data can help distinguish potential causes.

This study uses the recently released Survey of Consumer Finances Plus (SCF+) data set (Kuhn, Schularick and Steins (2020)) to investigate two of the most prominent explanations for the decline in r^* in the United States: the rise in income inequality and shifting demographics due to the particularly large size of the cohort of individuals born between 1945 and 1964 (known as the baby boom generation). In theory, both of these forces could be important in boosting the amount of savings in the economy relative to available investment opportunities, thereby pushing down r^*.

The SCF+ is an important resource in evaluating these two explanations, as it covers the 1950 to 2019 period and it includes information on both household income and the age of the head of the household. We use the SCF+ to estimate saving rates and shifts in income across the age and income distribution over the past 70 years; the main finding

is that the rise in income inequality is the more powerful force explaining saving patterns in the United States since 1980.

We follow a long tradition of using a shift-share empirical design to estimate how changes in aging and income inequality affect saving in the U.S. economy. Central to this technique are two main inputs: (1) variation in saving rates across the cross-sectional distribution at a fixed point in time, and (2) subsequent shifts in income shares across the distribution over time. If a given group displays a particularly high saving rate and this group begins to earn a larger share of income, then the shift-share approach predicts a rise in saving by this group.

The shift-share design is implemented using two sources of variation across the population: the age distribution and the within-birth cohort income distribution. It is important to recognize from the outset that the income distribution implementation compares high, middle, and low income households *within the same birth cohort*. This removes any mechanical demographic factor when evaluating the effect of rising income inequality on saving over time.

Saving rates across the within-birth cohort income distribution vary far more than saving rate differences across the working-age distribution. The top 10% income households within a given birth cohort have a saving rate that is between 10 and 20 percentage points higher than the bottom 90%. The large difference is present over the entire sample period, and it becomes even larger over time. Furthermore, there was a large shift in the share of income going to the top 10% of the within- birth cohort income distribution from 1983 to 2019. By the end of the sample period, the top 10% of the within-birth cohort income distribution had an income share that was almost 15 percentage points higher than the top 10% prior to the 1980s.

The higher saving rate of the top 10% together with the large shift in income to the top 10% combined to generate a significant increase in savings entering the financial system from high in- come households. Overall, we estimate that between 3 and 3.5 percentage points more of national income were saved by the top 10% from 1995 to 2019 compared to the period prior to the 1980s. This represents 30 to 40% of total private saving in the U.S. economy from 1995 to 2019. The rise in saving by high income households is likely a powerful force putting downward pressure on r^*.

In contrast, the evidence is less favorable to the view that the baby boom generation is responsible for a rise in saving that pushes down r^*. For example, saving rates across the working age distribution do not vary substantially. As a result, even when the baby boomers entered into the higher saving rate middle-age group, the rise in actual saving was modest. More generally, the limited variation in saving rates across the working age distribution makes it difficult for any large shift in income across the age distribution to explain patterns in household saving behavior.

Another challenge to the baby boom generation explanation is the time series of income share shifts across the age distribution since the 1980s. The decline in r^* has been monotonic and steady from 1980 onward. In contrast, the income share received by age groups with the highest saving rates has shown significant upward and downward movement since the 1980s, reflecting the entry and exit of the baby boom generation

into the middle of the working age distribution. There is no statistically significant relationship in the time series between r^* and the income share going to households headed by an individual between 45 and 64. This issue is especially pronounced in recent years. The baby boom generation is entering the low saving rate retirement years at the end of the sample, and so their saving should be expected to decline substantially. Yet measures of r^* continue to decline.

Finally, the large differences in saving behavior between high income households and the rest of the population is present within the baby boom generation. While the top 10% of the baby boom generation saved more than earlier generations, the bottom 90% actually saved less. The difference in saving behavior within the baby boom generation highlights the drawback of treating this generation as a monolith; the rich and non-rich households of the baby boom generation have displayed substantially different saving behavior over their life cycle.

We focus on the baby boom generation narrative, as it is the most prominent argument in the literature for why demographic shifts may lower r^*. Alternative channels for the effect of demographics on r^*, such as the direct effect of population aging on growth and investment, are likely more important, and we discuss these in Section VI. A conclusion we reach based on the analysis here is that any argument in which demographics have a large effect on r^* needs to be theoretically precise on the exact channel, and it should provide testable implications for empirical analysis.

The findings of this study fit into a broader agenda tying rising income inequality directly to important macroeconomic variables such as r^* and the wealth to income ratio (e.g., Straub (2019), Mian, Straub and Sufi (2021a), Mian, Straub and Sufi (2021b)). Most macroeconomic models used for policy analysis assume a constant saving rate out of lifetime income across all households in the economy, even though this assumption is counter-factual (Straub (2019)). Policy-makers should recognize that rising income inequality is more than a distributional issue; it is likely a central force shaping broader macro-economic trends.

II. Conceptual framework and empirical strategy

The conceptual framework for understanding the reasons behind the decline in r^* has been shaped by the influential empirical study by Laubach and Williams (2003). In a standard representative-agent Ramsey model, the household Euler equation produces a steady state relationship in which r^* is a function of the growth rate of output and a residual component that corresponds to a shift in household preferences. In the notation of Laubach and Williams (2003):

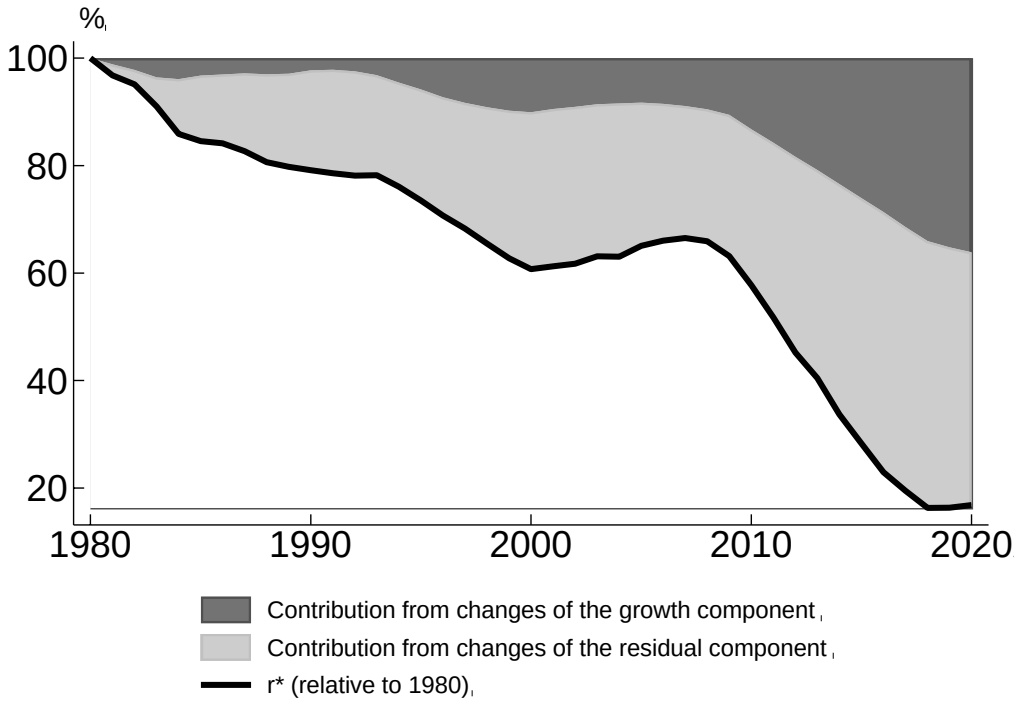
$$r = \frac{1}{\sigma} \cdot g_c + \theta \tag{1}$$

where g_c is the per-capita output growth of the economy and θ is the rate of time preference of the representative agent in the economy. This study focuses on the following question: what forces over the past 40 years in the United States pushed down θ and therefore r? In other words, what secular trends over the last 40 years may have pushed down θ making the household sector effectively more "patient" and therefore

put upward pressure on saving and downward pressure on *r*? The two key forces we examine are the rise in income inequality and shifts in demographics due to the aging of the baby boom generation.

An alternative approach to explore changes in *r* is to focus on forces that may have led to a decline in *g*. However, a focus on *g* faces an empirical challenge: research shows that the long- term growth rate is less powerful empirically in explaining changes in r^*. Rachel and Smith (2015) conclude that "our quantitative analysis highlights slowing global growth as one force that may have pushed down real rates recently, but shifts in saving and investment preferences appear more important in explaining the long-term decline." Focusing on the United States, Hamilton, Harris, Hatzius and West (2016)

Figure 2: Factors driving the decline in r^*



Note: Decomposing the decline in the natural rate of interest (r^*) following Laubach and Williams (2003). As a filter, an equally weighted moving average with nine lags is applied.

conclude that "[the equilibrium interest rate's] relationship with trend GDP growth is much more tenuous than widely believed." Lunsford and West (2019) argue that their results "suggest that GDP growth and real rates do not show a reliably positive low-frequency correlation."

Furthermore, the Laubach and Williams (2003) methodology with updated data shows that the estimated decline in r^* is driven more by changes in θ relative to changes in g, a fact shown in Figure 2.[1] The figure displays the evoluation of a smoothed r^* relative to the r^* in 1980. Before the Great Recession, on average 77% of the decline in r^* was caused by changes in the residual component. After 2008, the lower long-term growth rate makes up an increasingly larger share of the changes, although the contributions of the residual component still average 64% in the post-crisis period. It is for these reasons that the methodology pursued in this study focuses on factors that may have led

to an outward shift in saving that can explain the decline in r^*. However, we discuss in more detail how these same factors may have affected the growth rate in Section VI.A.

II.A. Rising income inequality

The large rise in income inequality in the United States is well documented. The rise in income in- equality is present in tax filing data (e.g., Piketty and Saez (2003), Piketty, Saez and Zucman (2018), CBO (2019)), household survey data (Kuhn, Schularick and Steins (2020)), and administrative data from the Social Security Administration (Kopczuk, Saez and Song (2010), Guvenen, Kaplan, Song and Weidner (2021)). The SSA data set used by Guvenen, Kaplan, Song and Weidner (2021) has the major advantage of being a panel following the same individuals over time. Their study uses the SSA data set to show that their has been a substantial rise in lifetime income inequality within gender groups. In other words, the rise in income inequality is not uniquely a function of a rise in transitory income shocks, nor is it due to across-birth cohort differences in income. Kopczuk, Saez and Song (2010) find a similar result: "virtually all of the increase in the variance in annual (log) earnings since 1970 is due to increase in the variance of permanent earnings (as opposed to transitory earnings)."

Theoretical research suggests that rising inequality in lifetime income may explain an expansion in savings that pushes down r^*.[2] The basic logic is that households higher in the income distribution have higher saving rates out of lifetime income. As a result, a shift in income toward high income households with high saving rates puts downward pressure on aggregate demand, necessitating a decline in the expected return on wealth to clear the goods market (e.g., Straub (2019), Auclert and Rognlie (2020), Mian, Straub and Sufi (2021a)). Straub (2019) and Mian, Straub and Sufi (2021a) incorporate non-homothetic preferences over savings into otherwise standard macroeconomic models, and they show that a rise in lifetime income inequality pushes down the expected return on wealth.

The studies by Straub (2019) and Mian, Straub and Sufi (2021a) focus on general equilibrium steady state solutions. Using more reduced form techniques, several studies also argue that rising income inequality is a potential driver of a decline in r^* because high income households have a higher propensity to save (e.g., Summers (2014), Rachel and Smith (2015), Lunsford and West (2019), Rachel and Summers (2019), and Furman and Summers (2020)). A rise in savings coming from high income households could have potentially large effects on asset prices and expected returns if the elasticity of asset prices with respect to shifts in savings is large. Gabaix and Koijen (2021) suggest that this elasticity is quite large, which is another reason to focus on the savings of the rich when trying to explain the evolution of r^*.

II.B. Demographic shifts

A prominent explanation for the decline in r^* is shifts in the aggregate age distribution caused by varying sizes of birth cohorts (e.g., Auerbach and Kotlikoff (1990), Abel (2003), Carvalho, Ferrero and Nechio (2016), Eggertsson, Mehrotra and Robbins (2019b), and Gagnon, Johannsen and López-Salido (2021)). This literature is motivated to a large degree by the "baby boom generation," or individuals born between 1945 and 1964. This birth cohort was particularly large, and subsequently had lower fertility than

previous birth cohorts. This fact led to theoretical exploration of how a "bulge" passing through the age distribution affects asset prices and equilibrium rates of return. We therefore refer to this mechanism as the "baby boom generation" view.[3]

Similar to research on income inequality, a crucial ingredient of these models is differences in saving behavior across the distribution. While the income inequality literature focuses on differences across the *income distribution*, the baby boom generation literature focuses on differences across the *age distribution*. The models typically follow an overlapping generation structure in which households in the middle of the age distribution drive the saving behavior of the overall economy. As a result, a bulge of middle-age workers relative to the rest of the population pushes up savings, resulting in lower expected returns.

This mechanism is clearly demonstrated in Eggertsson, Mehrotra and Robbins (2019b). The study contains a simple stylized model and a richer quantitative life-cycle model. In the stylized model, younger individuals earn nothing, and therefore must borrow from middle-age workers. The oldest workers do not save; they consume all of their wealth before dying. The borrowing by younger individuals therefore must match the saving by middle-age workers. If the cohort of middle-age workers is large relative to younger individuals, interest rates must fall to clear the lending-borrowing market. A population bulge therefore lowers rates of return when it passes through middle age.

Saving behavior across the age distribution is stark in the stylized model of Eggertsson, Mehrotra and Robbins (2019b) given that only the middle-age workers save. The younger individuals have no income and therefore cannot save, and the older workers consume their wealth. While the Eggertsson, Mehrotra and Robbins (2019b) model highlights this crucial age profile of saving most prominently, it is also featured in other theoretical studies in which the baby boom generation lowers the expected return on wealth (e.g, Abel (2003), Carvalho, Ferrero and Nechio (2016), Gagnon, Johannsen and López-Salido (2021)).

While the baby boom generation view is the most prominent argument made for how demographics affect r^*, there is also an argument about longevity in the literature (e.g, Carvalho, Ferrero and Nechio (2016)). This view argues that a rise in life expectancy has contributed to a higher amount of savings as individuals prepare for a longer retirement period. Unlike the baby boom generation argument, the longevity argument does not have obvious implications for saving behavior across the age distribution. Indeed, individuals across the working age distribution should be expected to save more if everyone expects to have longer retirement periods. We discuss the longevity view in more detail in Section VI.

