Macroeconomic Implications of Income Inequality

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July 1, 2026

Abstract

We explore the long-run macroeconomic implications of an increase in wealth inequality due to more volatility in household income. We distinguish between labor and asset income as well as changes caused by persistent and transitory influences. We find that, consistent with empirical trends in recent decades, increased inequality due to greater income volatility tends to lead to a fall in the risk-free rate and a larger gap between the risky and risk-free rate irrespective of the source. At the same time, the magnitude of these changes as well as the direction and size of the broader effects on the economy—including on the capital stock, output, and factor prices—depend importantly on the source of rising inequality. Our analysis cautions that assumptions about the drivers of inequality are not without loss of generality in economic models.

JEL Codes: D31, D33, E21, E25, J11.

Keywords: income and wealth inequality; heterogeneous returns; interest rates; risk premium.

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1 Introduction

Income and wealth have become increasingly concentrated in the U.S. in the past few decades. In this paper, we analyze how volatility in households' labor and asset income might contribute to rising inequality and affect the broader macroeconomy—including interest rates and real activity—using a general-equilibrium, overlapping-generations model. Unlike most previous quantitative explorations that focus on heterogeneous labor earnings as the driver of inequality, we consider a variety of sources of income volatility and examine whether the particular source matters.[1] We find that increased labor and asset income volatility typically leads to a rise in measures of income and wealth inequality, a fall in the risk-free rate, and an increase in the spread between the risky and the risk-free rate of return—implications that are qualitatively consistent with observed trends. However, we also find that the size of these effects (as well as the direction and magnitude of changes in risky returns, the stock of capital, and output) depend on the drivers of inequality. Our analysis indicates that different drivers of inequality have different macro implications. Thus, in the context of macroeconomic modeling, the choice of the drivers of inequality is not without loss of generality.

We carry out our analysis using a life-cycle model that allows for heterogeneity across households in both labor and asset income. Our heterogeneous-agents, overlapping-generation model builds on the Bewley-Huggett-Aiyagari (BHA) framework. As is typical with this framework, we assume that households are subject to persistent idiosyncratic labor income shocks each period until they reach retirement. Thereafter, they rely on their savings and social security transfers to sustain consumption. To match observed levels of inequality in income and wealth, we augment labor income dynamics for the general population with the possibility of becoming a top earner, as in Castañeda, Díaz-Giménez, and Ríos-Rull (2003). In addition, to explore the role of different drivers of inequality, we assume that households apportion their savings between a risky asset, which we model as a claim on physical capital, with a return that is heterogeneous across households and a risk-free one-period bond, which offers the same deterministic return to everyone. We further assume that households face a cost of adjusting their holdings of the risky asset, making that asset less liquid than the risk-free bond and inducing most households to hold both types of assets in equilibrium. Our discussion refers to the difference between the average return on the risky asset and the return on the risk-free asset as the risk premium; portfolio adjustment costs are reflected in this spread. Most previous studies do not include this portfolio choice or heterogeneity in returns across households and thus do not address how the returns on different assets may be differentially affected by inequality.[2]

[1] The focus on labor earnings has been facilitated by the relative availability of labor earnings data, which show that labor income inequality is pervasive, even when measured within demographic and skill groups, and that it has increased over time. However, there is growing recognition that heterogeneity in labor income alone is insufficient to account for the extent and evolution of inequality. See, for example, Benhabib, Bisin, and Zhu (2011), De Nardi and Fella (2017), and Stachurski and Toda (2019).

[2] One exception is Guvenen and others (2019), who introduce idiosyncratic returns to saving through a three-state entrepreneurial shock.

To assess whether the macroeconomic effects of increases in inequality depend on their origins, we compare the stationary equilibrium under our baseline calibration of the model and to those obtained under a variety of alternative parameterizations of the labor income and risky asset return processes that lead to equal-size increases in wealth inequality (as measured by the Gini coefficient of the distribution of net wealth). In particular, we explore changes in income volatility due to (i) the dynamics of labor earnings in the general population; (ii) the corresponding dynamics among top earners; (iii) the return on household savings; and (iv) the correlation between labor income and the return on savings. In doing so, we distinguish between changes to income processes that increase either the persistence or the period volatility of income shocks. Each alternative parameterization creates extra dispersion in total household income and, ultimately, greater concentration of wealth among the top quintile of households. Comparing across stationary equilibria, we find two key takeaways.

First, an increase in income volatility typically leads to a fall in the risk-free rate, and a widening of the risk premium. Intuitively, an increase in income volatility, whether it arises from changes in the persistence or volatility of the driving processes, heightens precautionary savings motives, with households seeking to protect against greater income risk by boosting their demand for the relatively safe asset. As a result, the risk-free rate typically falls and the spread between the risky and risk-free rate widens.[3] These results are consistent with the observed general trends over the past several decades in inequality, the risk-free rate, and the risk premium (see appendix C for evidence and a discussion). Thus, these results suggest that increased income volatility is a plausible contributor to these corresponding developments.

Second, the magnitudes of these changes, as well as the direction and size of the broader effects on the economy, depend importantly on the source of the rise in inequality. We find that, when the increase in inequality is from a change in the volatility of labor income in the general population, the overall demand for savings in both the risk-free and risky assets increases, leading both rates to fall, although the risk-free rate does so to a larger extend due to the enhanced precautionary benefit. An increase in overall savings also leads to an increase in economic activity. In contrast, when the increase in income volatility comes from the top earners, the overall demand for savings also increases, but primarily in the form of more demand for the risk-free asset because top earners tend to allocate a relatively larger share of their savings in the safe asset to economize in portfolio adjustment costs. Thus, the size of the implications for the risky return and output are much more muted. Alternatively, when the increase volatility is due to the returns to the risky asset households not only want to save more in the face of more uncertainty but they also want to reallocate their portfolio of savings away from the risky and towards the risk-free asset which leads the risky return to increase while capital and economic activity fall. Finally, we find that even when the underlying shock processes for labor income and the returns to savings are unchanged, adding correlation between the two processes increases overall income and wealth inequality. In this case, divergent

[3]For explanations other than increased income volatility consistent with a fall in the risk-free rate and a rise in the risk premium, see Caballero, Farhi, and Gourinchas (2017) and Marx, Mojon, and Velde (2021).

and offsetting responses between high- and low-income households lead to mostly offsetting effects in asset markets and the overall macroeconomic implications are limited.

Overall, we emphasize that some of these results could be specific to modelling choices. For instance, to the extent that much of the inequality in the economy is due to a small group of households having relatively large incomes and wealth, the economic effects will tend to be sensitive to relatively small changes in the income process of these households. Households' ability to mitigate income risk by changing the allocation of their savings across asset classes is another important determinant of the response of interest rates, the capital stock, and output in equilibrium. Portfolio adjustment costs that impede the rebalancing of households' risky asset holdings can, for example, influence whether heightened precautionary demand for savings shows up primarily as increased demand for the risk-free bond or is distributed more equally between the two asset classes. For these reasons, our analysis cautions that not only are the assumptions about the drivers of inequality but also the frictions in the model are important for broader inference about their macroeconomic effects.

Of course, there are several factors other than income risk that can give rise to inequality in income and wealth and shape their evolution. Other possible contributors to inequality not explored in our study include, among others, heterogeneous preferences, including risk tolerance (for example, Krusell and Smith (1998), Dynan, Skinner, and Zeldes (2004), Toda (2019), and Carroll and others (2017)); inheritances (for example, Wolff and Gittleman (2014)); heterogeneous household labor supplies (for example, Flavin and Yamashita (2002) Flavin and Yamashita (2002, 2011) and Yum (2018)); and changes in tax rates and transfers (for example, Kaymak and Poschke (2016), Cao and Luo (2017), and Aoki and Nirei (2017)). Accordingly, our study centers on the plausibility of greater income risk as a contributor to some salient macroeconomic trends and on understanding its broader macroeconomic implications, as opposed to providing a formal accounting of the many potential contributors to the observed rise in inequality measures.

To our knowledge, our paper is the first to explore the long-run macroeconomic implications of inequality with a focus on the source of income risk in a general-equilibrium, overlapping-generations model that combines idiosyncratic labor incomes, idiosyncratic asset returns, and a portfolio allocation decision. As our results illustrate, these features interact in ways that make the origins of the rise in inequality relevant for inference about the macroeconomy. For example, in a model in which the return on capital is identical to the risk-free rate by assumption, Auclert and Rognlie (2018) find that a redistribution of income toward relatively rich households leads to a rise in the aggregate demand for savings and a fall in interest rates because rich households tend to save more of their income than the rest of the population.[4] However, by introducing multiple assets and sources of inequality, we are able to explore how precautionary demand for savings depends on the drivers of income volatility and can manifest differently across asset markets.

Other papers have embedded heterogeneous asset returns in BHA-type quantitative models in

[4]In this model, the returns on a risk-free bond and on capital holdings are equal because of arbitrage and the absence of return risk. In addition, the share of capital in the portfolios of rich and poor households is inferred from the data, as opposed to being endogenously determined.

order to explore related questions. Because these papers focus on matching observed levels of inequality, as opposed to exploring their macroeconomic consequences, they tend to be partial-equilibrium in nature. Benhabib, Bisin, and Zhu (2011) and Benhabib, Bisin, and Luo (2019) consider households that differ permanently from one another in terms of labor income and asset returns, creating income and wealth dispersion but no household-level income risk. These authors find the inclusion of heterogeneous returns to be important for capturing the extent of wealth inequality, especially at the top of the distribution. In a setting with only a risky asset, Pugh (2018) argues that heterogeneous returns are a compelling explanation for the joint evolution of wealth inequality and social mobility in the past few decades. Without a portfolio decision, however, the model does not speak to the risk premium.[5]

Our paper also connects to heterogeneous-agent models in which households face uncertain income streams and choose to allocate risk to both risk-free and risky assets but, in contrast to our study, otherwise enjoy identical returns within asset classes. Kaplan, Moll, and Violante (2018) and Ahn and others (2017) use such models to illustrate how heterogeneity matters to the transmission of shocks. Closer to our goal of studying longer-run macroeconomic effects, Cao and Luo (2017) apply such a model to the study of changes in tax policy and financial deregulation. Our paper further connects with a literature that uses large overlapping-generations models to study how demographics incentivize capital accumulation, thus leading to secular declines in interest rates.[6] These models are characterized by heterogeneity in wealth across generations (and, in some cases, heterogeneity in the labor supply) but the income received for a given amount of labor or savings are typically identical across households. Finally, our paper connects to studies of how households' ability to manage risk relates to wealth inequality and interest rates. Our environment differs from the one in Favilukis (2013), in which improved access to capital markets leads to an increase in the aggregate stock of capital and depresses the return on capital and interest rates. Kasa and Lei (2018) allow for a portfolio choice between safe and risky assets in the context of Knightian uncertainty; they find that the robust portfolio choice helps explain the seemingly rapid rise in wealth concentration.[7]

Our paper is organized as follows. Section 2 reviews the evolution of inequality in the past few decades and the empirical evidence on the labor income and asset income processes. Section 3 introduces our model. Section 4 describes the model's calibration and empirical fit. Section 5 presents the macroeconomic effects of various channels leading to higher measured inequality and relates our findings to those in the literature. Section 6 concludes.

[5]Before these contributions, Quadrini (2000) and Cagetti and De Nardi (2006) had explored the role of entrepreneurs, who account for a significant share of the richest households and derive much of their income from capital.

[6]Among the contributors are Krueger and Ludwig (2007), Carvalho, Ferrero, and Nechio (2016), Kara and von Thadden (2016), Geppert, Ludwig, and Abiry (2016), Gagnon, Johannsen, and López-Salido (2021), Eggertsson, Mehrotra, and Robbins (2019), Jones (2023), and Auclert and others (2021).

[7]Also related is Paz-Pardo (2024), who traces the fall in home ownership rates across generations to liquidity constraints and changes in labor earning dynamics in a model with a portfolio decision and aggregate asset price risk.

2 Salient trends in the distribution of income and wealth

This section describes the trends in inequality measures over the last several decades and the evidence suggesting a possible role for increased income volatility in explaining these trends. Relatedly, appendix C documents concurrent trends in interest rates (namely, a fall in the risk-free rate and a widening gap between risky and risk-free rates) that our model seeks to explain as part of our quantitative exploration in section 5.

2.1 Inequality benchmarks

We use Gini coefficients as simple benchmarks for the extent and evolution of inequality. As depicted in figure 1, the Gini coefficient for total household income—the sum of labor income, asset income, and net transfers—rose from 49 points in the 1983 SCF to 61 points in the 2022 SCF. The corresponding coefficient for net worth rose from 73 points to 83 points over that period. These rises are not driven only by the super rich, as we find increases nearly as large when we exclude the top 0.5 and top 1 percent of households, though their presence is important for understanding the level of inequality. Inequality for net worth (a stock variable) is markedly higher than that for income (a flow variable).

Increased inequality may be driven by a combination of rising permanent, persistent, and transitory differences across households. The literature's initial assessment, based mostly on data from the Panel Study of Income Dynamics (PSID), was that household income has become more volatile since the 1970s.[8] Studies that use administrative data sets show that the overall increase is largely driven by permanent or persistent differences, whereas transitory shock variances have been flat or even decreasing over time.[9] Conclusions can be sensitive to methodological choices, however, including the assumed income process, the treatment of low-income households, data aggregation, or whether one focuses on labor or total family income.[10]

2.2 On the sources of labor income inequality

Researchers have traced the rise in labor income inequality in part to soaring incomes among entrepreneurs, CEOs, superstars in entertainment and sports industries, investment bankers, lawyers, and members of a few more professions.[11] Top earners aside, labor income polarization in the general population has also grown, a phenomenon linked to factors such as skill-biased technological change, a slowdown in growth of the supply of college graduates, a weakening of labor unions, and

[8] This conclusion is suggested by a net increase in the volatility of the unforecastable components of labor earnings and total family income. See, for example, Gottschalk and Moffitt (1994), Davis and Kahn (2008), Dogra and Gorbachev (2016), and Moffitt and Zhang (2018).

[9] See, for example, Sabelhaus and Song (2010) and Dahl, DeLeire, and Schwabish (2011).

[10] DeBacker and others (2013) find that the transitory component appears to play a role in the polarization of total household income but not of labor earnings. Carr and Wiemers (2021) discuss the treatment of low-income respondents in survey and administrative data. Crawley, Holm, and Tretvoll (2026) argue that the importance of permanent shocks is overstated because of a failure to account for the time aggregation of income data.

[11] For a discussion of top inequality, see Gordon and Dew-Becker (2007).

Figure 1: Gini coefficients on U.S. household income and net wealth

Note: Circles denote survey installments. For calculations excluding the top 0.5 and top 1 percent, households are ranked by income for the left panel and by net worth for the right panel.
Source: Authors' calculations using publicly available micro data from the Federal Reserve's Survey of Consumer Finances.

an erosion in the real minimum wage.[12]

Several researchers have estimated labor income processes to understand how labor income varies over the life cycle and across households. Because the estimation of life-cycle parameters—notably the effects of age and experience on labor income—requires long panels, researchers often assume that these parameters are constant over time.[13] By contrast, researchers interested in the evolution of income volatility often focus on a small number of characteristics, such as the college wage premium. Rather than take a stand on the precise drivers of increased inequality, we posit rich driving processes for labor and asset income and examine changes in their various parameters.

[12]For evidence of increased dispersion in labor earnings after controlling for demographic and ability characteristics, see Lemieux (2006) and Barth and others (2016). See also Katz and Autor (1999), Goldin and Katz (2007), and Autor, Katz, and Kearney (2008) for discussions and references on the drivers of growing labor income polarization.

[13]For example, see Kaplan (2012), Altonji, Smith, and Vidangos (2013), Karahan and Ozkan (2013), or Pora and Wilner (2020).

2.3 Evidence on asset return inequality

Asset income accounts for a smaller share of national income than labor income, but it may nonetheless be an important contributor to rising inequality due to its growing share of national income, relatively unequal distribution, and differences in households' risk attitudes and sophistication. Households have access to a broad range of investment vehicles with differing potential risks and rewards. Households with similar income profiles may choose different asset allocations, resulting in different returns on their savings.[14] Scandinavian administrative data, which include information on wealth, show that asset returns often differ much—and persistently so—across households even within asset classes. Our modeling of the returns to savings emphasizes this heterogeneity.

Our analysis draws on the evidence of Fagereng and others (2020) on the returns to savings among Norwegian households. Their data set offers several advantages over corresponding U.S. data sets. First, it covers the entire population. Second, Norwegian authorities collect information on both asset holdings and asset income, whereas U.S. administrative data capture only asset income (including capital gains, when realized). Finally, the sample's time coverage (2004 to 2015) makes it possible to estimate the persistence of individual returns to savings. One potential drawback is that Norwegian data need not be representative of U.S. data.[15]

To measure persistent differences in asset returns across households, Fagereng and others (2020) extract fixed effects in yearly individual returns on net worth. They find much dispersion in these fixed effects: The standard deviation on (pre-tax) returns on net worth is 6.0 percentage points and the corresponding difference between the 90^{th} and the 10^{th} percentiles is 7.7 percentage points. These values imply that an investment in 2004 with a return equal to the 90^{th} percentile of fixed effects would be valued nearly twice as much by 2015 as an equal investment with a return equal to the 10^{th} percentile. The dispersion of actual annual returns is appreciably greater than that of fixed effects because household returns reflect transitory influences in addition to permanent ones. The standard deviation of (pre-tax, uniformly weighted) returns on net worth is 22.1 percentage points, with a 90^{th}-10^{th} percentile difference of 16.4 percentage points.

There also appears to be large, persistent differences in U.S. households' returns to savings. Using PSID data, which periodically include information on wealth, Cao and Luo (2017) find a standard deviation of returns to wealth across households of 11.3 percentage points when they exclude capital gains and 27.1 percentage points when they include them. They also report a coefficient of correlation of about 0.2 in five-year returns between the 1984–89 and 1994–99 periods whether they include capital gains or not. Saez and Zucman (2016) and Xavier (2021) also find economically significant differences in asset income by asset class in administrative and SPF data, respectively.

While it is clear that asset returns vary across households, and persistently so, data are lacking

[14] For evidence of differences in portfolio composition and average returns across U.S. households by wealth levels, see Saez and Zucman (2016) and Xavier (2021).

[15] The top 10 percent of households in Norway own about half of the total net worth, compared with almost 80 percent in the U.S. In addition, public pensions, government transfers, and other income and consumption support programs are more prevalent in Norway than in the U.S.

on whether that variation has increased in past decades. Accordingly, we see our model simulations of increased heterogeneity in asset returns as exploratory of this mechanism.

2.4 Correlation between labor income and returns to savings

A further possible driver of inequality is the correlation between labor income and returns to savings. If high earners also tend to enjoy high asset returns, then they will have an easier time amassing wealth than the general population. Saez and Zucman (2016) and Xavier (2021) offer evidence of a modest positive correlation in the cross section of U.S. households. As with the dispersion in asset returns, evidence is lacking on whether that correlation might have changed over time. Given our interest in income risk, we focus on the comovement between households' labor income and asset returns over time rather than on permanent differences across households. Using PSID data and various definitions of labor earnings and risky asset returns (detailed in appendix A), we find only a small positive correlation between deviations from these variables' expected levels after controlling for socio-economic and cyclical factors. Accordingly, in our baseline calibration, we assume that the underlying processes for labor earnings and asset returns are uncorrelated. However, given the inability to empirically rule out a mild amount of correlation, we explore the consequences for measured inequality and the macroeconomy of introducing some positive correlation.

3 Model

Our model is an extension of the BHA framework that includes heterogeneity in rates of returns on capital across households. Households face an uninsurable risk of death each period. Households cannot insure against fluctuations in labor earnings and the return on capital. However, households can mitigate the effects of these fluctuations on their consumption by acquiring and selling capital units and risk-free bonds, subject to a borrowing constraint and portfolio adjustment costs. Risk-free bonds represent claims on the government and indebted households. There is no aggregate risk in this model and thus households have perfect foresight of aggregate objects.

We assume that time is discrete and that the length of a period is one year. The timing of events is as follows. At the start of each period, new households enter the economy, some existing households die, and the assets of dead households are redistributed as accidental bequests to surviving households. Shocks to labor earnings and returns to capital are then realized. Finally, surviving households decide how much to consume and save, firms hire factors of production to produce, while the government runs fiscal policy and social security.

3.1 Households

The economy is populated by J overlapping generations of households aged 20 to $J+20$. The size of entering cohorts grows at a constant rate n. Households face a mortality risk that depends on their age, with $\Psi_{j,j'}$ denoting the probability that a household aged j survives to age j'. Households must retire at an exogenously set age j_r, after which they fund consumption through their savings and social security. Working households exogenously supply h_j units of labor, which is constant at $\bar{h}$ over their productive years and drops to zero upon retirement.

The problem of household i that is aged j in period t is to maximize

$$E\left[\sum_{\tau=0}^{J-j}\beta^{\tau}\Psi_{j,j+\tau}U\left(c_{i,t+\tau}\right)\right], \tag{1}$$

where β is a constant discount factor, $U\left(c_{i,t}\right) = \left(c_{i,t}\right)^{1-\gamma}/(1-\gamma)$ is utility from household i's consumption in period t, with γ being the coefficient of relative risk aversion. Maximization is subject to a sequence of budget constraints,

$$\begin{aligned} c_{i,t+\tau} + a_{i,t+\tau+1} + Pb_{i,t+\tau+1} =& Wh_{j,t+\tau}\omega_{i,t+\tau} + a_{i,t+\tau}\left(1+\widetilde{r}_{i,t+\tau}\right) + b_{i,t+\tau} + beq \\ &+ ss_{i,t+\tau} - \Gamma\left(y^{l}_{i,t+\tau}, y^{s}_{i,t+\tau}\right) - \tau_{ss}y^{l}_{i,t+\tau} - Adj(a_{i,t+\tau+1}, a_{i,t+\tau}). \end{aligned}$$

In this expression, $a_{i,t}$ and $b_{i,t}$ are household i's holdings of physical capital and risk-free bonds, respectively, at the start of period t. P is the price of the one-period bond, which pays one unit of consumption in the subsequent period (for aggregate variables, we leave off a time subscript because we work with steady states, as explained later). Consumption and asset holdings are funded through various income sources. First, the household receives labor income from supplying $h_{j,t}$ units of labor with household-specific productivity $\omega_{i,t}$ at the wage rate W per efficient unit. The household also derives income from holdings of physical capital, whose household-specific rate of return net of depreciation is $\widetilde{r}_{i,t}$, and risk-free bonds. Household income is complemented by accidental bequests, beq, and social security payments upon retirement, $ss_{i,t}$. Total income at the disposal of the household is reduced by taxes on their labor income, $y^{l}_{i,t}$, and net asset income, $y^{s}_{i,t}$, according to the tax function $\Gamma\left(y^{l}_{i,t}, y^{s}_{i,t}\right)$ to be detailed later. Here, labor income is $Wh_{j,t}\omega_{i,t}$ whereas net asset income is $\widetilde{r}_{i,t}a_{i,t} + \left[\frac{1}{P}-1\right]b_{i,t}$. In addition, households pay an adjustment cost whenever they expand or draw down their holdings of physical capital (beyond the automatic reinvestment of their net returns),[16]

$$Adj(a_{i,t+\tau+1}, a_{i,t+\tau}) = \Theta_1\left(a_{i,t+\tau+1} - \left(1+\widetilde{r}_{i,t}\right)a_{i,t+\tau}\right)^{\Theta_2}.$$

Finally, household maximization is subject to a lower bound on risky asset holdings (that is, $a_{i,t} \geq \underline{a}$) and a requirement that households enter retirement with no debt (that is, $b_{i,t} \geq 0$ if $j \geq j^{ret}$).