From the outset, it is important to recognize that the baby boom generation view predicts a sharp decline in aggregate savings and a rise in r^* as the baby boom generation retires (a process which is already under way as of 2021). This point is made explicitly by much of the previous literature and is also a focus of the recent book by Goodhart and Pradhan (2020). This will be an important point we emphasize in Section IV.B below. The recent contribution by Auclert, Malmberg, Martenet and Rognlie (2021) argues that demographic shifts going forward are likely to lower r^*; we discuss the

Auclert, Malmberg, Martenet and Rognlie (2021) study in more detail in Section VI.C below.

II.C. The shift-share methodology

Both the rising inequality and demographic shifts view have empirical implications that can be tested using microeconomic data on saving behavior. This study tests the implications using an income shift-share approach, following early contributions by Summers and Carroll (1987) and Bosworth, Burtless and Sabelhaus (1991).

Let Θ_{jt} and Z_{jt} be the nominal saving and nominal income for any group j in year t, with Θ_t and Z_t being the aggregates over the groups. The change in the total saving to total income ratio for the groups from year 0 to year τ can be written as:

$$\frac{\Theta_\tau}{Z_\tau} - \frac{\Theta_0}{Z_0} = \sum_{j=1}^{j=J} (\alpha_{j\tau} - \alpha_{j0}) \cdot s_{j0} + \sum_{j=1}^{j=J} \alpha_{j\tau} \cdot \left(\frac{\Theta_{j\tau}}{Z_{j\tau}} - \frac{\Theta_{j0}}{Z_{j0}} \right) \quad (2)$$

where α_{jt} is the share of income for group j in year t. Let $s_{jt} = \frac{\Theta jt}{Z_{jt'}}$ which is the saving rate for z_{jt} group j out of its own income. Then the change in the total saving to total income ratio can be decomposed into a shift-share term and a residual term :

$$\frac{\Theta_\tau}{Z_\tau} - \frac{\Theta_0}{Z_0} = \underbrace{\sum_{j=1}^{j=J} (\alpha_{j\tau} - \alpha_{j0})\, s_{j0}}_{shift-share} + \underbrace{\sum_{j=1}^{j=J} (s_{jt} - s_{j0}) \cdot \alpha_{j\tau}}_{residual} \quad (3)$$

As equation 3 makes clear, the change in the total saving to total income ratio can be decomposed into a term driven by the shift in the share of income going to each of the individual groups and a residual term driven by changes in the saving rates of each group.

The first term in equation 3 is the critical object for empirical study. It represents the "all-else equal" prediction of what should happen to saving if there is a shift in income toward specific groups over time. If a certain group has a particularly high saving rate (s_j) and that group experiences a large rise in its share of income $(\alpha_{j\tau} - \alpha_{j0})$, then we can expect a large rise in saving coming from that group. In the extreme, if saving rates for a given group are stable over time (e.g, if $s_{j\tau} = s_{j0}$ for all groups j), then the change in income shares alone determines the change in the aggregate saving to income ratio.

Any partition of the overall population can be used for the shift-share approach. Following the discussion above, theory suggests that age groups and income groups are two important partitions. As a result, the two sets of groups considered in this study are (1) within-birth cohort income groups and (2) age groups. As shown in equation 3, the two most important objects of interest are the saving rates across these groups, and the change in income shares over time. Sections IV.A and IV.B will focus on saving rates and changes in income shares, respectively.

II.D. The macroeconomic response and the aggregate saving rate

The amount of aggregate saving in an economy is fundamentally a macroeconomic outcome, and therefore general equilibrium forces must be considered when evaluating the shift-share equation 3. The first term in equation 3, which we call the "shift-share" term, reflects the "all-else equal" response of saving in an economy if there are shifts in income to certain groups. However, the second term, which we call the "residual" term, reflects in part the macroeconomic response to the "all-else equal" initial change in income shares.

More specifically, the macroeconomic response to a shift in saving coming from a certain group can be decomposed using the national accounting identity equating the sources and uses of saving in year t:

$$\Theta_{it} = I_t + F_t + \Theta_t^g - \Theta_{jt} \quad (4)$$

where Θ_{it} and Θ_{jt} are saving by two different groups of households, I is net domestic investment, F is the current account, and $\Theta^g{}_t$ is net saving by the government. The right-hand side of equation 4 makes it clear that, if saving of group i increases significantly, then some other variable must adjust. If I, F, and Θ^g do not respond, then Θ_{jt} must fall.

This logic explains why an examination of the aggregate saving rate (which is $\Theta_{it} + \Theta_{jt} + \Theta_t^g$ from equation 4, scaled by national income) is not informative in assessing whether a force such as rising income inequality or demographic shifts affects r^*. A saving glut from one part of the population does not require a rise in aggregate saving even if it puts downward pressure on equilibrium interest rates. This would be the case if the rise in saving by one group of households is absorbed by a decline in saving by the government or other households.[4]

Mian, Straub and Sufi (2021b) show that while there was a rise in saving by the rich in the United States since the 1980s, I_t and F_t actually moved in the "wrong" direction: both net domestic investment and the current account surplus fell over the same time period that the "saving glut of the rich" emerged. Government saving (Θ_t^g) moved in the correct direction (that is, saving by the government fell), especially after 2008, but not enough to absorb the rise in saving coming from the rich. As a result, saving by the non-rich fell substantially. The analysis below confirms this finding.

As shown in the model by Mian, Straub and Sufi (2021a), valuation effects from lower r^* are an important part of mediating this dynamic. Consider a closed economy with no government. In this case, aggregate saving must equal aggregate investment. If saving by one group rises, then either investment must rise, or saving by the other group must fall. In the baseline model of Mian, Straub and Sufi (2021a), there is no investment. As a result, when there is a rise in income inequality and upward pressure on saving by the rich, investment cannot adjust and r^* falls. This boosts the value of asset prices in the economy, loosening borrowing constraints and enabling the non-rich to borrow more from the rich.[5] As discussed below in Section VI.C in more detail, valuation effects have been an important part of the macro trends in the U.S. economy since 1980.[6]

III. Data and measurement

III.A. Data

An investigation into the relative importance of demographics and income inequality for saving behavior and the long-run decline in r^* requires a long time series of microeconomic data covering age, wealth, and income. The recently released SCF+, constructed by Kuhn, Schularick and Steins (2020), is an advantage in this regard. This data set is the result of a major effort by these scholars to uncover and digitize historical waves of the SCF before 1989.[7] The data set was made available to the public in the replication kit provided by Kuhn, Schularick and Steins (2020). A full discussion of the data set is available in the Kuhn, Schularick and Steins (2020) article and the appendix. We refer readers to these sources for a more detailed explanation of its construction.

The data set covers the 1950 to 2016 period. The 1989 through 2016 waves are identical to the SCF waves published by the Federal Reserve, and so it is straightforward to add the latest 2019 wave. The final data set used in this study represents cross-sectional snapshots of households every three years from 1950 to 2019, with the exception of the 1971 to 1983 period in which only 1971, 1977, and 1983 are available. The data set reports pre-tax income from wages and salaries, professional practice and self-employment, rental income, interest, dividends, transfer payments, as well as business and farm income. The SCF+ reports pre-tax income, and as a result all saving rates below represent saving rates out of pre-tax income. The SCF+ also covers financial assets and liabilities for various asset classes. The survey waves cover between 2 and 8 thousand households, and population weights are provided in order to match aggregates. All of the analysis in this study uses the weights, which helps to ensure that the SCF+ aggregates approximate aggregate trends in demographics.

The main alternative data set and methodology used to evaluate long run saving behavior across the income or wealth distribution is the capitalization method using the Distributional National Accounts (e.g., Saez and Zucman (2016), Mian, Straub and Sufi (2021b)), which is available from 1962 onward. The main advantage of the SCF+ relative to the DINA is that it has the precise age of the household head, which allows for a detailed examination of the effects of demographic change on saving behavior. In addition, the ability to fix a birth cohort is better suited for the synthetic saving approach described in the next sub-section. The main disadvantages of the SCF+ relative to the DINA are that it does not capture the top of the income distribution well before 1989, and it does not contain as detailed information on the breakdown of income sources and taxes.

III.B. Measurement of saving

This study follows the long tradition of measuring saving in the SCF using the *synthetic saving approach* (e.g., Bosworth, Burtless and Sabelhaus (1991), Devlin-Foltz and Sabelhaus (2016), Feive- son and Sabelhaus (2019), and Bauluz and Meyer (2021)).[8] In the absence of panel data or explicit questions on saving, it is necessary to approximate saving by focusing on the evolution of wealth, inheritances, and valuation effects across groups within the SCF.

Formally, the synthetic saving approach estimates nominal saving from $t-1$ to t by group j from the following identity:

$$\Theta_{jt} = W_{jt} - W_{jt-1} \cdot (1 + \pi_t) - H_{jt} \quad (5)$$

where Θ_{jt} is nominal saving by group j at time t, W_{jt} is nominal wealth of group j at time t, π_t is the pure valuation gain on wealth, and H_{jt} is net inheritances going to group j at time t.

There are seven categories of wealth that together make up total household net worth. They are: fixed income assets, corporate equity, private business wealth, real estate, mortgage debt, personal debt, and a miscellaneous category. Consumer durables are excluded. The data appendix describes in detail the mapping from the underlying SCF+ data to these categories, including how mutual funds, pensions, and claims on life insurance companies are separated into these seven categories. Wealth in these categories for group j is readily observable in the SCF+, and so the real effort in this technique is estimating π_t and H_{jt}. The methods used in this study to estimate these two objects follow the existing literature. We follow the methodology of Feiveson and Sabelhaus (2019) and Mian, Straub and Sufi (2021b) to estimate π_t and Feiveson and Sabelhaus (2019) and Bauluz and Meyer (2021) to estimate H_{jt}. The full explanation of how we estimate these objects is in the data appendix. The SCF+ does not capture wealth from defined benefit pensions. However, Sabelhaus and Volz (2021) provide estimates of defined benefit pension wealth for 1989 through 2019. A robustness test on the 1989 to 2019 period reported in Section V.C shows that the core results of the study are stronger when including defined benefit pension wealth.

III.C. Formation of groups

For each survey wave, households are sorted into birth cohorts based on the birth year of the house- hold head. Each birth cohort contains households where the head was born in a 10 year window (e.g., 1925 to 1934, 1935 to 1944, etc.). This leads to a synthetic panel for each birth cohort, which is similar to the approach in Feiveson and Sabelhaus (2019) and Bauluz and Meyer (2021). Given that each birth cohort reflects a 10 year window of birth years, we refer to the "age" of the birth cohort in a given year as the median age of the household head within the cohort. This is important in the analysis below when we show saving by age bins. The age bins include a cohort based on the median age of the household heads in the birth cohort.

The main novelty in this study is to further break down each birth cohort into three income groups: the top 10%, the next 40%, and the bottom 50%[9]. It is crucial to note that this further breakdown is done *within birth cohort*. This allows us to compare high and low income households within the same birth cohort, thereby eliminating life cycle factors that are common to households based on the age of the household head. This is important given the fact that placement in the overall income distribution is likely correlated with age: individuals that are in their forties and fifties on average earn more than individuals that are in their twenties and thirties. The top 10% of the overall income distribution therefore may be a different age profile than the bottom 90%. The within-birth-cohort income sort removes this confounding factor, which allows us to separate how income versus age affect saving behavior.

Ideally, to evaluate hypotheses related to the long-run saving behavior out of income, the income sort would use a measure of lifetime or permanent income as opposed to current income (e.g., Straub (2019)). This would ensure that the groups were more homogeneous over time, and would eliminate transitory income changes from influencing the formation of groups.

In Section V.B, we conduct a variety of robustness tests that mitigate the concern that transitory shocks are responsible for the saving rate patterns documented below. For example, Feiveson and Sabelhaus (2019) use a measure of permanent income from the SCF based on a survey question of what income would be in a "normal" year, and Devlin-Foltz and Sabelhaus (2016) show that this question accurately approximates the permanent component of income. This survey question is only available from 1995 through 2019, and so we cannot use this measure for the full sample. However, a robustness test reported in Section V.B. shows that saving rates out of income across the income distribution are almost identical when this measure of permanent income instead of actual income is used. Furthermore, there is a panel of individuals followed from 1983 to 1989 in the SCF, which is used by Dynan, Skinner and Zeldes (2004) to estimate saving rates across the permanent income distribution. In Section V.B, we show that using this panel dimension yields similar conclusions.

III.D. Matching aggregates

The analysis in this study uses a scaled version of each asset class in the SCF+ in order to match aggregates from the Financial Accounts of the Federal Reserve (FA) and the National Income and Product Accounts (NIPA). This is common in the literature (e.g., Feiveson and Sabelhaus (2019), Mian, Straub and Sufi (2021b), Bauluz and Meyer (2021)), and is also the central goal of the Distributional Financial Accounts (e.g., Batty, Bricker, Briggs, Friedman, Nemschoff, Nielsen, Sommer and Volz (2020)).
This is accomplished by distributing the aggregate wealth in each asset class and year reported in the FA to each birth-cohort-income group in the SCF+ according to the share of the asset class held in the SCF+ in that year by the birth-cohort-income group. Formally, let $\omega_{jt}^{c} = \frac{A_{jt}^{c}}{A_{t}^{c}}$ be the share of asset class c held by group j in year t, where A is the asset as measured in the SCF+. Then $W_{jt}^{c} = \omega_{jt}^{c} \cdot W_{t}^{c}$, where W_{t}^{c} is the aggregate wealth in asset class c in year t reported in the FA. There are two key reasons for scaling the SCF+ to match the FA: it helps to ensure that aggregate changes in wealth approximate what is reported in the FA, and it helps ensure that asset portfolio shares in the SCF+ match the aggregates in the FA. Kuhn, Schularick and Steins (2020) have an extensive discussion on how well the SCF+ matches aggregates; the SCF+ matches aggregates quite well, but the portfolio composition can be different. The differences between the SCF and the Financial Accounts is the subject of a large literature, with Feiveson and Sabelhaus (2019) and Batty, Bricker, Briggs, Friedman, Nemschoff, Nielsen, Sommer and Volz (2020) containing excellent detailed discussions.
In order to ensure that aggregate saving to income ratios from the analysis approximate the aggregate private saving to national income ratio from the NIPA, the methodology used here also scales income in the SCF+ to match national income as reported in NIPA. As before, this is accom plished by distributing national income to each birth-cohort-income group according to the share of income in the SCF+ reported in that year.[10]

This scaling exercise is done to match aggregates, and as a result total saving and total income across all birth-cohort-income groups match those reported in the NIPA. However, a robustness exercise reported in Section V.C shows that the main results of the study are similar if we use the original wealth and income variables from the SCF+. The cross-sectional differences in saving rates across the income distribution, for example, are similar whether we scale to match aggregates or use the original SCF+ data.