3.2 Processes for labor earnings and returns on physical capital

Our choice of a labor income process starts with the parsimonious approach of Kaplan (2012), which is fairly standard in the literature and can be approximated with reasonable accuracy using a limited

[16] This cost formulation is similar to the adjustment cost on illiquid assets in Kaplan, Moll, and Violante (2018) in that it discourages large adjustments in risky asset holdings. These authors, who focus on business-cycle dynamics rather than long-run implications, also impose an inaction region on illiquid asset holdings through a linear cost component.

number of discrete states. We assumed that the log of a worker's labor productivity depends on four additive terms,

$$\log\left(\widetilde{\omega}_{i,t}\right) = \varepsilon_j + \alpha_i + \nu_{i,t} + \theta_{i,t}. \tag{2}$$

The term ε_j is an age-specific productivity component that evolves deterministically over a household's lifetime. α_i is a permanent component that is realized when the household enters the economy. The third and fourth terms are persistent and i.i.d. shocks, respectively. The persistent shock follows a first-order autoregressive ("AR(1)") process,

$$\nu_{i,t} = \rho_\nu \nu_{i,t-1} + \epsilon_{\nu,i,t}$$

with $\epsilon_{\nu,i,t} \sim NID\left(0, \sigma_\nu^2\right)$, whereas $\theta_{i,t} \sim NID\left(0, \sigma_\theta^2\right)$. While equation 2 offers a reasonable depiction labor income dynamics in the general population, it does not capture the skewness of aggregate income toward top-earning households. In our discrete-state implementation of that equation, we therefore add a persistent state for top earners similar to Castañeda, Díaz-Giménez, and Ríos-Rull (2003).

To introduce heterogeneity in risky returns across households, we assume that

$$\widetilde{r}_{i,t} = R - \delta - \delta_{i,t}.$$

R is the economy-wide marginal product of capital, δ is an economy-wide time-invariant depreciation rate, and $\delta_{i,t}$ is an idiosyncratic term that creates persistent differences in rates of return across households. Similar to the persistent shock to labor income, we assume that $\delta_{i,t}$ follows an AR(1) process,

$$\delta_{i,t} = \rho_\delta \delta_{i,t-1} + \epsilon_{\delta,i,t},$$

with $\epsilon_{\delta,i,t} \sim NID\left(0, \sigma_\delta^2\right)$. Although we capture differences in rates of return through heterogeneity in the effective depreciation rates, we think of the above specification as standing-in for a variety of factors that might create dispersion in returns.

Our specification of risky returns as persistent, but ultimately transitory, differs from the identifying assumption in Fagereng and others (2020) that individual returns contain a fixed-effect component. In practice, distinguishing between permanent and highly persistent (but ultimately transitory) differences in returns across households is challenging because available panels of individual returns are short. In the context of our study, the AR(1) assumption helps us illustrate how the volatility and persistence of returns influence the saving, consumption, and portfolio decisions of households in the model.[17]

[17]It is conceivable that a portion of differences in returns across households could be permanent because of, say, differences in sophistication and risk tolerance across investors, the existence of fixed costs of trading assets with relatively high returns, or differences in the economic fate of regions over long periods. Inclusion permanent differences in asset returns in our model, as do Benhabib, Bisin, and Luo (2019) in a partial-equilibrium model with deterministic asset returns within each generation, would increase the importance of idiosyncratic returns for income and wealth inequality. However, it would also eliminate income risk as an explanatory factor for macroeconomic trends. Similarly, the inclusion of purely transitory shocks to asset returns might boost income and wealth polarization.

3.3 Firms

We assume that a representative firm operates a Cobb-Douglas production function,

$$Y = AK^{\zeta}H^{1-\zeta}. \tag{3}$$

The firm rents labor and capital inputs in competitive markets, taking real wages and the real rental rate of capital as given. At the optimum, the following first-order conditions must be satisfied:

$$R = \zeta \left(\frac{H}{K}\right)^{1-\zeta} \tag{4}$$

and

$$W = (1-\zeta)\left(\frac{H}{K}\right)^{-\zeta}. \tag{5}$$

3.4 Government

Government spending, G, is assumed to be done in an unproductive sector and funded through taxes and debt issuance. The government's budget constraint is

$$G + B_t^g = PB_{t+1}^g + \int \Gamma\left(y_{i,t}^l, y_{i,t}^s\right) di.$$

The variable B_t^g represents the stock of one-period, risk-free public debt issued in period $t-1$ that matures in period t (we maintain a time subscript on government debt to avoid confusion in the flow budget constraint). The tax function is

$$\Gamma\left(y_{i,t}^l, y_{i,t}^s\right) = \Upsilon_1\left(y_{i,t}^l + y_{i,t}^s - \left(\left(y_{i,t}^l + y_{i,t}^s\right)^{-\Upsilon_2} + \Upsilon_3\right)\right)^{-\frac{1}{\Upsilon_2}}.$$

The right-hand-side term is as in Gouveia and Strauss (1994) and captures tax policy in a simple but flexible manner. The parameters Υ_1, Υ_2, and Υ_3 allow taxes to be progressive, flat, or regressive and to feature a standard tax deduction. The specification embeds the assumption that, at the margin, labor income and asset income are taxed at the same rates.

The government also operates a pay-as-you-go social security system, taxing current workers and rebating the proceeds to current retirees. The associated budget constraint is

$$SS = \int \tau_{ss,t} y_{i,t}^l di,$$

where SS represents total social security disbursements to retirees (detailed in section 4.1) and τ_{ss} is a flat tax rate on labor income. The inclusion of a social security regime improves the model's fit of consumption profiles during retirement. Absent such a regime, workers would face extra incentives to accumulate wealth to support consumption in retirement. Moreover, without social security, the consumption paths of retirees might eventually fall to unrealistically low levels because the rise in mortality risk boosts the rate at which they discount future consumption.[18]

As noted in the description of the household problem, our model includes both government debt and private debt in the form of household borrowing and lending from each other. We assume that both types of debt are free of default risk and treated as perfect substitutes. Asset holdings of deceased households, both positive and negative, are redistributed to survivors. By construction, the net supply of private debt is zero because each unit of private debt issued by a household is held by another household. Therefore, the sum of household bond holdings (positive and negative) equals outstanding government debt,

$$B_t^g = \int b_{i,t} di.$$

4 Model calibration and empirical fit

Given our goal of understanding longer-run trends in inequality, income risk, and the macroeconomy, we consider the stationary competitive equilibrium of model, which we formally define in appendix B. In short, we assume that the economy has reached a balanced-growth equilibrium in which the proportion of households across all possible states—age, safe and risky asset holdings, labor income shocks, and returns-to-savings shocks—is constant over time. Firms and households have rational expectations and behave optimally, and the government's revenues match expenditures on social security, public consumption, and debt service. All markets clear, including the markets for factors of production that underpin wages and interest rates. To gauge the macroeconomic implications of changes in the drivers of inequality, we compare the steady-state equilibria under our baseline calibration to those with greater income volatility.

4.1 Calibrated parameters

Table 1 summarizes the parameter values in our baseline calibration. Roughly speaking, the parameters belong to three groups: the processes for labor income and asset returns, which are at the core of our analysis; the parameters belonging to household preferences, demographics, production, and taxation, whose values we take from other studies; and the remaining parameters, whose values we select to approximate selected moments of the data.

To calibrate the labor income process of the general population, we discretize equation 2, as estimated by Kaplan (2012). We assume that the permanent ability component can take two values (α_L or α_H), with equal proportions in the population. Similarly, the i.i.d. component can take two values (θ_L or θ_H) with equal probabilities. Building on Kopecky and Suen (2010), we use the Rouwenhorst method to approximate the AR(1) process using five discrete states. To capture the upper tail of the income distribution, we further posit that households face a small probability π^b_{top} of becoming "top earners," in which case their productivity jumps to a multiple ν_{top} of typical productivity in the general population. Households stay in the top state with a constant probability

[18]The inclusion of a social security regime can also affect the normative aspects of the model. See Peterman (2013) for an illustration of how excluding social security affects optimal tax policy.

Table 1: Baseline calibration of the key model parameters

Parameter	Value	Description
Household utility		
β	0.997	Household discount rate
γ	2	Coefficient of relative risk aversion
$\bar{h}$	0.333	Labor supply of workers
Production function		
δ	0.083	Capital depreciation rate
ξ	0.36	Share of capital in production
Tax function		
Υ_1	0.258	Income tax function parameter
Υ_2	0.768	Income tax function parameter
Υ_3	0.098	Income tax function parameter
τ_{ss}	0.0949	Social security tax rate on labor income
Labor income (general population)		
α_L	-0.255	Permanent labor productivity: low value
α_H	0.255	Permanent labor productivity: high value
ρ_ν	0.958	Persistent shock: AR(1) coefficient
σ_ν	0.130	Persistent shock: standard deviation of innovations
σ_θ	0.2846	Transitory shock: standard deviation of innovations
Labor income (top earners)		
α_T	9.25	Permanent labor productivity
λ_T^b	0.005	Probability of becoming a top earner
λ_T^r	0.9	Probability of remaining a top earner
Risky asset return		
ρ_δ	0.9	Risky asset returns: AR(1) coefficient
σ_δ	0.0156	Risky asset returns: standard deviation of innovations
$\rho_{\nu\delta}$	0	Correlation between income sources
Portfolio		
$\underline{a}$	-0.65	Borrowing limit
Θ_1	0.35	Portfolio adjustment cost parameter
Θ_2	2.0	Portfolio adjustment cost parameter

Source: Authors' calibration.

π^s_{top}.[19] As discussed below, we calibrate the parameters for top earners to match features of the wealth distribution.

Our calibration of risky returns is also based on a discretization of an AR(1) process with normal innovations. We first set the persistence of annual returns (ρ_δ) to 0.9, then choose the standard deviation of innovations to idiosyncratic depreciation rates (σ_δ) such that the unconditional standard deviation of the AR(1) process is 3.59 percent, a value that matches the standard deviation of fixed effects in household-level returns to financial wealth estimated by Fagereng and others (2018).[20] We

[19] See appendix D for the details of our approach.

[20] This value is taken from the authors' working paper, whose definition of financial wealth maps most directly into our two-asset model structure. Overall, we see our calibration as more likely than not to underestimate the dispersion

see this calibration as capturing the salient feature that rates of return often differ persistently across households. That said, the process guiding risky returns is difficult to calibrate precisely due to data limitations. In addition to the lack of long panels with information on asset holdings and returns, the mapping between our two-asset framework and the variety of assets available to households is stylized. The imputation of marginal rates of return in household level-data is especially challenging in practice.[21]

Under our baseline assumptions, the AR(1) processes for labor income and for the return on risky assets are independent. As discussed in section 2.4, however, we find noisy, but mildly positive correlation between the two sources of income in PSID data. Thus, in section 5, we explore the implications of a rise in wealth inequality caused by the introduction of mild correlation between the two processes. This case is implemented using the method of Farmer and Toda (2017).

Our functional choices for household preferences, production, and demographics, along with their calibration, follow Peterman (2013). We set the retirement age (j^{ret}) to 66 years, the maximum life span (J) to 100 years, and the labor supply of workers ($\bar{h}$) to 1/3. The survival rates are consistent with the mortality rates for men reported by Bell and Miller (2005). For taxation, we take the parameters guiding the general level and progressiveness of income taxes (Υ_1 and Υ_2) from Gouveia and Strauss (1994). We also posit that, for each permanent ability type, social security payments equal 40 percent of labor income, averaged over the productive years of all workers of that type. This replacement rate aligns with the evidence in Huggett and Parra (2010). We choose the remaining tax function parameters (Υ_3 and τ_{ss}) such that government expenditures and government social security payments equal receipts from general income taxes and social security taxes, respectively. In doing so, we posit that government debt is 62.1 percent of GDP, in line with the observed ratio for total public debt in 2007.