In summary, the SCF+ and the methodology described above gives a measure of annual saving and income for each birth cohort-income group for every year that the SCF is available, where the summation of saving and income across all birth-cohort-income groups in a given survey year is designed to match aggregate saving and income from the NIPA. These data allow us to evaluate the relative importance of rising income inequality and demographic shifts in explaining the evolution of saving, which we turn to in the next section.

IV. Result of the shift-share methodology

IV.A. Saving rates across income and age groups

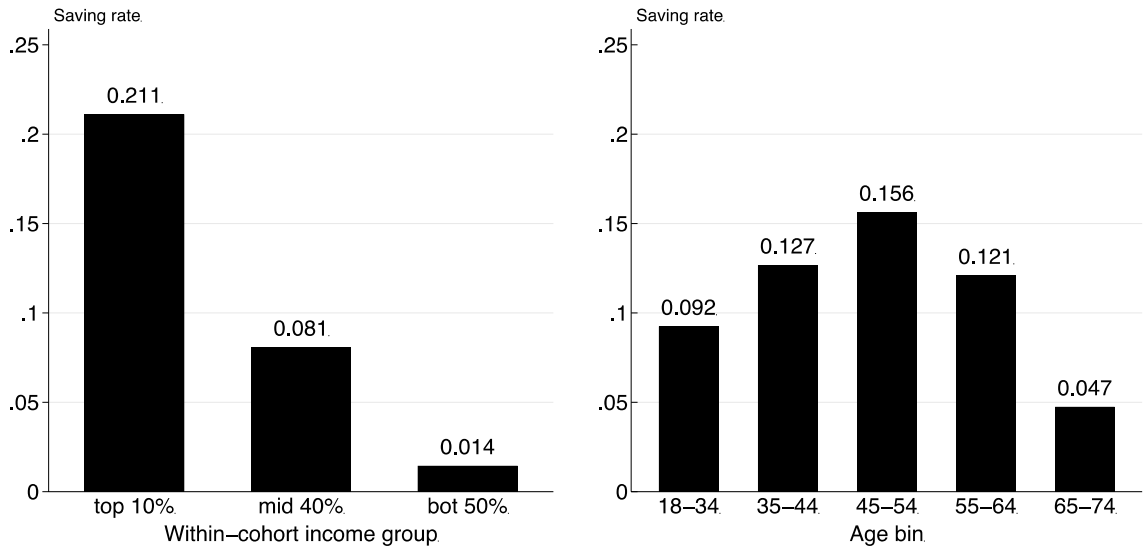
We are now in a position to implement the shift-share approach described in equation 3 of Section II.C. The left panel of Figure 3 shows the saving rates out of own income for within-birth cohort income groups. More specifically, the figure shows the average annualized saving rates out of own income for the period from 1953 to 2019. As mentioned in Section III, the income groups are formed within a given birth cohort. For example, for the group of households where the household head was born between 1955 and 1964, the methodology estimates the saving rate for each year for the top 10%, next 40%, and bottom 50% within this birth cohort. This helps to ensure that the differences in saving rates across income groups for a given birth cohort are not driven by life-cycle effects. By construction, households with a head that is in the same birth cohort are at similar points of their life cycle regardless of the income position within the birth-cohort.[11]

For every year of the SCF+, we sum the saving and income for each income group across all birth cohorts present in that year. We then calculate the saving rate of the income group as the sum of the saving by the income group scaled by the sum of income for the income group. For each SCF+ year, this yields a saving rate for the top 10%, next 40%, and bottom 50% of the within-birth- cohort income distribution. The left panel of Figure 3 reports the average saving rates for each of the groups across all years of the SCF+.

The left panel shows that saving rates are substantially higher for the top 10% income group within a given birth-cohort. The top 10% income group has a saving rate that is 13 percentage points higher than the next 40%, and almost 20 percentage points higher than the bottom 50%. It is well known that higher income households have higher saving rates than lower income households (e.g., Dynan, Skinner and Zeldes (2004), Straub (2019)). However, the within-cohort sorting done in this study shows that this large difference is not due to life cycle effects. This is important because high income households may have higher saving rates because high income households happen to be in the part of the life cycle associated with higher saving rates. By examining the within-

birth cohort distribution of income, the methodology used here ensures that a life cycle effect is not responsible for the large differences in saving rates across the income distribution. In short, high income households save a significantly larger fraction of their income relative to lower income households, even if they are similar in age.

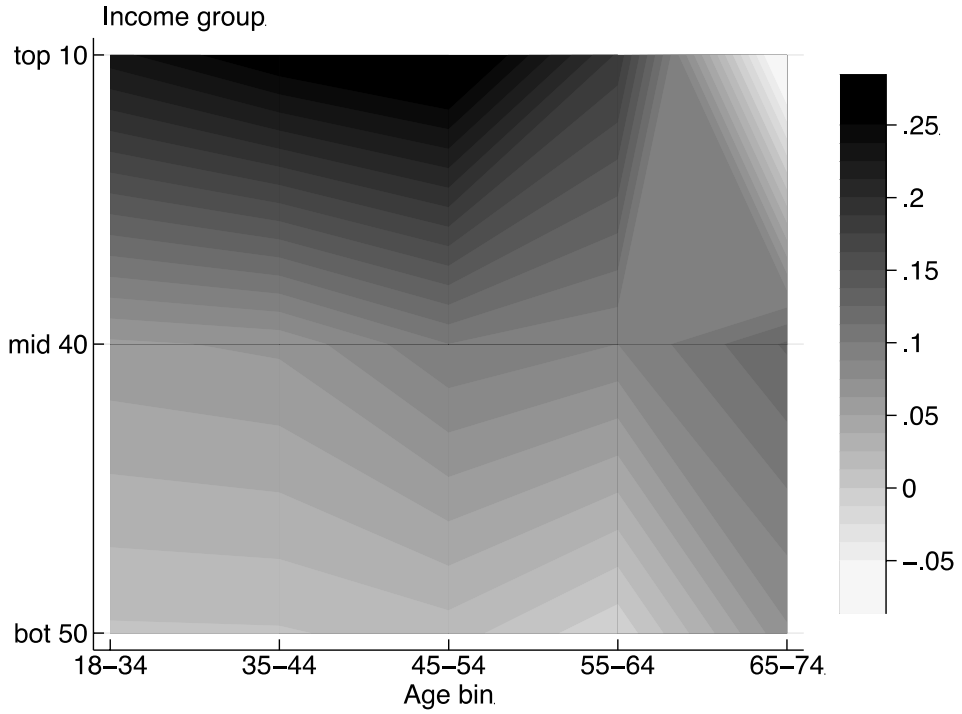
Figure 3: Saving rates across the within-cohort income and age distribution



Note: Estimated saving rates out of own income across the within-birth-cohort income distribution (left panel) and the age distribution (right panel). The sample period is 1953 to 2019.

The right panel focuses on saving rates across age bins. As mentioned in Section III, the saving rate of a given birth cohort is included in an age bin if in that survey year the median age of the birth cohort fits within the bin. As the right panel shows, there are life cycle differences in saving rates, but the differences are smaller in magnitude relative to the differences in saving rates across the within-birth cohort income distribution, especially for cohorts with a median age below 64. A birth cohort saves about 6 percentage points more when it is in the 45 to 54 age bin relative to the 18 to 34 age bin. This is less than half the difference in saving rates between the top 10% and middle 40%, and less than a third the difference between the top 10% and bottom 50%.

Figure 4: Saving rate heat map across the within-cohort income and age distribution



Note: Saving rate heat map across the within-birth-cohort income distribution and the age of household head distribution. The sample period is 1953 to 2019.

Figure 4 is a heat map showing the bivariate distribution of saving rates across the within-birth cohort income distribution and the age distribution. As it makes clear, differences in saving rates across the income distribution are substantial for every age group between 18 and 64. Moving south to north across income groups in every age group between 18 and 64 leads to a substantial rise in saving rates. In contrast, fixing the income group, there is much less variation in saving rates across the age distribution. Moving from west to east is not associated with a vast difference in saving rates. Saving rates vary far more by income than by age, at least for households with a head between 18 and 64.

The shift-share equation along with the results presented in Figures 3 and 4 provide the first reason why the rise in income inequality is a more powerful force affecting saving relative to demo- graphics. Saving rates differ far more across the within-birth cohort income distribution than the age distribution. Even if there are large changes in income shares across the age distribution due to a particularly large birth cohort such as the baby boom generation, those changes should not be expected to have large effects on saving given that the saving rate differences across the working age distribution are relatively small. In contrast, a change in the share of income across the income distribution should be expected to have large effects. We turn to the change in the share of income in the next section.

IV.B. Changes in income shares

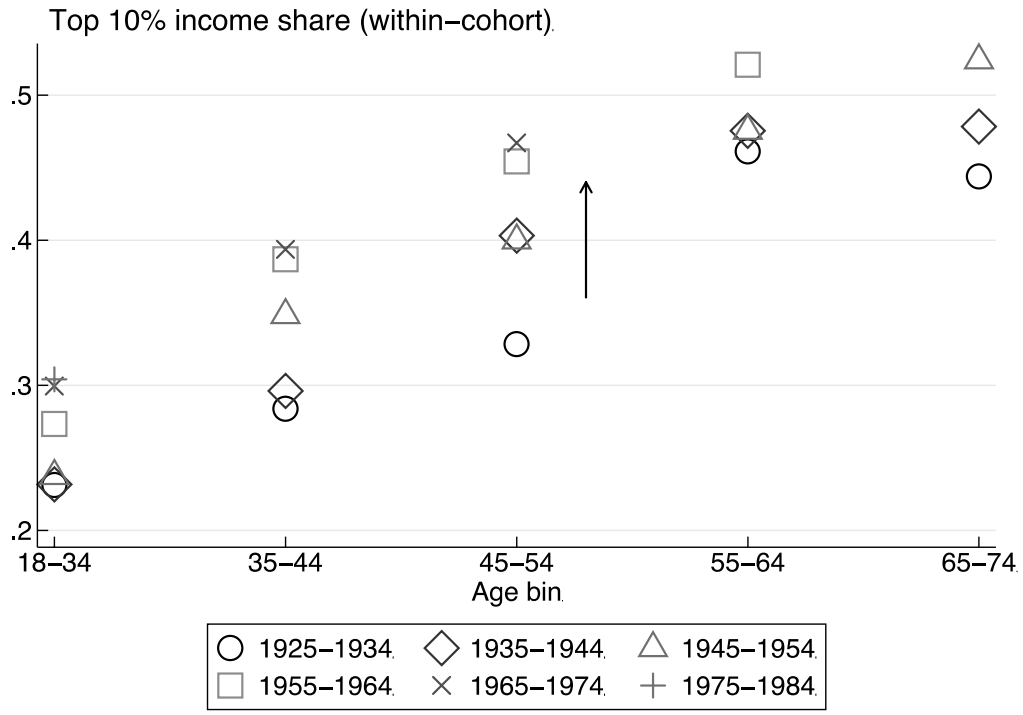
The shift-share equation 3 above makes it clear that shifts in the income share of groups are an important determination of the evolution of saving over time. The left panel of Figure 5 shows that the share of income going to the top 10% of the within-birth cohort income distribution has increased substantially since the early 1980s. In aggregate, the share of income earned by the top 10% has risen between 10 and 15 percentage points.[12]

Figure 5: Income shares over time, by within-cohort income and age groups

Note: The left panel plots the total income share of the top 10% income households of all birth cohorts over time. The right panel plots the total income share of all birth cohorts for which the median household is between 45 and 64 years old.

The rise in top income shares is well known and documented across a number of data sets, as discussed above in Section II.A. However, it is important to remember that the pattern shown in the left panel of Figure 5 reflects the within-birth cohort income distribution. As with saving rates, the rise in the income share going to the top of the income distribution may in theory be associated with a life cycle effect. By focusing only on the top 10% income earners within each birth cohort, the left panel of Figure 5 shows that this is not the case. Over time, the top 10% of a given birth cohort is earning more of the aggregate income earned by the cohort.

Figure 6: Top 10% income share, by birth cohort and age



Note: Each marker represents the income share of the top 10% of a birth cohort when the median household head in that birth cohort was in a given age bin.

Figure 6 shows this important result in more detail. Each marker in Figure 6 represents the share of a given birth cohort's overall income earned by the top 10% of that birth cohort when the cohort is in a given age bin. Each birth cohort is represented by the same set of markers across the age bins. The earliest birth cohort includes household heads born between 1925 and 1934 and the latest includes those born between 1975 and 1984.

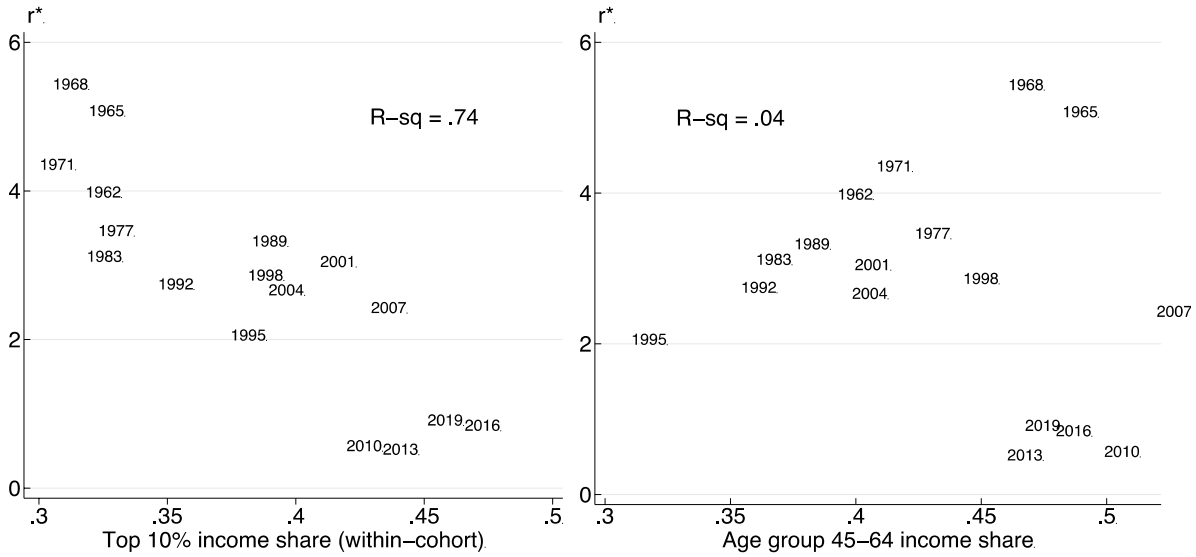
As the figure shows, there has been a steady upward trend in the top 10% income share for every subsequent birth cohort across all age bins. As an example, when the 1925 to 1934 birth cohort was in the 45 to 54 age bin (in the 1970s and 1980s), the top 10% of the 1925 to 1934 birth cohort earned 33% of the total income earned by the birth cohort. When the 1965 to 1974 birth cohort was in the 45 to 54 age bin (in the latest years of the sample period), the top 10% earned 47%. During the prime working age years, the top 10% of the 1965 to 1975 birth cohort had an income share that was 14 percentage points higher relative to the top 10% of the 1925 to 1934 birth cohort.

There has a been a steady and large rise in the income share of the top 10% within birth-cohort income group. What about shifts in income across the age distribution? The right panel of Figure 5 shows the share of income going to birth cohorts for which the household head has a median age between 45 to 64. We focus on this group because it tends to have the largest saving rates across the age distribution, and previous research suggests that this group is particularly important in driving saving (e.g., Rachel and Smith (2015), Lunsford and West (2019)).

The effect of the baby boom generation is clear. The share of income going to the 45 to 64 age group falls steadily until the late 1990s, when the baby boom generation enters into this age group. From the middle 1990s to 2010, the share rises. As the baby boom generation begins to retire during the 2010 to 2019 period (an individual born in 1950 hits 65 in 2015), the share of income going to the 45 to 64 age group begins to fall.

A comparison of the two panels of Figure 5 provides another reason why the rise in income inequality is a stronger candidate for explaining the decline in r^* relative to the baby boom genera- tion. The rise in the top 10% within-birth cohort income share starts in the 1980s and steadily rises through the end of the sample period, corresponding almost exactly to the downward pattern in r^*. In contrast, the income share of the 45 to 64 age bin starts high in the 1960s, falls until the middle 1990s, rises to 2010, and then begins to fall once the baby boomers begin to retire. This pattern is not correlated with the steady decline in r^* from 1980 onward.

Figure 7: Correlation of income shares and r∗



Note: The left panel plots the correlation between the total income share of the top 10% income households of all birth cohorts over time and the measure of r* from Laubach and Williams (2003). The right panel plots the correlation between the total income share of all birth cohorts for which the median household is between 45 and 64 years old and the measure of r* from Laubach and Williams (2003).

Figure 7 makes this point explicit by focusing on the time series correlation between r^* and the two income shares shown in Figure 5. The left panel shows a scatter plot of r^* against the top 10% within birth-cohort income share across the sample period. There is a remarkably strong negative correlation: the rise in the top income share has been closely associated with the decline in r^*. In contrast, the right panel shows a weak relationship in the time series between the income share of the 45 to 64 group and r^*. The R-squared from a linear regression is 0.74 for the top 10% but only 0.04 for the 45 to 64 group. The weak relationship in the right panel casts doubt on the view that a bulge entering the 45 to 64 age group is responsible for the downward long-term trend in r*.

IV.C. Shift-share results

The saving rate differences and shifts in income shares suggest that the rise in income inequality is the stronger determinant of the change in saving over time, a result that is confirmed in Table 1. In particular, Table 1 focuses on within-birth cohort income groups, and it reports each component of the shift-share equation 3. For the pre-period ($t = 0$), we focus on annual averages for the 20 years prior to the rise in top income shares: 1962-1983. For the post period ($t = \tau$), we focus on the last 25 years of the sample in which r^* has fallen to an extremely low level: 1995-2019. All values reported in the table represent the average annual values over these time periods.

The first column shows average saving rates in the pre-period (s_0), and it reveals that there are large differences across income groups, a fact already shown for the full period in Figure 3. The second column shows the change in the annual average top 10% within-birth cohort income share ($\alpha_\tau - \alpha_0$). The top 10% earn 11.8 percentage points more of total income in the post period relative to the pre period, with both the next 40% and the bottom 50% experiencing a substantial reduction. Multiplying these two columns together yields the change in saving expected using the shift-share approach, which is reported in column 3. If saving rates for each group remained stable, the methodology predicts a rise in saving by the top 10% of 3.0 percentage points of national income every year. To put this in perspective, the average private saving to national income ratio for the 1995 to 2019 period was 8.9 percentage points. The shift share alone for the top 10% predicts a rise in saving that is 1/3 of the aggregate amount in the post period. The decline in predicted saving for the bottom 90% is modest given the low initial saving rates.

Table 1: Shift-share results: within-cohort income groups

Income group	Saving rate s_0	Income shift $\alpha_\tau - \alpha_0$	Shift-share $s_0 \cdot (\alpha_\tau - \alpha_0)$	Δ Saving rate $s_\tau - s_0$	Post income share α_τ	Residual $(s_\tau - s_0) \cdot \alpha_\tau$	Total
Top 10	0.253	0.118	0.030	0.007	0.427	0.003	0.033
Next 40	0.082	-0.054	-0.004	-0.038	0.406	-0.016	-0.020
Bottom 50	0.026	-0.064	-0.002	-0.094	0.167	-0.016	-0.017

Note: This table presents the results of the shift-share methodology as outlined in equation 3 across the within-birth-cohort income distribution. Period $t = 0$ is 1963 to 1982 and period $t = \tau$ is 1995 to 2019. Annual averages are reported.

However, actual saving may differ from the shift-share prediction because saving rates may change in the post period. The fourth column shows the change in saving rates for each group. The saving rate of the top 10% group in the post period is similar to the pre-period. However, the saving rates of the bottom 90% fall considerably. Multiplying these changes in saving rates by income shares in the post period gives the residual saving of the shift-share approach. Adding the predicted and the residual yields the total saving by each group.

The saving by the top 10% is slightly larger than predicted, coming to 3.3 percentage points of national income annually. In other words, relative to the 1962 to 1983 period, the top 10% saves 3.3 percentage points more of national income every year, which represents 37 percent of annual average private saving in the post period. In contrast, the bottom 90% have reduced their saving substantially, given the large decline in saving rates.

Given the higher saving rates of the top 10% and the rise in their income share, it should not be surprising that there was a substantial rise in the actual saving by the top 10%. However, the large decline in saving rates of the bottom 90% in the post period relative to the pre period (column 4) is a striking result of Table 1 that is not accounted for by a pure shift-share approach. The shift-share methodology suggests that the rise in top income shares would have led to a rise in aggregate private saving of about 2.4 percentage points of national income had saving rates remained constant across income groups, which is the summation of values in column 3. The fact that actual private saving has fallen in the United States is attributable to the large decline in saving rates of the bottom 90% relative to the pre-1983 period.

This is closely related to the discussion above in Section II.D. In the absence of a rise in invest- ment, a decline in government saving, or a rise in the current account surplus, the saving coming from the bottom 90% must fall if there is a rise in saving by the top 10%.

The bottom line from Table 1 is that the rise in income inequality combined with high saving rates of high income households leads to a substantial rise in saving by the top 10% of the within- cohort income distribution from 1995 to 2019. The rise in income inequality leads to a large rise in saving, and therefore is a likely culprit when assessing forces that push down r^*.

Table 2: Shift-share results: Age bins

Age	Saving rate s_0	Income shift $\alpha_\tau - \alpha_0$	Shift-share $s_0 \cdot (\alpha_\tau - \alpha_0)$	Δ Saving rate $s_\tau - s_0$	Post income share α_τ	Residual $(s_\tau - s_0) \cdot \alpha_\tau$	Total
18-34	0.076	-0.109	-0.008	-0.028	0.146	-0.004	-0.012
35-44	0.077	-0.017	-0.001	0.087	0.208	0.018	0.017
45-54	0.160	0.028	0.005	-0.013	0.253	-0.003	0.001
55-64	0.204	0.030	0.006	-0.057	0.208	-0.012	-0.006
65-74	0.101	0.039	0.004	-0.093	0.121	-0.011	-0.007

Note: This table presents the results of the shift-share methodology as outlined in equation 3 across the age distribution. Period $t = 0$ is 1963 to 1982 and period $t = \tau$ is 1995 to 2019. Annual averages are reported.

Table 2 conducts a similar exercise using age bins as groups instead of income. As already shown, saving rates across the age distribution do not vary substantially, and the income share shift patterns are more subtle. As a result, it should not be surprising that the shift-share approach does not predict substantial differences in saving across

the age distribution. The aging of the population associated with the baby boom generation is evident, as income shares are higher for those between 45 and 74. But the size of the income share shift is modest, and the difference in saving rates is relatively small.

In terms of actual saving, saving rates have fallen across almost the entire age distribution, with the exception of the 35 to 44 age bin. They have fallen substantially for the oldest age group evaluated, the 65 to 74 bin. As a result, actual saving has fallen for almost all the age groups. This highlights an important implication: a methodology that ignores the within birth-cohort income distribution will tend to find a steady decline in saving across most of the age distribution.

The fact that in recent years households with a head between 65 and 74 have significantly lower saving rates relative to the past is a robust result also shown in Bauluz and Meyer (2021).[13] Bauluz and Meyer (2021) speculate that the lower saving rate of the older group of Americans is due to the fact that they have experienced a much larger rise in wealth due to pure valuation effects. Given that they have higher wealth in retirement due to these valuation effects, they can dissave while still maintaining high wealth. Bartscher, Kuhn, Schularick and Steins (2020) suggest that this lower rate of saving by older Americans could be due to the fact that they can more easily extract home equity. In this sense, older Americans are more likely to "consume" their home equity than in the past.

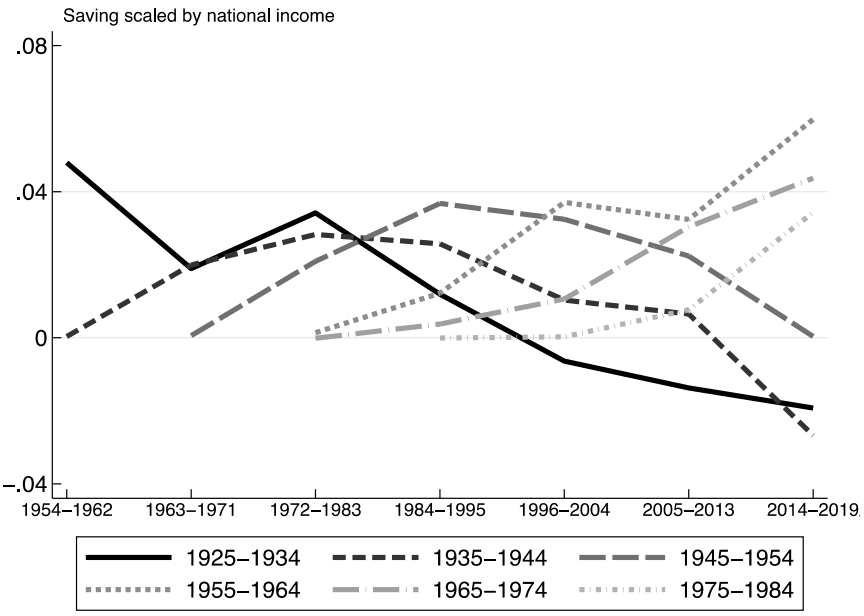
Taken together, the results of this section present two separate difficulties for the view that the aging of the baby boom generation explains the decline in r^* since the 1980s. First, differences in saving rates across the working age distribution are not that large. Second, the aging of the baby boom generation is not associated with a monotonic shift in income toward high saving rate age groups. Each of these factors on its own would mean that the aging of the baby boom generation would be unlikely to explain the decline in r^*. The fact that both are present in the data represents a serious challenge to this view.

IV.D. Saving to national income ratios

The shift-share methodology of Section IV helps explain the underlying economics of why the rise in income inequality is a powerful force leading to a decline in r^*: the rich save a higher fraction of income and they have been earning a larger share of total income over the past 35 years. This section takes a more descriptive approach by showing the evolution of saving by each birth cohort, and the evolution of saving by different income groups within each birth cohort. The SCF+ makes such a descriptive approach useful as it is the first data set that allows for the calculation of saving by birth cohort and income group over a long historical time period.

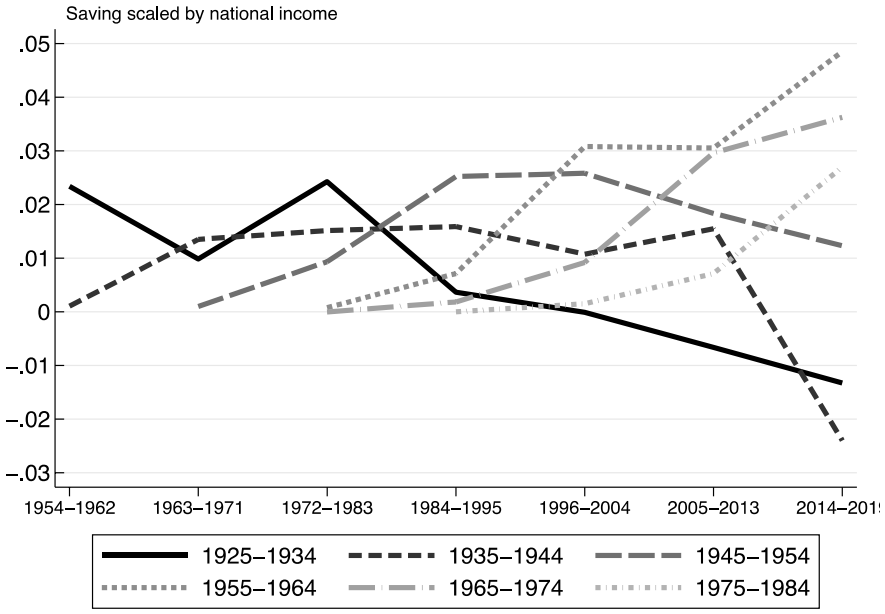
Figure 8 shows the saving to aggregate national income ratio for the six main birth cohorts of the sample, ranging from those born between 1925 to 1934 to those born between 1975 and 1984.[14] Saving by each birth cohort starts low as the cohort enters the work force, and then shows a hump shape that is particularly striking for the 1935 to 1944 and 1945 to 1954 cohort. The larger size of the baby boom generation translates into a rise in saving coming from that group, particularly for the late baby

Figure 8: Saving to national income ratio, by birth-cohort



Note: This figure plots the average annual saving to national income ratio for each birth-cohort across time.