We calibrate the remaining parameters to approximate selected features related to the distribution of income and assets in the economy in the mid-2000s—a period of moderate economic expansion that falls roughly half of the way between the launch of the SCF and the present. The parameters are the discount factor (β), the portfolio adjustment cost parameters (Θ_1 and Θ_2), the borrowing limit ($\underline{a}$), and the parameters guiding the labor income of top earners (α_T, λ_T^b, and λ_T^r). We begin by setting λ_T^b to 0.9, implying that two thirds of current top earners will exit the top state within 10 years, a proportion that matches the 10-year survival rate among the top 1 percent of earners reported by Larrimore and Splinter (2026). The remaining parameters are jointly chosen to match the aggregate capital-output ratio between 2003 and 2007; a gap between the return on capital and the risk-free rate of 4 percentage points; and four moments of the 2007 SCF. The

of actual returns over time and across households, in part because our target for the returns on risky assets excludes entrepreneur income and abstracts from the influence of transitory shocks. And while our assumed AR(1) process is persistent, it does not yield permanent differences in returns that could magnify inequality over lifetimes and across generations. Furthermore, wealth concentration is appreciably smaller in Norway than in the U.S.

[21] Fagereng and others (2020) focus on realized returns on positive asset positions. They observe assets for several asset classes, including elements such as checking accounts for which nearly all households have positive balances. Accordingly, they are able to derive rates of returns for households that have no or negative net wealth. Whether these rates of return are representative of households' investment opportunities is unclear, however.

latter moments are the Gini for net wealth; the share of net wealth going to the top-30 percent of households; the difference in shares of risk-free assets between low- and high-income households (a proxy for how portfolio decisions vary by wealth); and the ratio of average borrowing by 20–34 years old to average wealth by 60–64 years old (a proxy for the peak borrowing and peak asset holdings over households' productive years).[22] Because our model captures the dynamics of top earners using only one extra labor income state, our framework is designed to capture features of relatively rich households but not of "superstars." Accordingly, our calculations of SCF moments exclude the richest 0.5 percent of households by net worth unless otherwise specified.

4.2 Fit of targeted and non-targeted moments

Our calibration ensures that government spending and social security disbursements are matched by tax revenues. It produces a capital-output ratio of 2.6, the same as the observed average between 2003 and 2007. The model's share of wealth held in the safe asset by the high-ability type is 7.1 percentage points higher than for the low-ability type, compared with a difference of 8.4 percentage points in the 2007 SCF. The model also broadly aligns with the borrowing and asset accumulation over households' lifetime. The ratio of average borrowing by 20–34 years old to average wealth by 60–64 years old is 6.4 in the model, in line with 6.3 in the 2007 SCF. The model produces a 3.9 percentage point difference between the return on capital and the risk-free rate, essentially matching our 4 percent target.[23]

Our calibration of the income and wealth distributions are anchored by our targeting of the 2007 SCF's Gini coefficient for net wealth—which is importantly determined by top earners—and of the top-30 percent share of net wealth in the economy, which encompasses a broader set of households with positive asset holdings. The Gini for net wealth in the model (76.5 percent) is the same as in the SCF, while the top-30 wealth share (87.4 percent) is in line with the SCF (87.2 percent). Table 2 details the model's fit of the broader income and wealth distributions, which we do not target directly. The model broadly replicates the distribution of income across quintiles, including by producing significant income concentration in the top quintile. The model similarly generates a realistic amount of dispersion in net wealth across quintiles, though it understates wealth concentration at the very top, with the share of aggregate net wealth held by the richest 5 percent of households in the model being 9 percentage points below that in the SCF. This understatement

[22] We define risky assets in the SCF as directly held stocks, non-financial assets (measured as the gross value of residential and nonresidential property, privately owned businesses, and other miscellaneous), along with one third of the value of individual retirement accounts/Keoghs plans. We further assume that mortgage debt corresponds to a negative position in the safe asset category, consistent with loans to individuals routinely being packaged into portfolios to mitigate idiosyncratic risks. Of course, our stylized model cannot capture the full range of different assets types. So, we categorize the assets in the SCF as risky, which we think of as involving uncertain returns and often meaningful adjustment costs, and safe assets, which are characterized by more-certain returns. We calculate the capital-output ratio as the sum of the current-cost net stock of private fixed assets and consumer durables to nominal GDP.

[23] See appendix C for a discussion of our choice of this target. In the model, this difference importantly reflects barriers to arbitrage and mitigating risks: incomplete markets, portfolio adjustment costs, and borrowing constraints. In addition, the consideration of depreciation shocks has been shown to help produce realistic risk premiums in related settings; see Hasanhodzic and Kotlikoff (2013).

arises because matching wealth concentration at the top of the distribution, even after trimming out the top 0.5 percent of households, requires adding model features that lead to even more wealth accumulation among the richest few—for example, by considering concentration stemming from generational transfers or entrepreneurs with ebullient pay and returns. Given the uncertainty about the mechanisms leading to this concentration, we abstract from it in our analysis.[24]

Table 2: Statistics of the income and wealth distributions

	Share by quintile (percent)								**Gini coefficient**
	1^{st}				2^{nd}	3^{rd}	4^{th}	5^{th}	
	top 5%	next 5%	next 10%	total					
Income distribution									
2007 SCF	26.3	11.5	16.1	53.9	21.4	13.3	8.0	3.5	49.9
Baseline calibration	30.0	11.6	15.6	57.1	19.4	11.9	7.6	4.0	52.8
Net wealth distribution									
2007 SCF	49.2	13.6	15.5	78.4	14.6	5.8	1.4	0.3	76.5
Baseline calibration	40.4	17.1	19.1	76.6	17.4	5.9	0.8	-0.7	76.5

Note: SCF statistics exclude top 0.5 percent of households by net wealth.
Source: Authors' calculations using publicly available micro data from the Federal Reserve's Survey of Consumer Finances.

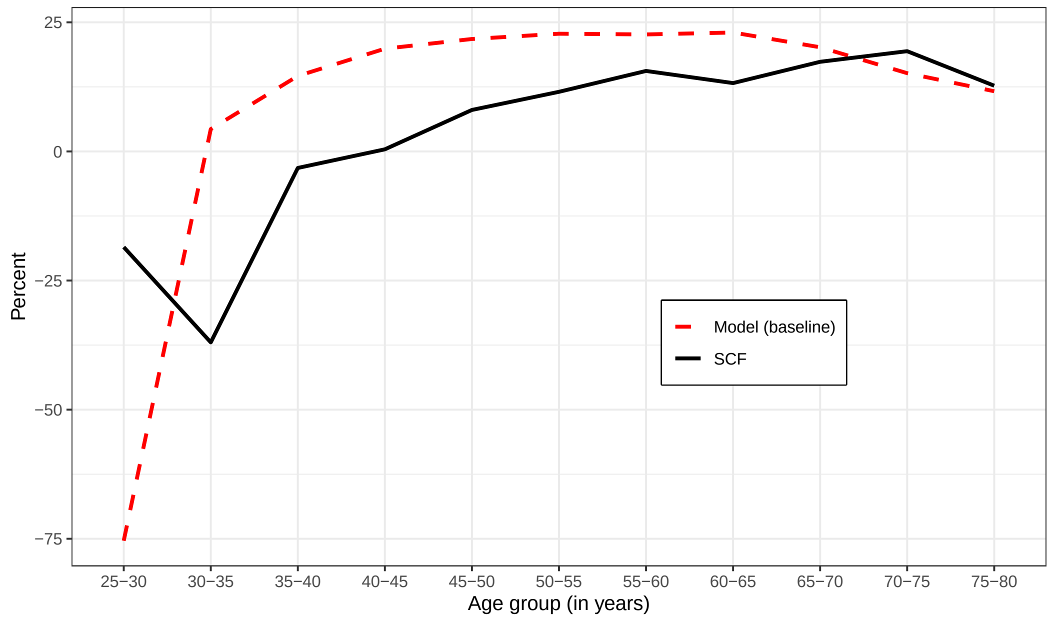
In addition, we find that the model produces a risk-free real interest rate of 1.4 percent and a return on capital of 5.3 percent, which are close to statistical estimates for the mid-2000s (see appendix C for such estimates and a discussion). Figure 2 further validates the model against moments not directly targeted by reporting the average share of wealth in the risk-free asset over a household's life. Similar to the data, this share is negative early in adulthood as households borrow to smooth their consumption, then turns positive as they accumulate both risky and risk-free assets ahead of retirement.

5 Main results

To explore some possible drivers of rising wealth inequality and their implications for the macroeconomy, we compare our model's baseline stationary equilibrium to the stationary equilibria obtained under alternative parameterizations of the labor income and asset return processes. To facilitate comparisons, all parameterizations induce a 1-point rise in the Gini coefficient for net wealth relative to the baseline. We consider eight possible drivers of rising wealth inequality. The first and second drivers are an increase in the volatility of innovations and in the persistence, respectively, of the AR(1) component of labor income for the general population. The next three drivers are an

[24]Empirical evidence, such as Guvenen and others (2021) and Fagereng and others (2020), suggests that extra skewness to the underlying processes could explain some of the additional concentration of wealth. Alternatively, more variation in the permanent differences in returns across households, as considered in Benhabib, Bisin, and Luo (2019) in a deterministic context, could also magnify the contribution to wealth inequality.

Figure 2: Share of wealth in risk-free asset



Source: Authors' calculations; Federal Reserve's 2007 Survey of Consumer Finances (SCF).

increase in the relative labor productivity of top earners, the probability of becoming a top earner, and the probability of remaining a top earner. The next two drivers are increases in the volatility of the innovations and in the persistence of the AR(1) process for households' returns on the risky asset. The final driver introduces correlation between the processes for labor income in the general population and for risky returns, otherwise keeping the unconditional variance and persistence of each process at their baseline values. We choose various ways to increase income volatility because of the empirical evidence suggestive of such an increase discussed in section 2. Of course, other developments could have played complementary roles; see appendix F for an example in which increased wealth inequality is due to a change in household preferences.

5.1 Effects on measures of inequality and the wealth distribution

Table 3 reports the change in Gini coefficients relative to the baseline, by income source and for consumption, for each of the eight possible drivers of wealth inequality considered herein. All drivers exacerbate total income inequality to varying degrees. Altering the labor income process of the general population (lines 1–2) and of top earners (lines 3–5) primarily does so through increased labor income inequality. These cases also raise asset income inequality, but to a lesser degree than they boost labor income inequality, because households with favorable labor income shocks tend to accumulate more assets, in turn leading them to enjoy more asset income. Greater inequality in income translates into greater consumption inequality.

Table 4 breaks down the wealth distribution by selected bins in order highlight the sensitivity of wealth inequality to changes in the income process of the wealthiest households. When we shift aggregate income toward top earners, the gap between these households' total income and that of the rest of the population widens, allowing them to accrue even more assets. As a result, the Gini coefficients for total household income and for wealth rise somewhat commensurately. When we instead make labor income in the general population more volatile, some households end up swapping places in the wealth distribution, which damps movements in the Gini coefficient for wealth. As a result, a relatively large increase in the dispersion of labor income is required to achieve a given-size increase in overall wealth inequality. A similar observation applies to changes to the risky return process: While these changes make the distribution of asset income more unequal, the effect on the Gini coefficient for wealth is damped by the reshuffling of households within the wealth distribution.

By construction—and in contrast to changes in the labor income process, changes to the risky return process (lines 6–7, back in table 3) or the introduction of correlation between labor income and risky asset returns (line 8) do not affect the distribution of labor income in the economy. In these cases, the boost to wealth inequality stems entirely from greater dispersion in asset income across households. In all three such cases, this dispersion translates into an increase in total income inequality. However, unlike changes in the labor income process, changes in the process for risky returns lead to either a fall or only a small increase in consumption inequality.

Intuitively, the differing response of consumption inequality across drivers of wealth inequality relates to the effect of these drivers on the wealthiest households in the model. Returning to table 4, all eight drivers raise overall wealth inequality by pushing a greater fraction of aggregate wealth to the top quintile of households. Changes in the labor income process (lines 1–5), particularly for top earners, tend to shift wealth toward the very top of that quintile (proxied by the top-5-percent wealth share in the table). In these instances, the share of wealth in the bottom eighty percent falls, accentuating consumption inequality. By contrast, for the two cases boosting asset return volatility (lines 6–7), the increase in wealth in the top quintile is not concentrated at the very top of the distribution, with the top-5-percent wealth share even falling. Instead, there is a reshuffling of wealth away from the wealthiest households toward the remainder of the top two quintiles, which helps reduce consumption inequality. This reshuffling occurs because the wealthiest households tend to hold relatively larger shares of their portfolio in the risk-free asset to mitigate adjustment costs. Accordingly, the wealthiest households tend to benefit from positive shocks to risky asset returns to a lesser degree households with lesser wealth.