Figure 9: Saving to national income ratio, top 10% income group (within-cohort)

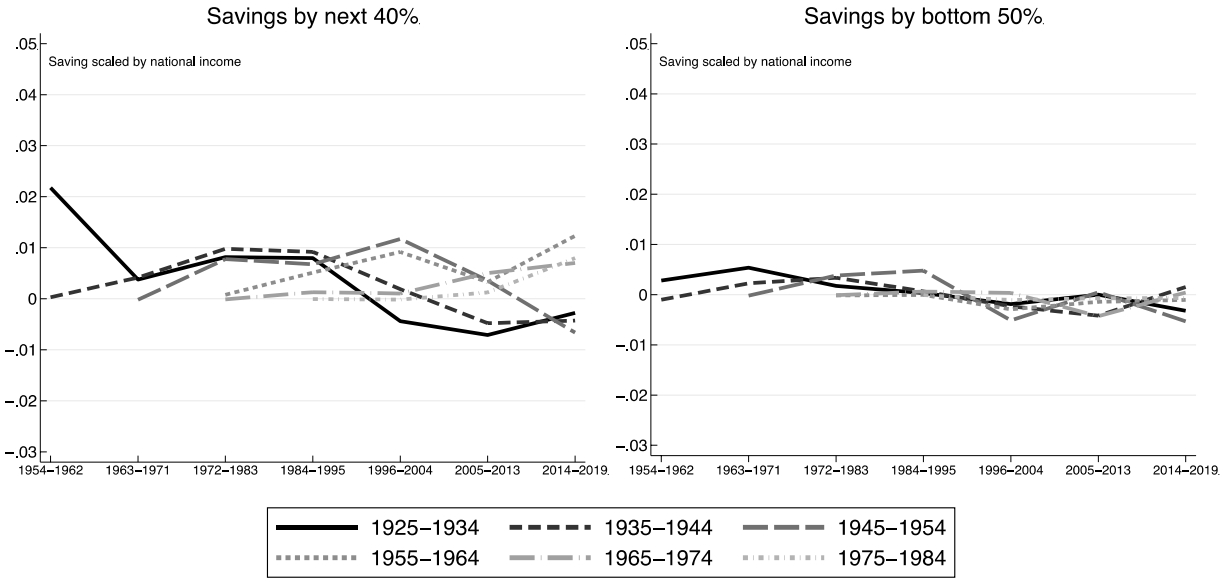


Note: This figure plots the average annual saving to national income ratio for the top 10% income households of each birth-cohort across time.

boomers born between 1955 and 1964. However, the birth cohort coming after the baby boomers (1965 to 1974) also saves substantially more than previous generations. From 2014 to 2019, the saving to national income ratio of the 1965 to 1974 cohort is larger than saving at any point in time for the 1935 to 1944 and 1945 to 1954 birth cohorts.

As the results in Section IV.C suggest, this rise in saving coming from the later birth cohorts is driven entirely by the top of the income distribution within these cohorts. This fact is shown in Figure 9. Starting with the 1955 to 1964 birth cohort (the late baby boomers), the top 10% of each birth cohort shows a substantial rise in saving relative to the top 10% of earlier birth cohorts. For example, consider the top 10% of the 1965 to 1974 birth cohort. This is not a particularly large cohort, and yet the saving by the top 10% of this cohort is larger than saving by the top 10% of any previous cohort with the exception of 1954 to 1965 cohort (the late baby boomers). In contrast, if we focus on the next 40% and bottom 50%, we see that saving is actually falling with each subsequent birth cohort. This is shown in Figure 10. This is particularly striking for the 1965 to 1974 and the 1975 to 1984 birth cohort. The next 40% and bottom 50% are saving less than previous birth cohorts.

Figure 8: Saving to national income ratio, next 40% and bottom 50% income group (within- cohort)



Note: The left and right panels of this figure plot the average annual saving to national income ratio for the next 40% and bottom 50% income households of each birth-cohort across time, respectively.

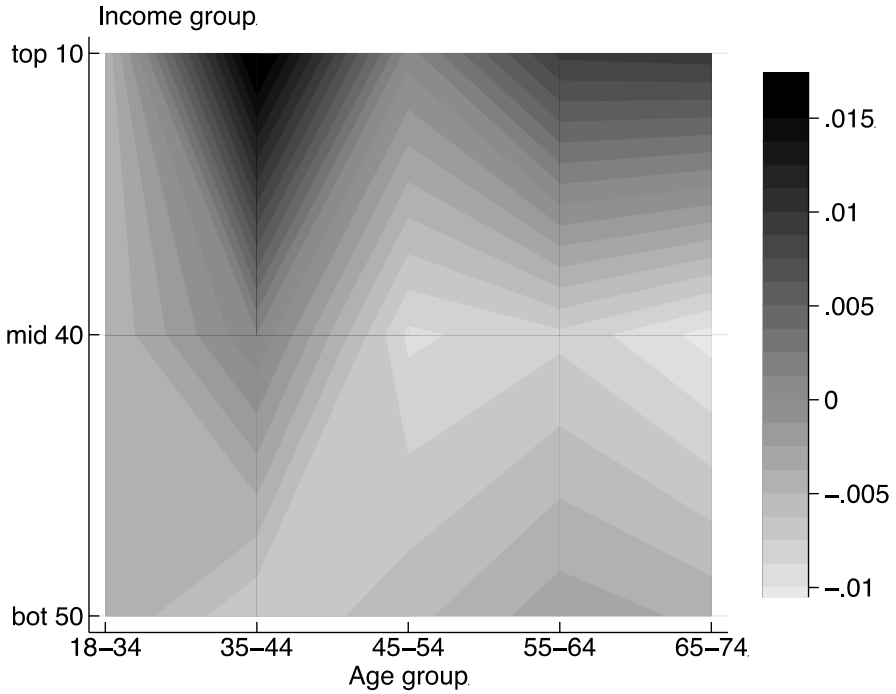
The saving heat map in Figure 11 summarizes these results. More specifically, Figure 11 is constructed by taking the average annual saving to national income ratio in each within-cohort income group and age group cell from 1995 to 2019, and then subtracting average from the pre- period from 1962 to 1983. For every age bin except for the 18 to

34 group, the top 10% is saving significantly more in recent years relative to the pre-period. The bottom 90% is saving less in almost every age bin. As with saving rates, the crucial variation is across the within-cohort income distribution, not the age distribution.

In recent years, the rich are saving more and the non-rich are saving less. This statement is true when defining the rich and non-rich within a given birth cohort, and so this result is not due to mechanical life cycle effects. In Figure 12, the saving by the top 10% and bottom 90% of all of the birth cohorts are summed, respectively. As the figure shows, since the 1980s, saving by the top 10% has risen substantially while saving by the bottom 90% has fallen substantially. By the end of the sample period, when evaluating the sum of each group, all of the private saving in the U.S. economy is generated by the top 10%.

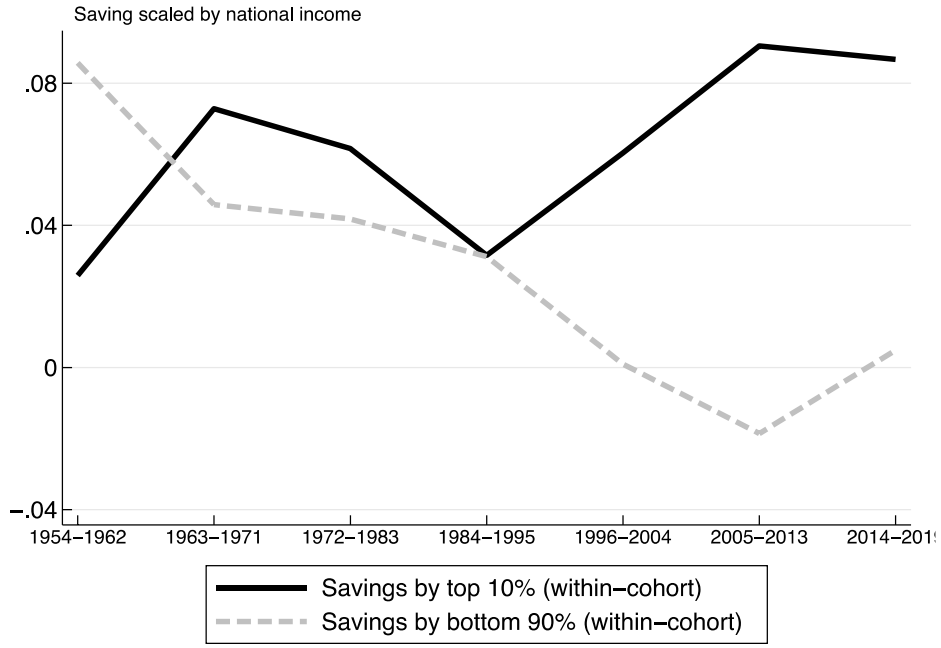
In summary, the conclusion we reach based on these results is that the central pattern in the discussion of household saving behavior in the United States since the 1980s is the widening gap in saving between the top 10% and the bottom 90% of the income distribution. Furthermore, this gap does not appear to be driven by life cycle issues, as it is present even when comparing the rich and non-rich within the same birth cohort. Explanations for the decline in r^* should be consistent with this widening gap in saving between the rich and the non-rich.

Figure 9: Change in actual savings heat map: 1995 to 2019 minus 1962 to 1983



Note: This figure is a heat map of the change in the average annual saving to national income ratio across the within- birth-cohort income distribution and the age distribution. The average annual saving to national income ratio from 1962 to 1983 is subtracted from the average annual saving to national income ratio from 1995 to 2019.

Figure 10: Actual savings of top 10% and bottom 90%, combining all within-cohort income groups



Note: This figure plots the average annual saving to national income ratio for the top 10% income households of all of the birth cohorts and the bottom 90% income households of all of the birth cohorts.

V. Robustness of saving rates

V.A. Comparison with previous estimates

To the best of our knowledge, this study is the first to estimate saving rates across the age and within-birth-cohort income distribution over the entire 1950 to 2019 period in the United States. However, there are a large number of studies that estimate saving rates over different time periods with a focus on only the age or income distribution. The estimates in this study are largely similar to the estimates of the previous literature, which gives us comfort that the data construction and measurement methodology are not generating spurious results. The literature using household sur- veys in the United States almost universally finds that high income households have higher saving rates than middle and low income households.

The most closely related study is Feiveson and Sabelhaus (2019), who use the SCF to estimate saving rates across the age and "normal" income distribution from 1995 to 2016. This study was influential for our analysis, especially for the estimation of bequests and inheritances. The findings across the within-cohort income distribution are similar to the findings presented here. In particular, the average saving rates for the top 10%, next 40%, and bottom 50% for households with a head between 18 and 74 are 0.22, 0.10, and -0.03 for the 1995 to 2016 period.[15]

Another closely related study is Bauluz and Meyer (2021), who also use the SCF+ to estimate saving rates for different birth cohorts. In particular, they focus on saving rates across the age distribution for the cohort born between 1900 and 1929 and the cohort born between 1930 and 1959.[16] The findings are remarkably similar.Saving rates across the age distribution do not show large variation for either of the cohorts during the working age years. For both cohorts, saving rates begin to decline at age 60. They also find that saving rates for the later cohort born between 1930 and 1959 fall more rapidly after age 60. Finally, the authors show that all of the higher rate of wealth accumulation for the later generation is driven by valuation gains instead of saving, a point we return to below in Section VI.C.

In a recent study using Norwegian administrative panel data, Fagereng, Holm, Moll and Natvik (2021) show that saving rates are increasing in the income distribution, and they rise sharply when crossing into the top 10% of the distribution.[17] At the very top of the income distribution, saving rates out of income are above 30 percentage points. The bottom 50% have a saving rate out of income that is less than 5 percentage points. Girshina (2019) uses administrative panel data from Sweden to show that individuals with post high school education college have a saving rate out of income that is four to six percentage points higher than individuals with only compulsory schooling.

The classic citation for estimation of saving rates across the lifetime income distribution is Dynan, Skinner and Zeldes (2004), who use the SCF panel and the PSID panel to show that saving rates tend to be 25 to 50 percentage points higher for those in the top of the lifetime income distribution. Their sample is restricted to the 1983 to 1989 period; the results of this study suggest that these estimated differences are robust to a longer estimation time period.

Summers and Carroll (1987) and Bosworth, Burtless and Sabelhaus (1991) provide estimates of saving rates across the age and income distribution. Summers and Carroll (1987) also find a relatively flat saving rate profile across the age distribution for individuals aged 25 through 54. Saving rates fall from an average of 11% to 8% for individuals 55 to 64, and then become negative for individuals over 65.[18] Bosworth, Burtless and Sabelhaus (1991) find similar results across the age distribution, and they also explore the income distribution.[19] The findings across the income distribution are similar to the findings presented here; saving rates are significantly higher at the high end of the income distribution relative to the low end.

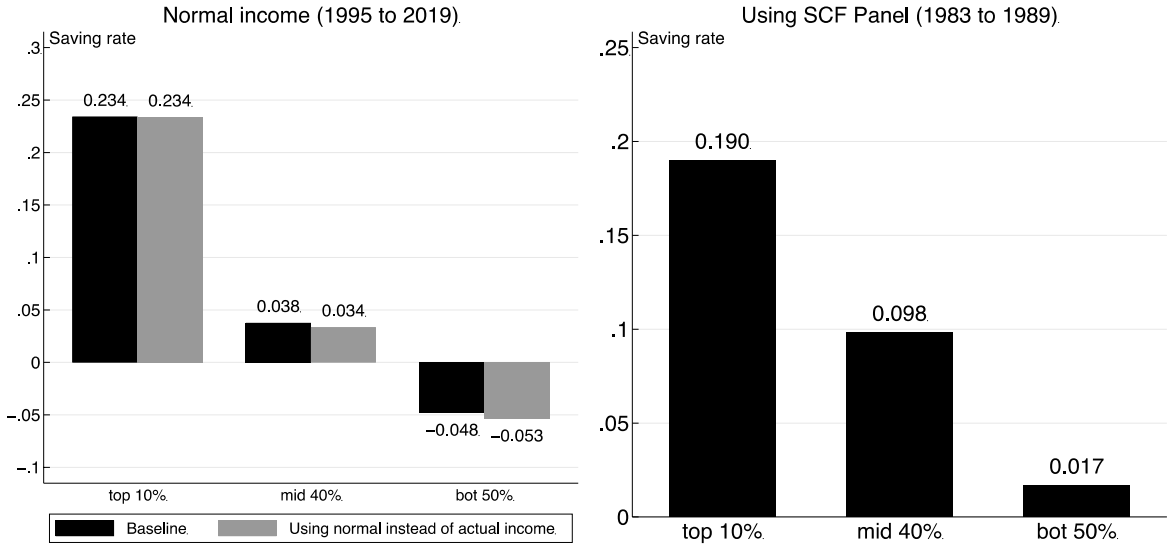
With regard to the age distribution, it is remarkable how similar the conclusions of Bosworth, Burtless and Sabelhaus (1991) are to the conclusions of this study. After examining saving rates across the age distribution, they write: "... we find that changes in the age structure of the population have had and will continue to have only a modest effect on the overall saving rate ... The household survey data thus provide little support for the claim that the saving rate will climb sharply in the near future as the baby-boom generation moves into age groups with historically high saving rates, nor is there good evidence that saving will inevitably decline in the future as the relative size of the retired population climbs." Thirty years later, the findings of this study suggest that this claim was largely correct.[20]

V.B. Permanent income versus transitory shocks

One concern with the estimated large saving rate differences across the income distribution is that the difference is biased upward due to transitory income shocks that shift households into different groups over time. It is important to remember that we are conditioning on being born within the same cohort before sorting on income. As a result, the assumption the methodology makes is that a household's placement in the within-birth cohort income distribution is relatively stable over time. This is a clear weakness in the synthetic panel approach; however, in the absense of a long panel covering saving behavior it remains the best that can be done.

There are two tests we conduct to mitigate this concern. First, the SCF contains a variable measuring the "normal" income of a household in a given year from 1995 to 2019. As mentioned above, this is the measure used by Feiveson and Sabelhaus (2019), and Devlin-Foltz and Sabelhaus (2016) show that this measure of normal income accurately approximates the permanent component of income. The left panel of Figure 13 shows that the saving rates across the within-cohort income distribution are similar when using normal income as opposed to actual income for the 1995 to 2019 period. This suggests that transitory income shocks that move people across the within-cohort income distribution are not responsible for the differences in saving rates.

Figure 11: Robustness: Permanent income



Note: The left panel uses "normal" income from the SCF instead of actual income to sort households and to calculate saving rates. The right panel uses the 1983 to 1989 panel to estimate saving rates across the income distribution.

The second test is based on the influential study by Dynan, Skinner and Zeldes (2004). This study exploits the panel dimension of the SCF from 1983 to 1989. As a result, there is no issue regarding the movement of individuals across the income distribution. As mentioned above, Dynan, Skinner and Zeldes (2004) find similarly large differences in saving rates across the income distribution, where various measures of permanent income for a given individual are used.

Motivated by Dynan, Skinner and Zeldes (2004), we implement the methodology detailed in Section III.B among the panel of households followed in the SCF from 1983 to 1989. There are only 819 households, and so statistical power is an issue. For these 819 households, we observe total income in both 1983 and 1989, and we also observe the birth year of the household head. We sort these households into their respective birth cohorts, and then sort within the birth cohort into income groups based on the household's average real income in 1983 and 1989. We then estimate eachhousehold's saving rate exactly as explained in Section III.B.[21] With these household specific saving rates in hand, we then take the median saving rate for the top 10%, next 40%, and bottom 50% of each birth cohort.[22] Finally, we weight these cohort-specific saving rates of each income group by the total income of the cohort to get an overall saving rate of the top 10%, next 40%, and bottom 50% for the entire panel.

The right panel of Figure 13 shows the results. The saving rate differences are slightly smaller in the 1983 to 1989 panel relative to the overall sample difference shown in Figure 3, but they remain substantial. The top 10% have a saving rate that is between 9 and 17 percentage points higher than the rest of the population. By construction, this exercise is done in a panel and so movement across groups due to transitory income shocks does not bias the estimated saving rates. This gives us further confidence that the difference in saving rates across the within-birth cohort income distribution is substantial.

V.C. Distribution technique, defined benefit pensions, heterogeneous returns

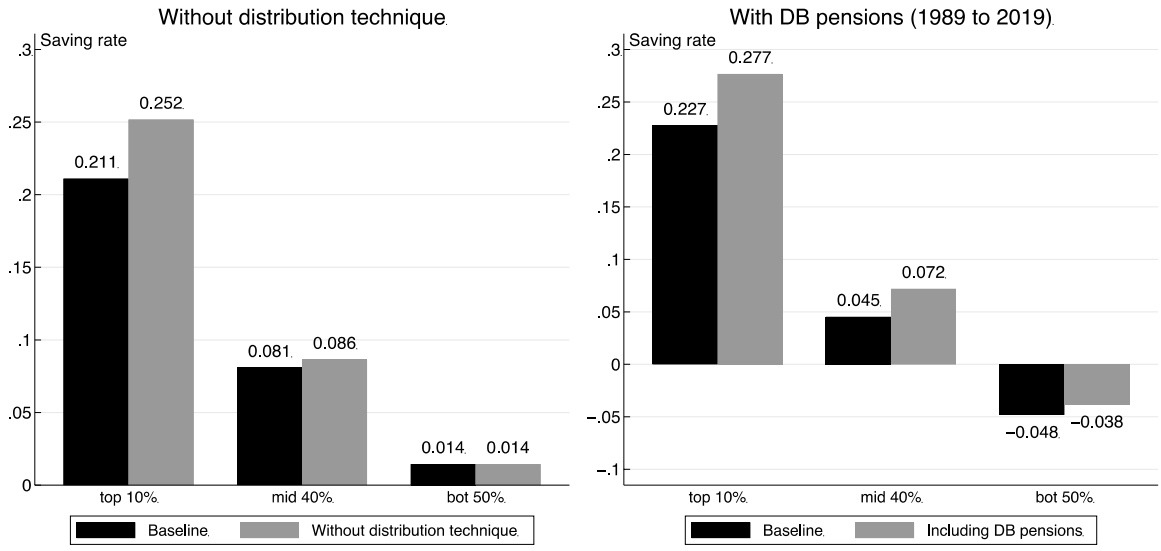
Figure 14 shows the results of two additional robustness tests. The left panel addresses concerns regarding the "distribution" technique described in Section III.D. In particular, the saving rates shown in the left panel of Figure 14 are constructed using the raw data from the SCF+ on wealth and income, as opposed to the technique where SCF+ wealth shares are used to distribute wealth from the Financial Accounts and the NIPA.[23] The saving rates are on average higher, which makes sense given that the income from the SCF+ does not include all components of national income, and therefore the denominator is lower. The differences in saving rates across the income distribution remain substantial.

Another issue relates to defined benefit pensions. A concern with the analysis here is that the difference in saving rates between high income households and the rest of the population is exagger- ated by the exclusion of defined benefit pensions in the baseline SCF+. It is important to remember that savings is approximated by the change in wealth, not by the level of wealth. Using the Sabelhaus and Volz (2021) defined benefit pension data for the SCF (which is available from 1989 onward), it becomes apparent that the bottom 50% of the within-cohort income distribution has experienced a flat profile in their defined benefit pension wealth to national income ratio through 2019. The top 10% and the next 40% have seen a rise in their defined benefit pension wealth to national income ratio.

Given these facts, it should not be surprising that the saving rates when including defined benefit pension wealth increase for the top 50% of the distribution for the 1989 to 2019 period, while the saving rate of the bottom 50% does not increase substantially. The right panel of Figure 14 shows these effects. These findings suggest that the

exclusion of defined benefit pensions likely leads to an underestimate of the difference in saving rates between high income households and the bottom 50% in particular.

Figure 12: Robustness: Distribution technique and defined benefit pensions



Note: The left panel estimates saving rates using the wealth and income recorded in the SCF+ as opposed to using wealth and income shares from the SCF+ to distribute aggregate wealth from the Financial Accounts and aggregate national income from the NIPA. The right panel estimates saving rates including defined benefit pension wealth.

A final issue worth discussion is evidence that higher income households earn higher returns on their asset positions (e.g., Fagereng, Guiso, Malacrino and Pistaferri (2016), Cao and Luo (2017)). A concern may be that savings are mechanically over-estimated for high income households in equation 5 if they earn higher returns on their asset portfolios. This concern is mitigated for two reasons. First, the valuation gain term π_t is calculated for each separate asset class. As a result, any higher returns earned by the higher income households due to portfolio composition is already accounted for in equation 5. Second, it is important to remember that the valuation gain adjustment (π_t) used in the calculation of savings in equation 5 is not the return on the asset. Instead, it is the pure valu- ation gain on the asset. This is part of the overall return, but it is distinct from higher dividends or interest payments on assets. If higher income households earn higher dividends or higher interest payments on a given asset class, then these higher returns show up in the change in wealth term in equation 5, and hence are part of savings. For example, if high income households have deposit accounts that pay higher interest payments than the non-rich, then this is already accounted for in equation 5. Further research is needed to investigate whether high income households experience a higher pure valuation gain on their asset positions than medium and low income individuals.

VI. Other considerations and areas for future research

VI.A. Demographics, inequality, and growth

The demographic shift argument that has been most prominent in the literature is based on the idea that the particularly large size of the baby boom generation would have large effects on r^* because of differences in saving rates across the age distribution. The results in Section IV present a challenge to this view. There are, however, alternative arguments for why demographic shifts are likely to affect r^*.

One view is that demographic shifts and aging in particular affect r^* through their effect on per-capita growth.[24] Several channels through which demographics affect per-capita growth are discussed in Rachel and Smith (2015), which include the effects of aging on the labor force, inno- vation, and capital formation. These effects play an important role in a number of models, including Cutler, Poterba, Sheiner and Summers (1990), Jones (2020), Gagnon, Johannsen and López-Salido (2021), and Auclert, Malmberg, Martenet and Rognlie (2021). However, as already mentioned in Section II, the argument that demographic shifts affect r^* through growth must face the empirical evidence that the long-run relationship between growth and r^* is statistically weak.

Furthermore, it is also theoretically possible that a rise in inequality could affect per-capita growth. Mian, Straub and Sufi (2021a) provide a theoretical result that a rise in top income shares leads to a rise in debt burdens and downward pressure on interest rates, given weakness in demand associated with the higher saving rates out of income by the rich relative to the non-rich. Such a decline in interest rates could endogenously lead to lower productivity growth due either to market concentration issues (as in Liu, Mian and Sufi (2021)) or through Keynesian feedback effects on firm investment in productivity growth in a stagnation trap (as in Benigno and Fornaro (2018)).

Put differently, the empirical evidence presented in this study suggests that rising inequality is the stronger force generating a rise in savings that puts downward pressure on r^*. Any mechanism that leads to a decline in productivity growth as a result of extremely low interest rates could then help explain why growth is lackluster. At the least, the view that demographic shifts and population aging have large effects on r^* through its effect on growth needs to be subjected to rigorous empirical testing. The identification challenges are large as both population aging and a rise in inequality have occurred in many advanced economies throughout the world.

One final note on growth is worth considering. In the representative agent Ramsey framework, a steady state with lower per-capita growth is associated with a lower r^* through the household Euler equation. The logic is that a steady state with lower growth is associated with higher savings today given lower expected income in the future and a desire to smooth consumption. The interest rate must fall to accommodate this larger demand for savings.

However, the empirical patterns are worth exploring further to understand whether this Ramsey logic holds true in the cross-section. Sections IV.C and IV.D show that in any given birth cohort, the households that are saving more today relative to previous birth cohorts are those at the top of the income distribution. Households in the bottom 90%

are actually saving less relative to previous birth cohorts. The Euler equation logic suggests that these patterns are due to the fact that house- holds in the top 10% of recent birth cohorts expect lower income growth relative to the top 10% of previous birth cohorts, whereas households in the bottom 90% of recent cohorts expect higher income growth relative to previous cohorts. Is actual income growth higher or lower today for the top 10% relative to the past? More modeling and empirical research is needed to explore these cross-sectional patterns.

VI.B. Longevity

An alternative factor often cited to explain a rise in saving that puts downward pressure on r^* is rising life expectancies. It is important to note that an increase in longevity is a distinct reason for higher saving relative to the baby boom generation argument articulated in Section II. This point is made nicely in the model by Carvalho, Ferrero and Nechio (2016) who show that rising longevity puts downward pressure on real interest rates as people save more in anticipation of a longer retirement, but it puts upward pressure on real interest rates as it eventually leads to a higher ratio of retirees dis-saving relative to workers saving. There is a need for more theoretical research on exactly how an increase in life expectancy should be expected to affect both the level and distribution of saving across households.

There are two empirical patterns worth considering when evaluating how longevity should affect r^*. As noted by Carvalho, Ferrero and Nechio (2016), longevity may eventually lead to a larger fraction of dis-saving retirees relative to saving workers, which in theory could put upward pressure on r^*. We have already entered such a regime shift in recent years as the baby boom generation retires, and yet measures of r^* and forward measures of r^* continue to decline. In addition, the longevity explanation should acknowledge the differences in saving rates across the within-cohort income distribution. If life expectancy has risen across the income distribution, why have saving rates for the bottom 90% actually fallen? As Table 1 above shows, this is not due only to the bottom 50%, but also for the next 40%. Put differently, the view that higher life expectancy is leading to a rise in saving must be consistent with the fact that the rise in saving is driven entirely by the top 10% of the within-birth-cohort income distribution. There may be reasons why only the top 10% are responding to the rise in life expectancy, and this is a fruitful avenue for future research.

VI.C. Shift-share based on wealth

The shift-share approach used in this study follows a long tradition of using the difference in saving rates as the primitive cross-sectional factor, and then evaluating how shifts in the distribution of income affect saving given differences in saving rates. An alternative technique is a wealth-based shift share approach.[25] This approach starts with the profile of wealth across the age distribution at a given point in time, and it then estimates how shifts in population across the age distribution affect the aggregate wealth to income ratio. A simplified version of the shift-share equation takes on the following form:

$$\frac{W_\tau}{Z_\tau} - \frac{W_0}{Z_0} = \sum_{j=1}^{j=J} (\beta_{j\tau} - \beta_{j0}) \cdot \omega_{j0} + \sum_{j=1}^{j=J} \beta_{j\tau} \cdot (\omega_{j\tau} - \omega_{j0}) \quad (6)$$

where $\beta_{jt} \equiv \frac{N_{jt}}{N_t}$ is the population share of age group j at time t, and $\omega_{jt} \equiv \frac{W_{jt}/N_{jt}}{Z_t/N_t}$ is the ratio of average household wealth for age group j to average household income for all households in the economy. One issue with the wealth-based shift-share approach is that the baseline year age-wealth profile (ω_{j0} in equation 6 above) may be sensitive to the year chosen because of pure valuation effects that are unrelated to saving. This is indeed what has happened to the age-wealth profile in the United States, as shown in Figure 15. The age-wealth profile has changed significantly over the past 50 years, becoming steeper over time. This is especially striking for households with a head that is 65 or older. As a result, a shift-share approach using the age-wealth profile from a baseline year of, say, 1971 will find smaller effects of aging on the wealth to income ratio relative to a shift-share approach using the age-wealth profile from a baseline year of 2019.

Figure 13: Average household wealth across the age distribution

Note: This figure plots $\omega_{jt} \equiv \frac{W_{jt}/N_{jt}}{Z_t/N_t}$ across the age distribution from the SCF+ for different survey waves. This is the ratio of average household wealth for age group j to average household income for all households in the economy.