5.2 Macroeconomic effects

Table 5 summarizes the associated changes in interest rates, the risk premium, the stock of risk-free bonds, the aggregate capital stock, and real output relative to their respective baseline values. There are three main takeaways.

First, for all but one of the possible drivers considered (namely, an increase in correlation across labor and asset income), greater wealth inequality is associated with a drop in the risk-free rate and

Table 3: Effect of increased income volatility on inequality measures

Potential driver	Parameter: Base.	Parameter: Alt.	Change in Gini coefficient (points): Net wealth	Labor income	Asset income	Total income	Consumption
Labor income (general pop.)							
1. AR(1) innovation st. dev. (σ_ν)	0.130	0.213	1.0	7.1	2.9	5.8	4.0
2. AR(1) persistence (ρ_ν)	0.9580	0.9802	1.0	3.2	0.5	2.5	2.1
Labor income (top earners)							
3. Income level (α_T)	9.25	10.11	1.0	1.2	0.3	1.0	0.6
4. Prob. remaining top earner (λ_T^r)	0.900	0.920	1.0	1.4	0.2	1.1	1.0
5. Prob. becoming top earner (λ_T^b)	0.0050	0.0053	1.0	1.4	0.7	1.1	0.5
Risky returns							
6. AR(1) innovation st. dev. (σ_δ)	0.0156	0.0457	1.0	0.0	18.2	1.9	-1.7
7. AR(1) persistence (ρ_δ)	0.900	0.967	1.0	0.0	5.9	0.2	-0.7
8. Correl. with labor income ($\rho_{\nu\delta}$)	0.00	0.06	1.0	0.0	1.8	0.6	0.2
Addendum							
9. Transitory labor income (σ_θ)	0.2846	0.0000	1.0	-1.9	0.5	-0.8	0.2

Note: All alternative calibrations lead to a 1-point rise in the Gini coefficient on wealth relative to the baseline simulation. All symbols correspond to parameters of the model, with the exception of the correlation between the labor income and risky return processes ($\rho_{\nu\delta}$), which corresponds to the correlation in the model's simulated data.
Source: Authors' calculations.

a rise in the gap between the risky and risk-free rates. Across these cases, the widening of the risk premium undoes half or more of the drop in the risky rate that would result if the risky rate simply moved one-for-one with the risk-free rate, as researchers often assume in their economic models.

Second, for a given-size increase in wealth inequality, movements in the risk-free rate and risk premiums are largest when they originate from greater volatility in asset returns. In part, this is because significant changes in parameter values for the risky return process are required in our model to induce a rise in wealth inequality due to the reshuffling of wealth shares away from the very top of the distribution, as discussed above. Also, a higher volatility of risky returns makes holding the capital asset less desirable relative to holding the perfectly liquid, risk-free bond, fueling the widening gap between the returns on the two assets. By contrast, changes in the volatility of labor income for the general population and top earners do not directly affect the relative desirability of the two assets.

Third, the accompanying effects on other macroeconomic aggregates—such as the capital stock, output, and factor prices—are less clear cut than for the risk-free rate and the risk premium because they depend on the subtle interplay between households' overall desire to save and their willingness to hold the risky, productive assets in the model. As we detail below, these three findings with regard to the relationship between inequality and the macroeconomy depend on the nature of income risk and how it affects the supply and demand for capital and the risk-free bond in the economy.

Table 4: Percentage point change in wealth distribution relative to baseline

Potential driver	Quintile							
	1st				2nd	3rd	4th	5th
	top 5%	next 5%	next 10%	total				
Labor income (general pop.)								
1. AR(1) innovation variance	-0.58	1.33	1.43	2.19	-0.85	-1.22	-0.20	0.09
2. AR(1) persistence	1.14	0.89	0.04	2.07	-1.29	-0.86	-0.04	0.12
Labor income (top earners)								
3. Top-earner income	1.53	0.09	-0.46	1.15	-0.72	-0.33	-0.08	-0.01
4. Prob. remaining top earner	1.64	0.20	-0.48	1.36	-0.90	-0.38	-0.08	-0.01
5. Prob. becoming top earner	0.60	0.42	0.09	1.12	-0.54	-0.39	-0.14	-0.04
Risky return								
6. AR(1) innovation variance	-1.82	0.80	1.94	0.92	0.21	-0.59	-0.26	-0.28
7. AR(1) persistence	-2.10	0.61	2.18	0.69	0.73	-0.81	-0.35	-0.25
8. Correl. with labor income	0.62	0.31	0.22	1.15	-0.43	-0.48	-0.19	-0.06
Addendum								
9. Transitory labor income	1.09	0.05	-0.27	0.87	-0.39	-0.28	-0.16	-0.04

Note: All calibrations induce a 1 Gini point rise in the Gini coefficient on net wealth relative to baseline. Calibrations for the general population's labor income and the risky returns alter the first-order autoregressive ("AR(1)") components.
Source: Authors' calculations.

5.3 Long-run supply and demand of assets

To help understand how changes in income inequality relate to macroeconomic objects, figures 3 through 6 report supply and demand curves for the two assets in the model, expressed in deviations from baseline values, so that their intersection coincides with the effects reported in table 5 for each potential driver of wealth inequality.[25] The approach to creating supply curves (labeled "Borrowers") differs somewhat between the two assets. For the risk-free bond, the supply curve includes the sum of all negative bond holdings of households and government borrowing.[26] For the risky asset, we derive a supply curve (labeled "Borrowers (MPK)") from the firms' demand for physical capital, which is determined by its first-order condition with respect to capital (equation 4).[27] Because the marginal product of capital is invariant to the process for labor income and risky returns in the model, the supply curve for the risky asset is the same for all eight possible drivers of rising

[25]These partial-equilibrium curves map out changes in aggregate asset supply and demand when the return to only one of the asset changes, holding everything else constant. For expositional convenience, we express the supply and demand of assets in terms of interest rates, which vary inversely with asset prices.

[26]We do not allow for the possibility that fiscal authorities could alter the debt-to-GDP ratio in response to interest rate changes. For advanced economies, the average debt-to-GDP ratio largely moved sideways from the mid-1980s to before the pandemic-driven recession (see Poghosyan (2018)), suggesting a disconnect between interest rates and public finances over long periods.

[27]The economy-wide risky rate corresponds to the rental rate of capital net of depreciation, $R_t - \delta$. Because we assume competitive factor markets, that rental rate equals the marginal product of capital, which is a decreasing function of the aggregate capital stock under our neoclassical production function.

Table 5: Alternative calibrations: macroeconomic effects

Potential driver	**Risk-free rate (bp)**	**Risky rate (bp)**	**Risk premium (bp)**	**Risk-free bonds (percent)**	**Capital (percent)**	**Output (percent)**
Labor income (general pop.)						
1. AR(1) innovation variance	-118.3	-63.7	54.6	-1.3	7.7	2.7
2. AR(1) persistence	-49.1	-10.4	38.7	0.1	1.2	0.4
Labor income (top earners)						
3. Top-earner income	-29.9	-2.8	27.1	0.8	0.3	0.1
4. Prob. remaining top earner	-27.1	0.6	27.6	0.8	-0.1	0.0
5. Prob. becoming top earner	-32.2	-6.1	26.1	0.6	0.7	0.2
Risky return						
6. AR(1) innovation variance	-424.0	174.0	598.1	-8.1	-17.1	-6.5
7. AR(1) persistence	-217.3	15.8	233.1	-5.0	-1.8	-0.6
8. Correl. with labor income	1.7	-13.0	-14.7	-0.3	1.5	0.3
Addendum						
9. Transitory labor income	11.6	3.4	-8.2	-0.3	-0.4	-0.1

Note: The table reports deviations from corresponding values under the baseline calibration. All calibrations induce a 1 Gini point rise in the Gini coefficient on net wealth relative to baseline. Calibrations for the general population's labor income and the risky returns alter the first-order autoregressive ("AR(1)") component.
Source: Authors' calculations.

inequality as in the baseline.

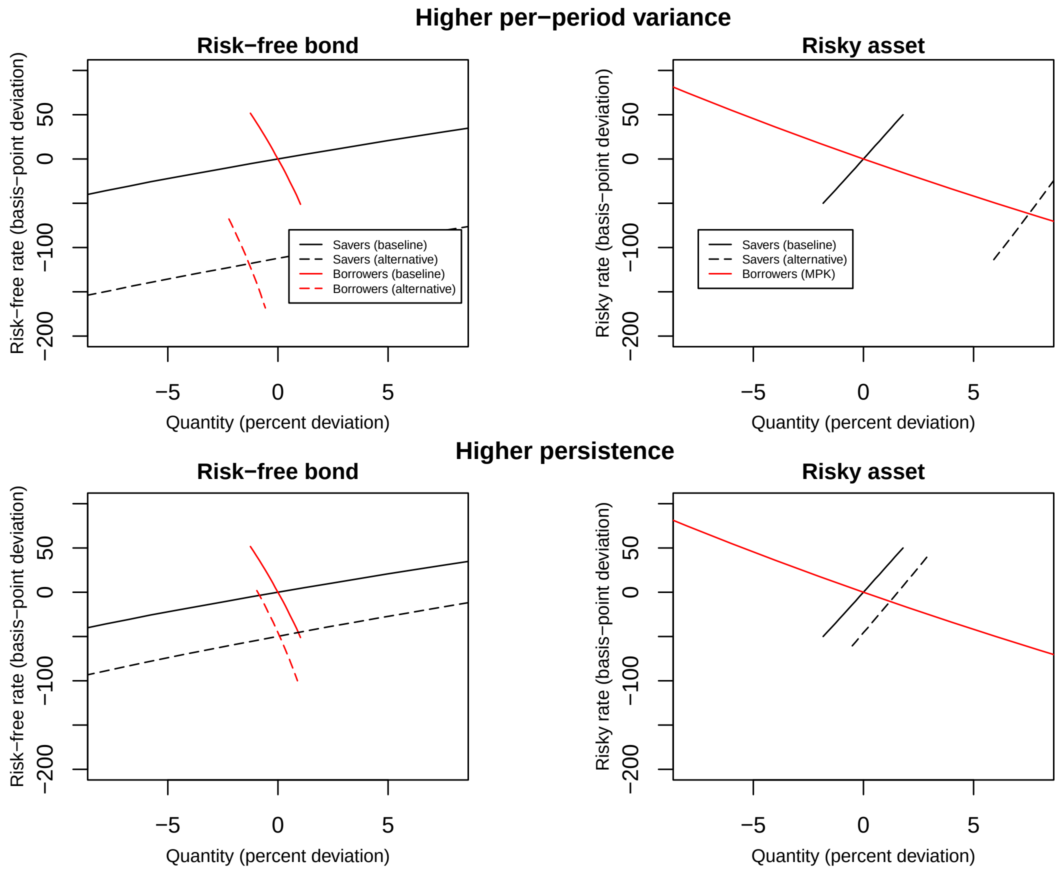
5.3.1 Greater volatility in labor income

Beginning with the general population, figure 3 shows that a rise in the volatility of innovations to the AR(1) labor income process (top row) and an increase in that process' persistence (bottom row) have qualitatively similar effects on the supply and demand curves of the two assets. In both cases, households face greater uncertainty regarding the evolution of their labor income, heightening their precautionary demand for both assets, as visually captured by the downward shifts in savers' demand curves. A stronger precautionary motive also means that fewer households borrow in the safe asset, and those who do borrow less, so that borrowers' supply of risk-free asset also shifts down. In equilibrium, these downward shifts in demand curves cause both the risk-free rate and the risky rate to fall, and the capital stock and output expand. The risk-free rate falls more than the risky rate because the risk-free asset offers better protection against increased income risk and because its supply contracts modestly.[28]

Quantitatively, the drops in the risk-free and risky rates and the expansion of capital and output

[28] A more uncertain labor income path also means that, over the work life, households are likely to make more frequent or larger adjustments (or both) to their stock of savings than otherwise. Because adjusting holdings of the risky asset is costly, whereas adjusting holdings of the risk-free bond is not, the risk-free asset is a relatively attractive investment to hedge the increased labor income risk.