The age-wealth profile has become steeper over time due to valuation effects, a point that is closely related to the discussion of valuation effects in Section II.IV. Over the past 40 years, the rise in the wealth to income ratio in the United States has not been driven by a rise in aggregate saving. As mentioned above, high income households are saving

more, but middle and low income households are saving less. In Table 3, we focus on the following annual decomposition of changes in wealth:

$$W_t - W_{t-1} = \Theta_t + \pi_t \cdot W_{t-1} \tag{7}$$

where Θ_t is total private saving in year t from NIPA, π_t is the pure valuation effect calculated as in Mian, Straub and Sufi (2021b), W_t is household net worth as measured in Table L.101 of the Financial Accounts. The change in wealth $W_t - W_{t-1}$ can be due to saving (Θ_t) or valuation gains ($\pi_t \cdot W_{t-1}$). We scale each of these three items by national income in year t, and Table 3 shows the averages for the pre-period (1963 to 1983) and post period (1983 to 2019).

Table 3: The determinants of the change in household wealth

Period	ΔW	Θ	$\pi \cdot W$
1963 - 1983	0.145	0.132	0.016
1983 - 2019	0.183	0.094	0.089

Note: This table decomposes the average annual change in wealth to national income ratio into the part that comes from saving and the part that comes from valuation gains: $W_t - W_{t-1} = \Theta_t + \pi_t \cdot W_{t-1}$.

The table shows that valuation effects are fully responsible for the higher rate of wealth accumulation over the past 40 years relative to the pre-period. On an annualized basis, the change in wealth scaled by national income has increased on average 4 percentage points more from 1983 to 2019 relative to 1963 to 1983. This rise in wealth to income ratios is the subject of a large body of research (e.g., Piketty and Zucman (2014)). However, households have actually been saving 3.7 percentage points of national income less relative to the pre-period.

The age-wealth profile has become steeper over time because cohorts that passed through their main working years during this period of large valuation gains experienced a large valuation gain on their portfolio. This is shown explicitly in Bauluz and Meyer (2021). Table 1 of their April 2021 draft compares annual wealth growth for the the 1900 to 1929 birth cohort and the 1930 to 1959 birth cohort. Annual wealth growth has been 3 percentage points higher for the 1930 to 1959 cohort. However, this entire difference is due to valuation effects. The 1930 to 1959 cohort has actually saved less on an annual basis compared to the 1900 to 1929 birth cohort. The age-wealth profile has become steeper as a response to the valuation gains associated with a decline in the expected return on wealth. The key question is what caused this decline in the expected return that boosted valuation ratios; this study argues that the rise in inequality is a chief culprit.

VII. Conclusion

Theoretical hypotheses that seek to explain the decline in r^* generate testable predictions. This study uses a shift-share empirical design to evaluate the predictions of theories that postulate rising income inequality and demographic shifts due to the baby

boom generation as central explanations for the decline in r^*. The evidence supports the idea that rising income inequality is an important factor putting downward pressure on r^*. The saving rates of high income households within a given birth cohort are significantly higher than middle and low income households. As income has shifted toward high income households over time, they have saved 3 to 3.5 percentage points more of national income compared to the pre-1980 period.

The evidence is less convincing for the baby boom generation explanation for the decline in r^*. Saving rates across the working age distribution do not vary as much compared to saving rates across the within-birth-cohort income distribution, and income shift patterns are ambiguous. Demographics are one of the most cited explanations for the decline in r^*. The analysis here casts doubt on one prominent channel for demographics to affect r^*. There are likely other channels through which demographics matter for r^*; however, these other channels should be articulated clearly and they should be subjected to empirical testing.

The relative strength of the rising inequality and shifting demographics hypotheses is perhaps best measured by looking into the future. Current measures of r^* are extremely low, and futures markets indicate an expectation that r^* will stay low in the future. The traditional demographics view argues that measures of r^* should be expected to rise as the baby boom generation retires, a process that is already underway. More recently, there has emerged disagreement on whether shifting demographics should be expected to raise or lower r^* going forward.

In contrast, the rising income inequality view explains the current situation with considerable ease. Income inequality today remains extremely high relative to its pre-1980 level, and there does not appear to be any reversion in inequality in the near future. As a result, according to the rising income inequality view, it is not surprising that current and future expected levels of r^* remain low. If the inequality view is correct, then it suggests that macroeconomic forecasters should closely track the evolution of inequality when forecasting movements in r^* going forward. It also suggests that inequality should play a more central role in macroeconomic models used for policy analysis.

References

Abel, Andrew B, "The effects of a baby boom on stock prices and capital accumulation in the

presence of social security," *Econometrica*, 2003, *71* (2), 551–578.
Acemoglu, Daron and Pascual Restrepo, "Secular stagnation? The effect of aging on economic

growth in the age of automation," *American Economic Review*, 2017, *107* (5), 174–79.
Auclert, Adrien and Matthew Rognlie, "Inequality and Aggregate Demand," 2020.

, Hannes Malmberg, Frédéric Martenet, and Matthew Rognlie, "Demographics, Wealth, and Global Imbalances in the Twenty-First Century," *Working paper, NBER, Cambridge, MA*, 2021.

Auerbach, Alan J and Laurence J Kotlikoff, "Demographics, fiscal policy, and US saving in the 1980s and beyond," *Tax policy and the economy*, 1990, *4*, 73–101.

Bartscher, Alina K, Moritz Kuhn, Moritz Schularick, and Ulrike Steins, "Modigliani Meets Minsky: Inequality, Debt, and Financial Fragility in America, 1950-2016," 2020.

Batty, Michael, Jesse Bricker, Joseph Briggs, Sarah Friedman, Danielle Nemschoff, Eric Nielsen, Kamila Sommer, and Alice Henriques Volz, "The Distributional Financial Accounts of the United States," in "Measuring and Understanding the Distribution and Intra/Inter- Generational Mobility of Income and Wealth," University of Chicago Press, 2020.

Bauluz, Luis and Timothy Meyer, "The Great Divergence: Intergenerational Wealth Inequality in the US and France," *Available at SSRN 3834260*, 2021.

Benhabib, Jess, Alberto Bisin, and Mi Luo, "Wealth distribution and social mobility in the US: A quantitative approach," *American Economic Review*, 2019, *109* (5), 1623–47.

Benigno, Gianluca and Luca Fornaro, "Stagnation traps," *The Review of Economic Studies*, 2018, *85* (3), 1425–1470.

Bhutta, Neil, Jesse Bricker, Andrew C Chang, Lisa J Dettling, Sarena Goodman, Joanne W Hsu, Kevin B Moore, Sarah Reber, Alice Henriques Volz, and Richard Windle, "Changes in US family finances from 2016 to 2019: Evidence from the Survey of Consumer Finances," *Federal Reserve Bulletin*, 2020, *106* (5).

Bosworth, Barry, Gary Burtless, and John Sabelhaus, "The decline in saving: Evidence from household surveys," *Brookings Papers on Economic Activity*, 1991, *1991* (1), 183–256.

Bricker, Jesse, Alice Henriques, Jacob Krimmel, and John Sabelhaus, "Measuring income and wealth at the top using administrative and survey data," *Brookings Papers on Economic Activity*, 2016, *2016* (1), 261–331.

Cao, Dan and Wenlan Luo, "Persistent heterogeneous returns and top end wealth inequality," *Review of Economic Dynamics*, 2017, *26*, 301–326.

Carroll, Christopher D, "Why do the rich save so much?," *Does Atlas Shrug? The Economic Consequences of Taxing the Rich*, 2000, pp. 465–84.

Carvalho, Carlos, Andrea Ferrero, and Fernanda Nechio, "Demographics and real interest rates: Inspecting the mechanism," *European Economic Review*, 2016, *88*, 208–226.

CBO, "The distribution of household income, 2016," *CBO Slides*, 2019, . (.), .

Cutler, David M, James M Poterba, Louise M Sheiner, and Lawrence H Summers, "An aging society: opportunity or challenge?," *Brookings papers on economic activity*, 1990, *1990* (1), 1–73.

Devlin-Foltz, Sebastian and John Sabelhaus, "Heterogeneity in economic shocks and household spending in the US," *Fiscal Studies*, 2016, *37* (1), 153–192.

Dynan, Karen E, Jonathan Skinner, and Stephen P Zeldes, "Do the rich save more?," *Journal of political economy*, 2004, *112* (2), 397–444.

Eccles, Marriner, *Beckoning Frontiers: Public and Personal Recollections*, New York: Alfred A. Knopf, 1951.

Eggertsson, Gauti B, Manuel Lancastre, and Lawrence H Summers, "Aging, output per capita, and secular stagnation," *American Economic Review: Insights*, 2019, *1* (3), 325–42.

, Neil R Mehrotra, and Jacob A Robbins, "A model of secular stagnation: Theory and quanti- tative evaluation," *American Economic Journal: Macroeconomics*, 2019, *11* (1), 1–48.

Fagereng, Andreas, Luigi Guiso, Davide Malacrino, and Luigi Pistaferri, "Heterogeneity in returns to wealth and the measurement of wealth inequality," *American Economic Review*, 2016, *106* (5), 651–55.

, Martin Blomhoff Holm, Benjamin Moll, and Gisle Natvik, "Saving Behavior Across the Wealth Distribution: The Importance of Capital Gains," 2021.

Feiveson, Laura and John Sabelhaus, "Lifecycle patterns of saving and wealth accumulation," *Finance and Economics Discussion Series 2019-010. Washington: Board of Governors of the Federal Reserve System*, 2019.

Furman, Jason and Lawrence Summers, "A reconsideration of fiscal policy in the era of low interest rates," 2020.

Gabaix, Xavier and Ralph SJ Koijen, "In search of the origins of financial fluctuations: The inelastic markets hypothesis," Technical Report, National Bureau of Economic Research 2021.

Gagnon, Etienne, Benjamin K Johannsen, and David López-Salido, "Understanding the new normal: the role of demographics," *IMF Economic Review*, 2021, *69* (2), 357–390.

Girshina, Anastasia, "Wealth, savings, and returns over the life cycle: the role of education," *Swedish House of Finance Research Paper*, 2019, (19-10).

Goodhart, Charles and Manoj Pradhan, *The great demographic reversal: Ageing societies, wan- ing inequality, and an inflation revival*, Springer Nature, 2020.

Greenwald, Daniel L, Matteo Leombroni, Hanno Lustig, and Stijn Van Nieuwerburgh, "Fi- nancial and Total Wealth Inequality with Declining Interest Rates," Technical Report, National Bureau of Economic Research 2021.

Guvenen, Fatih, Greg Kaplan, Jae Song, and Justin Weidner, "Lifetime Earnings in the United States over Six Decades," *University of Chicago, Becker Friedman Institute for Economics Work- ing Paper*, 2021, (2021-60).

Hamilton, James D, Ethan S Harris, Jan Hatzius, and Kenneth D West, "The equilibrium real funds rate: Past, present, and future," *IMF Economic Review*, 2016, *64* (4), 660–707.

Hobson, John Atkinson, *Imperialism: A Study*, New York: James Pott, 1902.

Jones, Callum, "Aging, Secular Stagnation and the Business Cycle," *Working Paper*, 2020.

Jordà, Òscar and Alan M Taylor, "Riders on the Storm," Technical Report, National Bureau of Economic Research 2019.

Kaymak, Barıs, and Markus Poschke, "The evolution of wealth inequality over half a century: The role of taxes, transfers and technology," *Journal of Monetary Economics*, 2016, *77*, 1–25.

Klein, Matthew C and Michael Pettis, *Trade wars are class wars: How rising inequality distorts the global economy and threatens international peace*, Yale University Press, 2020.

Kopczuk, Wojciech, Emmanuel Saez, and Jae Song, "Earnings inequality and mobility in the United States: evidence from social security data since 1937," *The Quarterly Journal of Eco- nomics*, 2010, *125* (1), 91–128.

Kuhn, Moritz, Moritz Schularick, and Ulrike I Steins, "Income and wealth inequality in america, 1949–2016," *Journal of Political Economy*, 2020, *128* (9), 3469–3519.

Laubach, Thomas and John C Williams, "Measuring the natural rate of interest," *Review of Economics and Statistics*, 2003, *85* (4), 1063–1070.

Liu, Ernest, Atif Mian, and Amir Sufi, "Low interest rates, market power, and productivity growth," *Econometrica*, 2021, *forthcoming.*

Lunsford, Kurt G and Kenneth D West, "Some evidence on secular drivers of US safe real rates," *American Economic Journal: Macroeconomics*, 2019, *11* (4), 113–39.

Mian, Atif, Ludwig Straub, and Amir Sufi, "Indebted Demand," *The Quarterly Journal of Eco- nomics*, 2021, *forthcoming.*

Mian, Atif R, Ludwig Straub, and Amir Sufi, "The Saving Glut of the Rich," Technical Report, National Bureau of Economic Research 2021.

Nardi, Mariacristina De, "Wealth inequality and intergenerational links," *The Review of Economic Studies*, 2004, *71* (3), 743–768.

and Giulio Fella, "Saving and wealth inequality," *Review of Economic Dynamics*, 2017, *26*, 280–300.

Pettis, Michael, "Why a savings glut does not increase savings," Technical Report, Carnegie Endowment for International Peace 2017.

Piketty, Thomas and Emmanuel Saez, "Income inequality in the United States, 1913–1998," *The Quarterly journal of economics*, 2003, *118* (1), 1–41.

and Gabriel Zucman, "Capital is back: Wealth-income ratios in rich countries 1700–2010," *The Quarterly Journal of Economics*, 2014, *129* (3), 1255–1310.

, Emmanuel Saez, and Gabriel Zucman, "Distributional national accounts: methods and esti- mates for the United States," *The Quarterly Journal of Economics*, 2018, *133* (2), 553–609.

Poterba, James M, "Demographic structure and asset returns," *Review of Economics and Statistics*, 2001, *83* (4), 565–584.

Rachel, Łukasz and Lawrence H Summers, "On secular stagnation in the industrialized world," Technical Report, National Bureau of Economic Research 2019.

Rachel, Lukasz and Thomas Smith, "Secular drivers of the global real interest rate," *Bank of England Working Paper*, 2015.

Sabelhaus, John Edward and Alice Henriques Volz, "Social Security Wealth, Inequality, and Lifecycle Saving," Forthcoming in Measuring and Understanding the Distribution and Intra/Inter-Generational Mobility of Income and Wealth," *National Bureau of Economic Research, Studies in Income and Wealth*, 2021.

Saez, Emmanuel and Gabriel Zucman, "Wealth inequality in the United States since 1913: Ev- idence from capitalized income tax data," *The Quarterly Journal of Economics*, 2016, *131* (2), 519–578.

and , "Trends in US Income and Wealth Inequality: Revising After the Revisionists," Technical Report, National Bureau of Economic Research 2020.

Smith, Matthew, Owen M Zidar, and Eric Zwick, "Top Wealth in the United States: New Estimates and Implications for Taxing the Rich," Technical Report, Working Paper 2020.

Straub, Ludwig, "Consumption, Savings, and the Distribution of Permanent Income," *Unpub- lished manuscript, Harvard University*, 2019.

Summers, Lawrence and Chris Carroll, "Why is US national saving so low?," *Brookings Papers on Economic Activity*, 1987, *1987* (2), 607–642.

Summers, Lawrence H, "US economic prospects: Secular stagnation, hysteresis, and the zero lower bound," *Business Economics*, 2014, *49* (2), 65–73.

A Data Appendix

A.1 Details on the SCF+

We use the novel SCF+ provided by Kuhn, Schularick and Steins (2020). From 1947 until 1971 the early SCF waves are conducted annually, then continued in 1977 and 1983. Kuhn, Schularick and Steins (2020) exclude the survey years 1947, 1948, 1952, 1961, 1964, and 1966, because of missing information on housing, mortgages, and liquid assets. We follow Kuhn et al. (2020) and pool the remaining early SCF waves across a three-year window.[26] Appending the 2019 SCF gives us a triennial cross-section of US households from 1950 to 2019, with the exception of a six-year distance from the last survey of the 1977 and 1983 SCF waves.

A.2 Details on the measurement of savings

This section will provide a detailed explanation of how we estimate the annual savings based on the three respectively six-year changes in the SCF+. We start with the basic assumption that the savings amount and the net inheritances are constant across the three respectively six years. We can rewrite equation (2) to

$$W_{jt} = \Theta_{jt} + H_{jt} + (1 + \pi_t) \cdot W_{jt-1} \tag{8}$$

where Θ_{jt} is nominal savings by group *j* at time *t*, W_{jt} is nominal wealth of group *j* at time *t*, π_t is the pure valuation gain on wealth, and H_{jt} is net inheritances going to group *j* at time *t*. We can expand equation 8 by recursively inserting the definition for W_{jt-x}, $\forall x \in \{1, ..., l\}$, whereas the choice of *l* depends on the distance to the most recent SCF wave, which can be either three or six years. So, for example, for $l = 6$, we have:

$$\begin{aligned} W_{jt} = \Theta_{jt} + H_{jt} + (1 + \pi_t)\left(\Theta_{jt-1} + H_{jt-1}\right) + (1 + \pi_t)(1 + \pi_{t-1})\left(\Theta_{jt-2} + H_{jt-2}\right) + \cdots \\ + (1 + \pi_t)(1 + \pi_{t-1}) \cdot \ldots \cdot (1 + \pi_{t-l+2})\left(\Theta_{jt-l+2} + H_{t-l+1}\right) \\ + (1 + \pi_t)(1 + \pi_{t-1}) \cdot \ldots \cdot (1 + \pi_{t-l+1}) W_{jt-l} \end{aligned}$$

The assumption of constant savings and net inheritances translates into $\overline{\Theta}_t = \Theta_t = \ldots = \Theta_{t-l+1}$ and $\overline{H}_{jt} = H_{jt} = \ldots = H_{jt-l+1}$. After solving equation 9, the annualized savings can be stated as the following identity

$$\overline{\Theta}_t = W_{jt} \frac{W_{jt} - \prod_{j=0}^{l-2}(1 + \pi_{t-i}) W_{jt-l}}{1 + (1 + \pi_t) + \cdots + (1 + \pi_{t-l+2})} - \overline{H}_{jt}, \forall t \in \{t - l, \ldots, t\}.$$

To obtain saving rates for a given group *j*, we divide $\overline{\Theta}_{jt}$ by annualized average income of group *j* between $t - l$ and *t*.

A.3 More details on wealth-based approach to measuring savings

The net worth variable in the SCF+ equals the difference between assets and debt. It consists of 12 categories, on the asset side there are: Bonds, saving bonds, liquid assets

and certificates of deposit, mutual funds, quasi-liquid retirement accounts, life insurance, other financial assets, business wealth, the real value of house, and miscellaneous assets. Whereas the last category is the residual component that measures any additional financial assets that are not captured in the categories composing the financial assets.

Specifically the miscellaneous assets are calculated as **min**(financial assets - (bonds + saving bonds + liquid assets and certificates of deposit + equity + mutual funds + quasi-liquid retirement accounts + life insurance + other financial assets), 0). The total debt is composed of personal and housing debt.

The synthetic savings approach requires an estimate of the asset price inflation π_t^c of asset c at time t. To allow for different valuation effects, the following asset categories are split into a fixed income and equity component: Mutual funds, quasi-liquid retirement accounts, life insurance, miscellaneous assets. We split these categories into fixed income and equity components using the aggregate shares of each category from the Financial Accounts. Starting with Table L.101 Households and Non-profit Organizations from the Financial Accounts by the Federal Reserve, the mutual funds fixed income shares are calculated using Table L.122 Mutual Funds. The fixed income share is defined as the ratio of loans (other loans and advances) and debt securities to total financial assets; the equity share is obtained by subtracting the fixed income share from one. Similarly, we calculate the pension and life insurance equity and fixed income shares using Table L.116 Life Insurance Companies respectively Table L.117 Private and Public Pension Funds.

After this split, we can aggregate the components of the net worth variable into seven categories: fixed income assets, corporate equity, private business wealth, real estate, mortgage debt, personal debt, and a miscellaneous category. Fixed income assets are obtained by the sum of bonds, saving bonds, liquid assets and certificates of deposit, mutual funds (fixed income part), quasi-liquid re- tirement accounts (fixed income part), life insurance (fixed income part), and miscellaneous assets (fixed income part). Corporate equity is the sum of corporate and non-corporate business equity, mutual funds (equity part), quasi-liquid retirement accounts (equity part), life insurance (equity part), and miscellaneous assets (equity part).

The estimation of the π_t^c terms follows closely the analysis in Mian, Straub and Sufi (2021b), and so we will not repeat the full explanation here. See in particular Section 2.4 and Appendix section A.4 of Mian, Straub and Sufi (2021b). A key point is that the estimate of the residual π_t^c for the asset class that includes corporate equity, non-corporate business equity, and miscellaneous assets is set in order to match aggregate private saving from the NIPA. As Mian, Straub and Sufi (2021b) show, this measure of π_t^c is strongly correlated with a measure of π_t^c using capital gains on the stock market, but it is a more accurate measure of pure valuation gains as capital gains on the stock market also include saving by businesses, which should be included in saving, not pure valuation gains. See Mian, Straub and Sufi (2021b) for more details.

A.4 Details on the net inheritance estimation

To estimate the net inheritances we closely follow the procedure from Feiveson and Sabelhaus (2019) and Bauluz and Meyer (2021). The received transfers (inheritances) are recorded by the SCF *Inheritances and Gifts Received* module, whereas the transfers made at death (bequests) have to be estimated with the mortality multiplier method.

Estimation of bequests

Taking the givers' perspective, three input variables are required. Firstly, the wealth holdings from the SCF. Secondly, the cohort mortality rates from the Social Security Administration (SSA). Thirdly, the mortality differentials from the Congressional Budget Office (CBO). Since the SCF *Inheritances and Gifts Received* module asks to exclude interspousal transfers, the procedure only estimates the bequests for single households and married couples that die in the same year. Hence the bequests in year t are calculated as

$$B_t = \sum_{n \in N_{Single}} \omega_{it}^{adj} \cdot p^{adj}(s_i, a_i, t) \; + \sum_{n \in N_{Married}} \omega_{it}^{adj} \cdot \; p^{adj}(s_{i1}, a_{i1}, t) \; \cdot \; p^{adj}(s_{i2}, a_{i2}, t),$$

with N_{Single} and $N_{Married}$ being the set of single households respectively married households, ω_{it}^{adj} is defined as the adjusted wealth, and $p^{adj}(s_{i2}, a_{i2}, t)$ are the adjusted death probabilities for the reference person of household *i* dependent on gender *s*, age *a* in year *t*. For married households, the wealth is multiplied by the death probabilities of the reference person and the spouse. Following Feiveson and Sabelhaus (2019), the wealth variable is adjusted using the IRS estate tax statistics to account for funeral, legal and other administrative costs, charitable deductions as well as the effective estate tax rate. To refine the death probabilities, the Congressional Budget Office (CBOLT) Mortality Differentials are used. These multipliers are dependent on the reference persons' gender, race, age, education, income quintile, and marital status.

Estimation of inheritances

Feiveson and Sabelhaus (2019) use the reconciled inheritances calculated from the inheritance and gifts, assets, and income modules. Since they show that the latter two modules add relatively little to the aggregated inheritances for the survey waves between 1995 and 2016, we will follow Bauluz and Meyer (2021) and only use the reported values from the *Inheritances and Gifts Received* module.

In this section we will not match the aggregated bequests to the inheritances, the goal is rather to obtain a density estimate with respect to age to distribute the calculated bequests from the giving to the receiving household. The inheritance and gifts received module of the modern SCF waves (1989-2019) is pooled into three time periods: 1989-1995, 1998-2007 and 2010-2019. Since the module contains the information on when the inheritance was received, it is possible to estimate the density with respect to age for the three periods.

The received inheritance by age is defined as

$$H_{t,a} = B_t \cdot d_{t,a}$$

with B_t being the bequests in year t and $d_{t,a}$ corresponding to the density estimate of age a in year t.

Allocating the inheritance to the SCF+

The aggregated received inheritances by age are matched to the corresponding year and age infor- mation in the SCF+. To ensure that each household obtains the proportion such that the weighted sum aggregates to the estimated bequests in year t, $H_{t,a}$ is divided by the weights for that year-age group. Hence the inheritance for household i in year t is obtained by

$$\mathrm{H_{i,t}} = \frac{\mathrm{H_{t,a}}}{\sum_i weight_{t,a}}.$$

To account for the in- and outflow of transfers, the net inheritance is defined as the difference between the received and given inheritance.

Endnotes

[1] See also Jordà and Taylor (2019) for similar evidence.

[2] The idea that the rich have higher saving rates out of lifetime income than the non-rich has a long history in economic research. Among others, see the classic arguments by Hobson (1902) and Eccles (1951). Among more recent work, see studies by Carroll (2000), De Nardi (2004), Kaymak and Poschke (2016), Benhabib, Bisin and Luo (2019), Straub (2019), and Klein and Pettis (2020). An excellent summary of the literature is De Nardi and Fella (2017). We discuss empirical research supporting higher saving rates of the rich in Section V.A.

[3] The influence of the baby boom generation on this literature can be seen by the fact that two of the most influential papers written on the topic–Poterba (2001) and Abel (2003)–both begin with a sentence focused on the baby boom generation. The study by Poterba (2001) starts with this as motivation, but finds limited evidence that the baby boom generation has a large effect on asset returns.

[4] See Pettis (2017) and Klein and Pettis (2020) for a similar argument. The title of the Pettis (2017) article sums this logic up perfectly: "Why a Savings Glut Does Not Increase Savings."

[5] There is empirical support to this mechanism: Bartscher, Kuhn, Schularick and Steins (2020) and Mian, Straub and Sufi (2021b) both show that the bottom 90% of the wealth distribution experienced large valuation gains on housing assets from 1998 to 2007, borrowed heavily against those assets, and actually saved less than in previous years.

[6] A closely related point is that any force that reduces r^* can amplify wealth inequality through a valuation effect related to duration of portfolios. See, for example, Greenwald, Leombroni, Lustig and Van Nieuwerburgh (2021).

[7] For details on the SCF from 1989 and after, please see Bhutta et al. (2020).

[8] The synthetic saving approach has also been implemented using tax filing data, as in Saez and Zucman (2016), Smith, Zidar and Zwick (2020), and Mian, Straub and Sufi (2021b)

[9] The SCF oversamples the top of the wealth distribution from 1989 onward, but does not do so prior to that year. For this reason, we do not focus on an even higher income group within a birth cohort such as the top 5% or top 1%. See Kuhn, Schularick and Steins (2020) for more details.

[10] Bricker, Henriques, Krimmel and Sabelhaus (2016) and Feiveson and Sabelhaus (2019) have a detailed discussion of the difference in income concepts from NIPA, tax filings, and the SCF.

[11] In the shift-share methodology section, we focus only on birth cohorts in any given year in which the median age of the household head is 74 or younger. For households with a head older than 75, saving rates are noisily measured given the large decline in income associated with retirement. In Section IV.D, we include those that are 75+ in a given year.

[12] As a comparison, the updated shares of national income by Saez and Zucman (2020) show a rise in the top 10% share from 1983 to 2019 of 10.2%, and the CBO (2019) shows a rise from 1983 to 2016 of 7.2%.

[13] See Figure 10 of the April 2021 draft.

[14] The sample includes earlier and later birth cohorts, but we do not see them over a substantial part of their life cycle. For example, there are households in the late years of the SCF+ for which the head of household is born between 1985 and 1994, but we only see these households at young ages. To keep the graphs readable, we do not plot the earlier and later birth cohorts.

[15] See Table 5 of the July 2019 revision.

[16] See in particular Figure 10 from the April 2021 draft.

[17] See Figure 9 of the May 2021 draft.

[18] See their Table 10.

[19] See their Table 3 for the age distribution and Table 5 for the income distribution.

[20] The slightly later study by Poterba (2001) concludes similarly: "Most of the empirical results suggest very little relationship between population age structure and asset returns."

[21] The same measures of valuation gains (π_t) described in Section III are used when estimating savings by a given household. For this exercise, we ignore net inheritances.

[22] We use the median instead of the mean because there are extreme outliers.

[23] The same measures of valuation gains (π_t) and net inheritances (H_{it}) as described in Section 3 are used to estimate savings in this robustness test, but the changes in wealth and the income are from the original SCF+.

[24] There is a long history of studies exploring the direct effect of demographic shifts on per-capita growth. See for example Cutler, Poterba, Sheiner and Summers (1990), Acemoglu and Restrepo (2017), and Eggertsson, Lancastre and Summers (2019a).

[25] Using a wealth-based shift share approach across a large number of countries, Auclert, Malmberg, Martenet and Rognlie (2021) find that demographic trends will put downward pressure on r^* and upward pressure on the wealth to income ratio in the future. As the authors discuss, this prediction is the opposite of the prediction of much of the existing demographics literature, which argues that going forward r^* is likely to rise (e.g., Goodhart and Pradhan (2020)).

[26] Detailed summary statistics on the number of households in the pooled survey years can be found in Table A.1. in Kuhn, Schularick and Steins (2020).