Figure 3: Long-run effects on asset markets: labor income (general population)



Note: The panels show long-run supply and demand curves, in deviations from baseline equilibrium values, under alternative calibrations of the AR(1) process for labor income in the general population. The alternative calibrations induce a 1-point rise in the Gini coefficient on wealth. MPK is marginal product of capital.
Source: Authors' calculations.

are larger when the change in the driving process originates from a rise in the volatility of innovations (top panel) than from greater persistence (bottom panel). Intuitively, precautionary motives are exacerbated to a lesser extent in the latter case because greater persistence makes households' labor income more predictable over the coming several years, even as it makes labor income more uncertain at longer horizons.[29]

Turning to top earners, we consider three ways to allocate a greater share of aggregate labor income to the subset of top earners. In the first case (depicted in the top row of figure 4), the fraction of households in the top labor income state in unchanged, but those lucky few enjoy greater labor earnings relative to the general population than under the baseline. In the other two cases, top earners' relative labor earnings is unchanged, but a larger fraction of the population finds itself being a top earner because more households are elevated to the top state each period (middle row)

[29]For a discussion of this point, see appendix E

or because top earners remain so for longer on average (bottom row). Either way, because top earners know that they will not remain in the top state forever, they have relatively high marginal propensities to save. And because adjusting capital holdings is costly, they channel much of their extra savings to the risk-free asset, causing a decline in the risk-free rate both in absolute terms and relative to the risky rate—that is, the risk premium widens. In the first two cases, top earners' greater propensity to save also leads to increased demand for capital, inducing a decline in the risky rate. In the third case, households tend to spend more time on average in the top state, given them a greater chance to shift the composition of their portfolio toward the risky asset, which helps keep the aggregate demand for the risky asset—and thus the risky rate, capital stock, and output—little changed in equilibrium.[30]

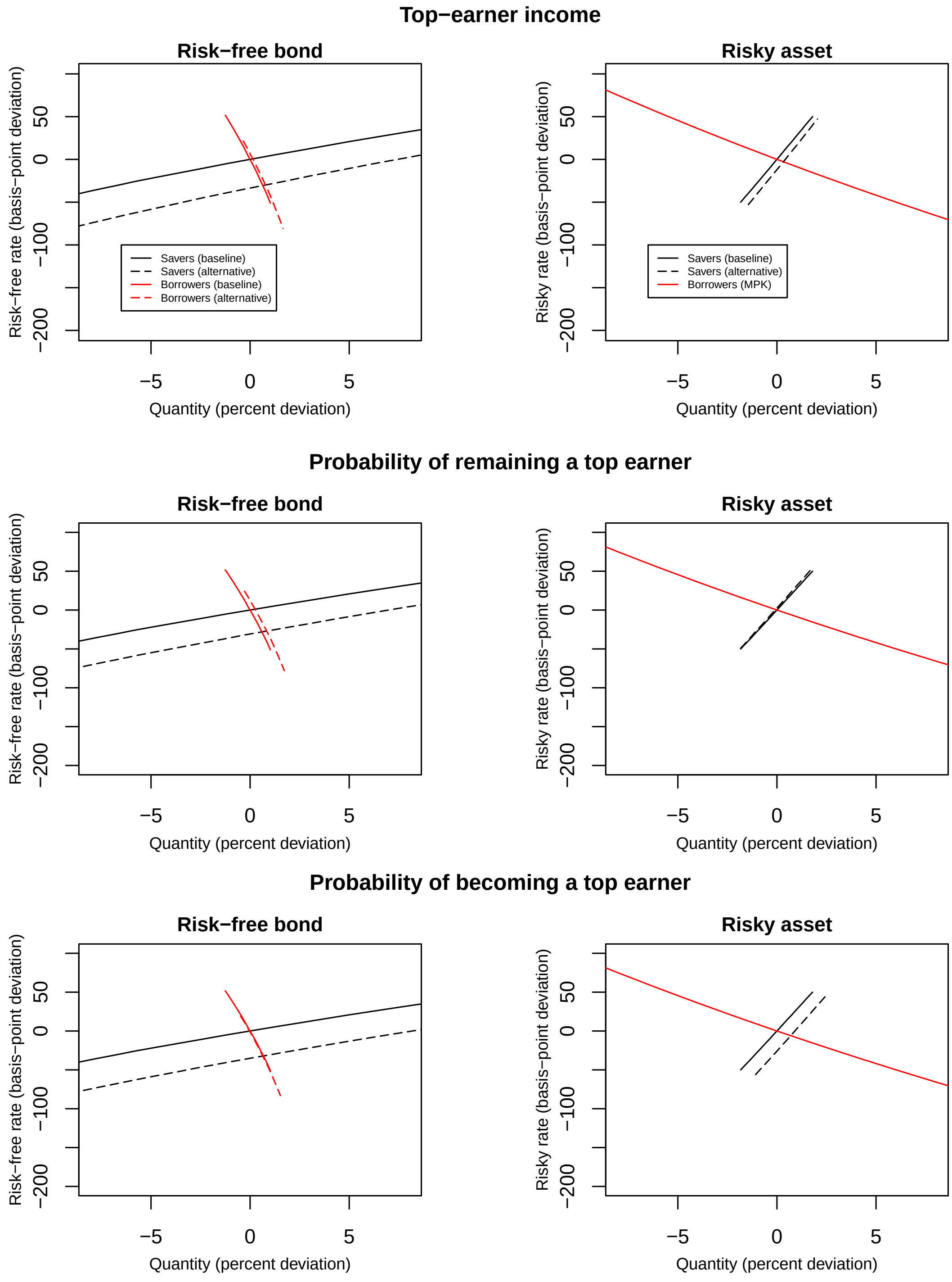
5.3.2 Greater volatility in risky asset returns

Figure 5 shows corresponding asset supply and demand curves when the increase in wealth inequality stems from a greater volatility of innovations to the AR(1) process for risky returns (top panel) or a higher persistence of that process (bottom panel). In both cases, the evolution of household income is more uncertain, accentuating precautionary saving motives. In addition, all else equal, the greater riskiness of physical capital makes this asset less suited for hedging income risk, causing households to want to rebalance their portfolios toward the risk-free asset. As a result, savers' demand for the risk-free asset increases notably, inducing a marked drop in the risk-free rate. Heightened precautionary motives also leads some households to cut back on borrowing, causing borrowers' supply curve for safe assets to move down, with the equilibrium amount of risk-free asset edging down.

In the risky asset market, the equilibrium depends on the interplay between greater precautionary demand and reduced demand due to capital being a poorer hedge for income risk. The latter force dominates in both alternative parameterizations, leading to contraction in the capital stock and, thus, a fall in output, along with a rise in the risky rate. Households' desire to rebalance their portfolio away from the risky asset is especially strong in the case of a higher variance of innovations, causing large contractions in the stock of capital and output, and a marked rise in the risky rate.

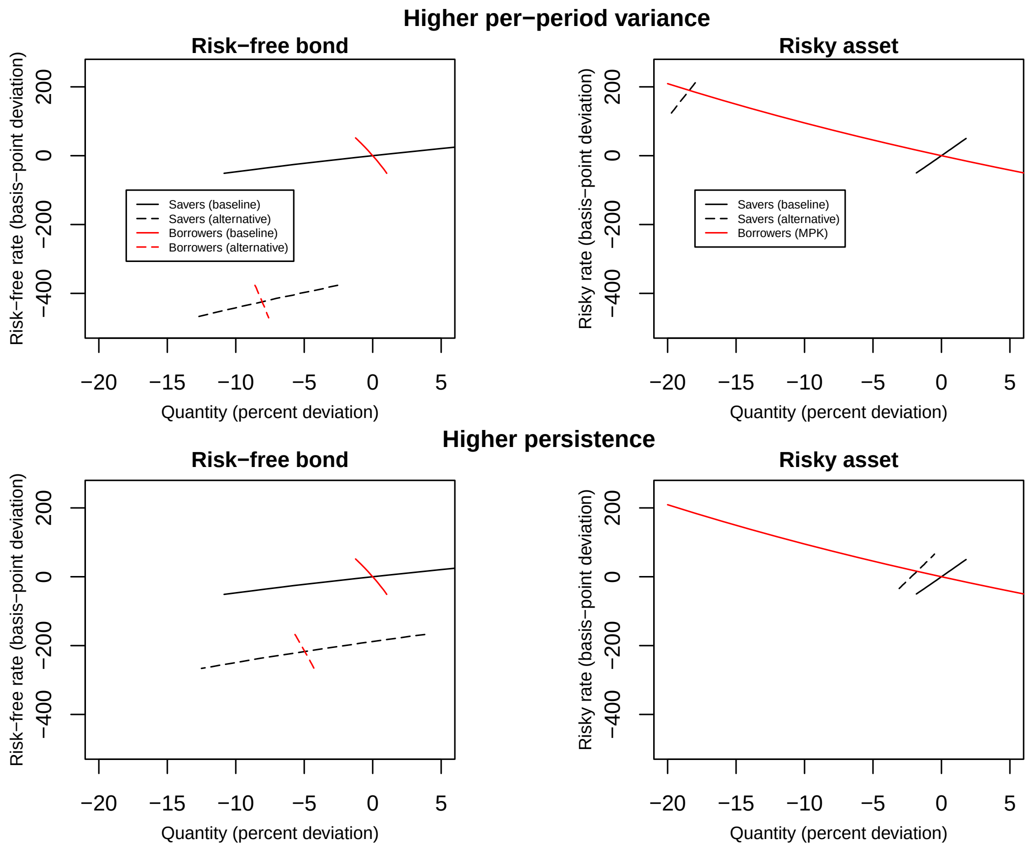
[30] Asset supply and demand curves are also affected by dynamics in the general population. Under our assumptions, an increase in the productivity of top earners is matched by a decline in the productivity of the general population, so as to keep the effective aggregate labor supply constant. All else equal, this normalization depresses the labor income of new households relative to life-time earnings, making them more inclined to borrow early on or to limit their purchases of safe and risky assets to smooth consumption. Such an effect helps to explain why, in contrast to figure 3, borrowers' supply of risk-free assets does not move down and savers' demand for the risky asset is contained.

Figure 4: Long-run effects on asset markets: labor income (top earners)



Note: The panels show long-run supply and demand curves, in deviations from baseline equilibrium values, under alternative calibrations of the labor income process for top earners. The alternative calibrations induce a 1-point rise in the Gini coefficient on wealth. MPK is marginal product of capital.
Source: Authors' calculations.

Figure 5: Long-run effects on asset markets of greater dispersion in risky returns



Note: The panels show long-run supply and demand curves, in deviations from baseline equilibrium values, under alternative calibrations of the AR(1) process for the return on the risky asset. The alternative calibrations induce a 1-point rise in the Gini coefficient on wealth. MPK is marginal product of capital.

Source: Authors' calculations.

5.3.3 Correlation between labor and asset income

Next, we introduce correlation between labor income and risky returns such that households tend to experience periods during which the AR(1) components of their labor income and asset returns are either both above or both below normal levels. This correlation exacerbates income and wealth inequality. We set the amount of correlation so that, as in the other cases, there is a 1-point increase in the Gini coefficient.[31]

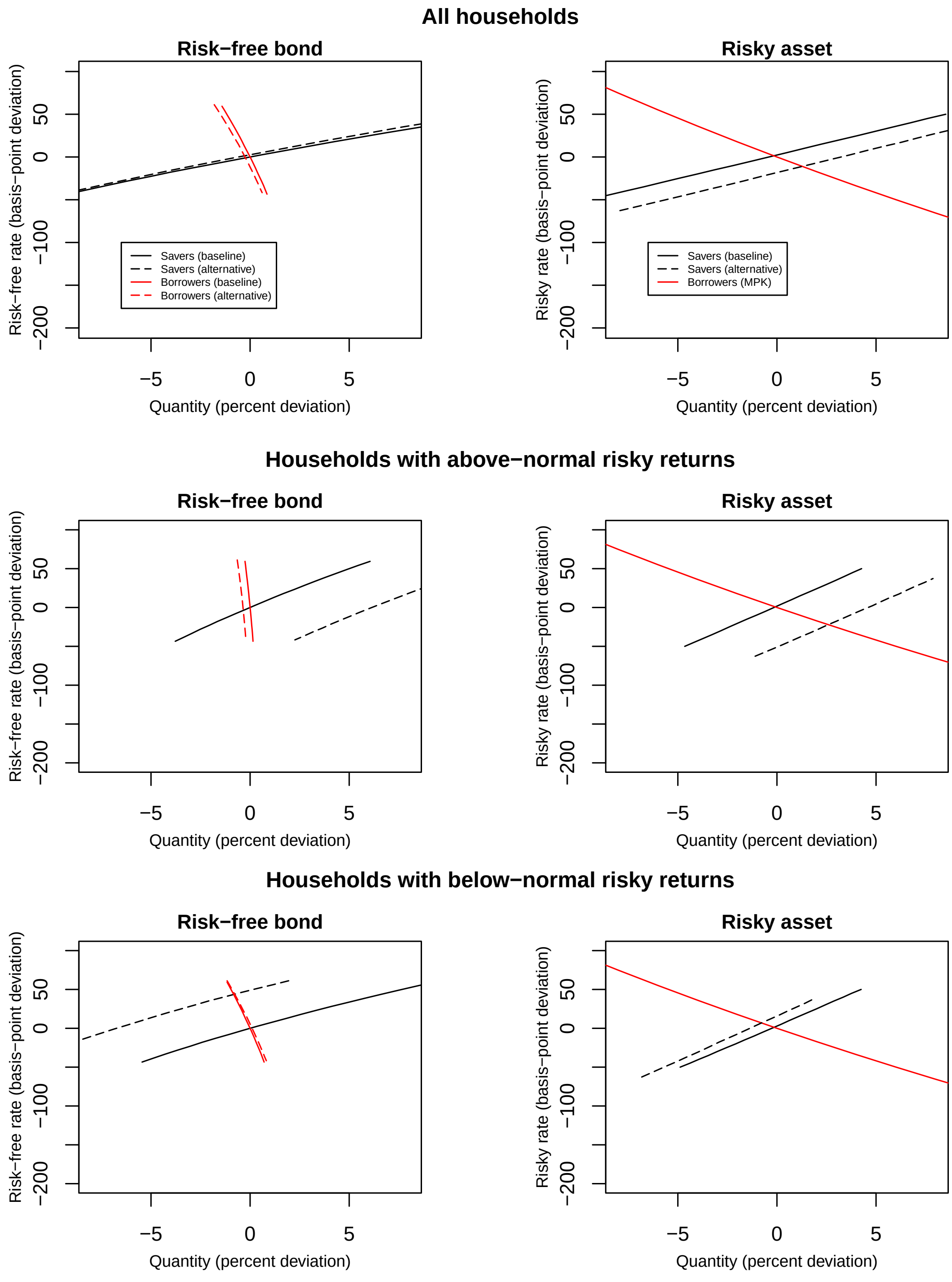
Figure 6 illustrates how this correlation is associated with a greater demand for the risky asset than under the baseline calibration, thus leading to a lower risky rate than in our baseline, as well as a higher capital stock. By contrast, movements in the supply and demand curves for the risk-free asset are small, inducing only a slight decline in the equilibrium quantity of risk-free asset and slight rise in the risk-free rate. The effects on interest rates and the accompanying narrowing of the risk premium are somewhat at odds with observed trends in recent decades. For this reason, if the empirical correlation went up, then our model indicates that other developments with differing implications must have dominated.

To understand why a higher correlation leads to a higher capital stock and lower risky rate, it is useful to consider households with positive and negative surprises to their risky returns. Households with above-normal returns on capital holdings (middle row of figure 6) see the risky asset as a relatively attractive investment. Because of the positive correlation, they also tend to have elevated transitory labor income, and, thus, a higher-than-normal desire to save. Due to adjustment costs in capital holdings, much of their increased demand for savings spill over to the safe asset. Conversely, households with below-normal risky returns (bottom row of figure 6) tend to have unusually low transitory labor income, leading to a pullback in their demand for capital and less savings more generally. Again, because of capital adjustment costs, households are reluctant to reduce their holdings of the capital asset much despite its depressed return, inducing them to reduce their demand for the risk-free asset as they seek to smooth consumption.

On balance, because households with elevated transitory income tend to have more aggregate resources for savings than households with negative shock realizations, the overall demand for the risky asset expands and its return falls, so that the capital stock and output rise in equilibrium. For the risk-free asset, the increased demand of households with above-normal returns roughly balances out the pullback in demand from those with below normal risky returns, leaving the equilibrium risk-free rate and quantity little changed.

[31] The Rouwenhorst method used to discretize the AR(1) components of labor income and risky returns produces Markov transition matrices across realizations on a grid. To introduce correlation, we make risky-return Markov matrices conditional on the labor income realization. Specifically, we adjust the Markov matrices such that the conditional means (but not the conditional standard deviations) of the returns process is higher (lower) when agents have better (worse) labor income outcomes. Many potential changes to conditional means could generate a given amount of correlation. To operationalize our procedure, we start by increasing (decreasing) the conditional expected return by χ for the highest (lowest) realization of the discretized labor income. We then adjust the conditional means of the risky-return process for the other realizations of the labor income process so that the adjustment smoothly increases from the lowest to highest labor income realization. To determine the transition probabilities that yield the change in the conditional means (and that also ensure no change in period variance), we use the methodology of Farmer and Toda (2017). We select χ to generate a 1-point increase in the Gini coefficient on net wealth.

Figure 6: Long-run effects on asset markets: correlation between labor income and risky returns



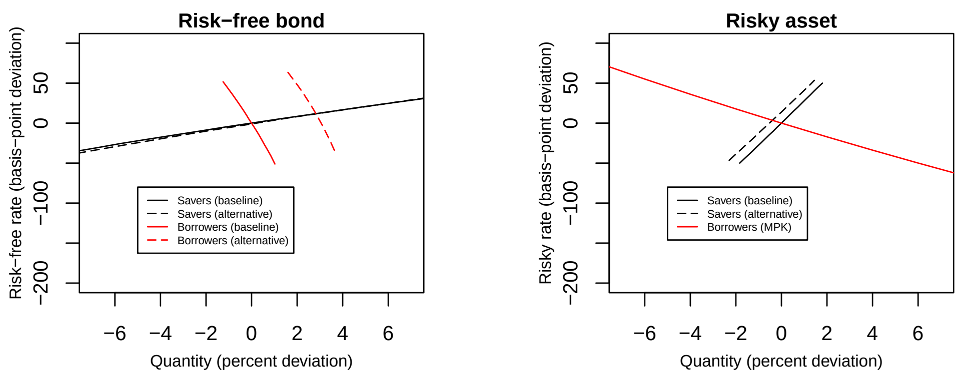
Note: The panels show long-run supply and demand curves, in deviations from baseline equilibrium values, for all households (top row) and for the subsets with higher-than-normal and lower-than-normal returns on capital holdings (middle row and bottom row, respectively). The alternative calibration induces a 1-point rise in the Gini coefficient on wealth. MPK is marginal product of capital.

Source: Authors' calculations.

5.3.4 Lower transient labor income volatility

In all parameterizations discussed so far, an increase in income risk leads to higher income and wealth inequality, consistent with the concurrent rise in such measures documented in figure 1 using SCF data. In contrast to these implications, our final parameterization shows how changes in the volatility of purely transitory shocks to labor income can give rise to a negative relationship between income risk and wealth inequality. In that case, raising the Gini coefficient on wealth by 1 point requires lowering the volatility of transitory shocks to essentially zero, thus making labor income more predictable. As figure 7 shows, the reduction in transitory volatility raises the economy-wide supply of the risk-free asset in equilibrium, pushing up its return and quantity. At the same time, the aggregate demand for the risky asset declines, leading investors to require slightly higher returns on capital holdings.

Figure 7: Long-run effects on asset markets: Lower transitory labor income volatility



Note: The panels show long-run supply and demand curves, in deviations from baseline equilibrium values, under alternative calibrations in which the volatility of i.i.d. shocks to household's labor income is reduced to near zero. The alternative calibration induces a 1-point rise in the Gini coefficient on wealth. MPK is marginal product of capital.
Source: Authors' calculations.

Intuitively, the lower volatility of labor income makes households with few or negative asset holdings less fearful of negative income shocks that might drive their period consumption to very low levels. Because of the lessened precautionary motive, these relatively poor households are less averse to having low or negative asset holdings, as evidenced in table 4 by the fall in the wealth shares of the lowest two quintiles. Some of this increase borrowing originates from young households, who are more inclined to smooth consumption over their lifetime. While this phenomenon accentuates measured wealth inequality, table 4 also shows that it leads to less income inequality overall. In that sense, to the extent that increased wealth inequality reflects an improvement in households' ability to smooth income fluctuations through adjustments in asset holdings, it may be associated with an overall improvement in welfare. That said, because of this parameterization's diverging implications for income and wealth inequality, it seems unlikely to have played a dominant role in past decades.

5.4 Discussion

A motivating question for our paper is whether the observed rise in income and wealth inequality could have contributed to the observed fall in the risk-free rate and widening gap between the risk-free rate and the rate of return on capital in recent decades. In general, we find that greater volatility in labor income or in asset returns leads to greater inequality in both income and wealth, a fall in the risk-free real interest rate, and a widening risk premium that leaves the return on physical capital comparatively little changed. That this constellation of effects is the same across most of the parameterizations considered and accords with the direction of observed changes suggest that, at least conceptually, these various macroeconomic trends could have been jointly influenced by a rise in income risk. In addition, as we discussed in section 2, there is empirical support for some of these channels being at play, with researchers having documented an increase over time in the dispersion of labor income across households, even after controlling for socio-economic elements. The existence of a rise in asset income risk over time is more speculative, however, because of the general lack of household-level panel data with sufficiently long time spans and information about both asset holdings and asset returns.[32] At the same time, the rising prominence of entrepreneurs and other households reliant on asset income points to a possible role for increased dispersion in asset income to be a contributing factor to macroeconomic trends.

Of course, factors beyond those we consider could have contributed to greater inequality, a declining risk-free rate, and a widening risk premium. For example, two commonly cited explanations for the fall in the risk-free rate are slowing productivity growth and population aging. While these explanations help understand this fall, they counterfactually imply that the return on capital should also have fallen by a similar amount. Alternative explanations for the divergence in returns between risk-free and risky assets include economy-wide shortages of safe assets and shifts in risk attitudes that reallocate demand toward safe assets.[33] To be sure, it could be that rising inequality, a falling risk-free real interest rate, and rising risk premiums are ultimately driven by separate rather than joint factors. To the extent that these phenomena are linked in some ways, however, we believe that explanations that emphasize shifts in the distribution of income and risk, or in attitudes toward risk, are worth entertaining.

More generally, not all changes in income and return processes that generate greater inequality are consistent with observed macroeconomic trends. For instance, we show how a greater correlation between labor income and risky asset returns leads to a narrowing of the gap between the risk-free rate and the return on capital, in contrast to the observed widening. In appendix 5.3.4, we further illustrate how income risk need not always be positively associated with income and wealth inequality by considering the effects of a reduction in the volatility of purely transient shocks to labor income. Such a reduction lowers income risk while also making households less reluctant to take on debt,

[32] The panel data sets of administrative income and wealth data made available for Scandinavian countries offers hope that the joint process for labor income and asset returns could be estimated. However, these data sets are only available for the latest decade and half, a period that is arguably too short to assess how changes in returns and their correlation with labor income might have affected the trend toward greater inequality.

[33] See Bernanke (2005) and Caballero and Farhi (2018).

ultimately leading to increased dispersion in income and wealth in our model's equilibrium. As with a greater correlation across income sources, this case is associated with a narrowing risk premium. Thus, another highlight of our analysis is that it underscores how the relationship between inequality and the macroeconomy depends on the sources of inequality in terms of size—and, in cases, the direction—of the macroeconomic effects. These counterfactual implications suggest that, if present, a rise in correlation or greater purely transitory volatility in labor income are unlikely to be dominant influences on macroeconomic trends in recent decades.

We find that the relationship between inequality measures and variables such as output, the capital stock, and the rate of return on capital is especially sensitive to the source of inequality. Ultimately, the effects on these variables depend on households' incentives to accumulate the risky capital asset in the model. The demand for the risky capital asset, in turn, depends on how income risk affects households' precautionary motives—and, thus, their desire to accumulate savings—and how much of their savings they want to channel into the risky asset. Accordingly, the predicted effects on output, capital, and the risky return of a given change in inequality can be sensitive not only to the driver of income inequality but also to assumptions about risk tolerance, the income and return processes, available asset classes, portfolio adjustment frictions, and so on. The sensitivity of these effects might help understand why researchers have struggled to uncover a robust empirical link between inequality and real activity.[34]

We emphasize that there are multiple ways for income and wealth inequality to arise in practice. While we have examined several ways to raise inequality through greater income volatility, other potential contributors could be at play, including changes in risk attitudes, regulatory and fiscal developments, a growing role for bequests, financial innovation, and evolving returns to education.[35] Accordingly, we believe that any single factor is unlikely to fully account the observed rise in inequality.

In addition, our results underscore how the choice of an approach to introducing inequality in a model is not without loss of generality in terms of macroeconomic implications. For instance, the inclusion of a small group of top earners has been key to how our model replicates the Gini coefficient on wealth derived from SCF data. The model's Gini coefficient on wealth is sensitive to small changes in the labor income process for top earners, whereas comparatively large changes in the labor income process for the general population and the risky return process are needed to achieve equal-size moves. Abstracting away from top earners would impart a larger sensitivity of wealth inequality to these other parameters.

The consideration of asset market frictions—in our case, portfolio adjustment costs, borrowing constraints, and risky capital returns—also shapes the model's macroeconomic implications. For example, models that abstract from risk typically imply that the return on capital should move in

[34] See Barro (2008) and Madsen, Islam, and Doucouliagos (2018). We also note that there is a strand of empirical literature exploring potential causal links between inequality and macroeconomic outcomes; for example, the possibility that declines in equilibrium interest rates might fuel inequality by raising asset valuations in a manner that disproportionately benefits wealthy households. This literature is focused on the persistent, but ultimately transitory, effects of monetary policy, as opposed to the long-run relationship in our study.

[35] See appendix F for an exploration of increase risk aversion.

locked steps with the risk-free rate, so that the secular fall in the risk-free rate necessarily entails an expansion of capital and output, whereas changes in these variables are mixed in our model. And while we have posited a simple portfolio adjustment cost function in the context of two stylized assets, other approaches are possible—say, by modeling house purchases as lumpy investments that provide households with streams of services. We have also abstracted from global influences on the supply and demand of assets. For instance, in an open-economy context, the demand of assets could be more responsive to changes in domestic interest rates, so that country-level developments in income risk and other factors might have lesser effects on domestic interest rates and larger effects on the stock of outstanding assets than predicted by our model. At the same time, the rise in income and wealth inequality is a global phenomenon, as is the decline in the risk-free real interest rate, so that the model may nonetheless be informative about the macroeconomic effects of these global trends.[36]

6 Conclusion

In this paper, we have argued that increased volatility in household income is a plausible contributor to the observed rise in measures of income and wealth inequality, the fall in the risk-free rate, and the widening gap between the return on capital and the risk-free rate. At the same time, we showed how the magnitude of these changes as well as the direction and size of the broader macroeconomic effects depend on the source of rising income volatility and various features of economic models. Overall, our results point to the importance of incorporating realistic sources of income heterogeneity and frictions in models, not only to better fit the income and wealth distributions, but also because their incorporation is material for macroeconomic variables.

References

Ahn, SeHyoun, Greg Kaplan, Benjamin Moll, Thomas Winberry, and Christian Wolf (2017). "When Inequality Matters for Macro and Macro Matters for Inequality," in Martin Eichenbaum, and Jonathan A. Parker, eds., *NBER Macroeconomics Annual 2017*, vol. 32. Chicago: University of Chicago Press, pp. 1–75.

Aiyagari, S. Rao (1994). "Uninsured Idiosyncratic Risk and Aggregate Saving," *The Quarterly Journal of Economics*, vol. 109 (3), pp. 659–84.

Altonji, Joseph G., Anthony A. Smith Jr., and Ivan Vidangos (2013). "Modeling Earnings Dynamics," *Econometrica*, vol. 81 (4), pp. 1395–454.

Aoki, Shuhei, and Makoto Nirei (2017). "Zipf's Law, Pareto's Law, and the Evolution of Top Incomes in the United States," *American Economic Journal: Macroeconomics*, vol. 9 (3), pp. 36–71.

[36]On global trends in inequality, see Organisation for Economic Co-operation and Development (2014) and Hoffmann, Lee, and Lemieux (2020). On the global fall in interest rates, see King and Low (2014), Holston, Laubach, and Williams (2017), and Del Negro and others (2019).

Auclert, Adrien, Hannes Malmberg, Frederic Martenet, and Matthew Rognlie (2021). "Demographics, Wealth, and Global Imbalances in the Twenty-First Century," NBER Working Paper Series 29161. Cambridge, Mass.: National Bureau of Economic Research.

Auclert, Adrien, and Matthew Rognlie (2018). "Inequality and Aggregate Demand," NBER Working Paper Series 24280. Cambridge, Mass.: National Bureau of Economic Research.

Autor, David H., Lawrence F. Katz, and Melissa S. Kearney (2008). "Trends in U.S. Wage Inequality: Revising the Revisionists," *The Review of Economics and Statistics*, vol. 90 (2), pp. 300–23.

Barro, Robert J. (2008). "Inequality and Growth Revisited," Working Papers on Regional Economic Integration 11. Manilla: Asian Development Bank.

Barth, Erling, Alex Bryson, James C. Davis, and Richard Freeman (2016). "It's Where You Work: Increases in the Dispersion of Earnings across Establishments and Individuals in the United States," *Journal of Labor Economics*, vol. 34 (S2), pp. 67–97.

Bell, Felicitie C., and Michael L. Miller (2005). *Life Tables for the United States Social Security, 1900–2100*, Office of the Chief Actuary, Actuarial Study 120. Washington: Social Security Administration.

Benhabib, Jess, Alberto Bisin, and Mi Luo (2019). "Wealth Distribution and Social Mobility in the US: A Quantitative Approach," *American Economic Review*, vol. 109 (5), pp. 1623–47.

Benhabib, Jess, Alberto Bisin, and Shenghao Zhu (2011). "The Distribution of Wealth and Fiscal Policy in Economies with Finitely Lived Agents," *Econometrica*, vol. 79 (1), pp. 123–57.

Bernanke, Ben (2005). "The Global Saving Glut and the U.S. Current Account Deficit," Speech delivered at the Sandridge Lecture of the Virginia Association of Economists, Richmond, VA, March 10.

Bewley, Truman (1977). "The Permanent Income Hypothesis: A Theoretical Formulation," *Journal of Economic Theory*, vol. 16 (2), pp. 252–92.

Caballero, Ricardo J., and Emmanuel Farhi (2018). "The Safety Trap," *Review of Economic Studies*, vol. 85 (1), pp. 223–74.

Caballero, Ricardo J., Emmanuel Farhi, and Pierre-Olivier Gourinchas (2017). "Rents, Technical Change, and Risk Premia Accounting for Secular Trends in Interest Rates, Returns on Capital, Earning Yields, and Factor Shares," *American Economic Review: Papers and Proceedings*, vol. 107 (5), pp. 614–20.

Cagetti, Marco, and Mariacristina De Nardi (2006). "Entrepreneurship, Frictions, and Wealth," *Journal of Political Economy*, vol. 114 (5), pp. 835–70.

Cao, Dan, and Wenlan Luo (2017). "Persistent Heterogeneous Returns and Top End Wealth Inequality," *Review of Economic Dynamics*, vol. 26, pp. 301–26.

Carr, Michael D., and Emily E. Wiemers (2021). "The Role of Low Earnings in Differing Trends in Male Earnings Volatility," *Economics Letters*, vol. 199 (C), p. 109702.

Carroll, Christopher, Jiri Slacalek, Kiichi Tokuoka, and Matthew N. White (2017). "The Distribution of Wealth and the Marginal Propensity to Consume," *Quantitative Economics*, vol. 8 (3), pp. 977–1020.

Carvalho, Carlos, Andrea Ferrero, and Fernanda Nechio (2016). "Demographics and Real Interest Rates: Inspecting the Mechanism," *European Economic Review*, vol. 88 (C), pp. 208–26.

Castañeda, Ana, Javier Díaz-Giménez, and José-Víctor Ríos-Rull (2003). "Accounting for the U.S. Earnings and Wealth Inequality," *Journal of Political Economy*, vol. 111 (4), pp. 818–57.

Crawley, Edmund S., Martin Holm, and Håkon Tretvoll (2026). "A Parsimonious Model of Idiosyncratic Income," *International Economic Review*, vol. 67 (2), pp. 533–48.

Dahl, Molly, Thomas DeLeire, and Jonathan A. Schwabish (2011). "Estimates of Year-to-Year Volatility in Earnings and in Household Incomes from Administrative, Survey, and Matched Data," *Journal of Human Resources*, vol. 46 (4), pp. 750–774.

Davis, Steven J., and James A. Kahn (2008). "Interpreting the Great Moderation: Changes in the Volatility of Economic Activity at the Macro and Micro Levels," *Journal of Economic Perspectives*, vol. 22 (4), pp. 155–180.

De Nardi, Mariacristina, and Giulio Fella (2017). "Saving and Wealth Inequality," *Review of Economic Dynamics*, vol. 26, pp. 280–300.

DeBacker, Jason, Bradley Heim, Vasia Panousi, Shanthi Ramnath, and Ivan Vidangos (2013). "Rising Inequality: Transitory or Persistent? New Evidence from a Panel of U.S. Tax Returns," *Brookings Papers on Economic Activity*, vol. 44 (Spring), pp. 67–142.

Del Negro, Marco, Domenico Giannone, Marc P. Giannoni, and Andrea Tambalotti (2019). "Global Trends in Interest Rates," *Journal of International Economics*, vol. 118 (C), pp. 248–62.

Dogra, Keshav, and Olga Gorbachev (2016). "Consumption Volatility, Liquidity Constraints and Household Welfare," *Economic Journal*, vol. 126 (597), pp. 2012–37.

Dynan, Karen E., Jonathan Skinner, and Stephen P. Zeldes (2004). "Do the Rich Save More?," *Journal of Political Economy*, vol. 112 (2), pp. 397–444.

Eggertsson, Gauti B., Neil R. Mehrotra, and Jacob A. Robbins (2019). "A Model of Secular Stagnation: Theory and Quantitative Evaluation," *American Economic Journal: Macroeconomics*, vol. 11 (1), pp. 1–48.

Fagereng, Andreas, Luigi Guiso, Davide Malacrino, and Luigi Pistaferri (2018). "Heterogeneity and Persistence in Returns to Wealth," IMF Working Papers 2018–171. Washington: International Monetary Fund.

——————(2020). "Heterogeneity and Persistence in Returns to Wealth," *Econometrica*, vol. 88 (1), pp. 115–70.

Farmer, Leland E., and Alexis Akira Toda (2017). "Discretizing Nonlinear, Non-Gaussian Markov Processes with Exact Conditional Moments," *Quantitative Economics*, vol. 8 (2), pp. 651–83.

Favilukis, Jack (2013). "Inequality, Stock Market Participation, and the Equity Premium," *Journal of Financial Economics*, vol. 107 (3), pp. 740–59.

Flavin, Marjorie, and Takashi Yamashita (2002). "Owner-Occupied Housing and the Composition of the Household Portfolio," *American Economic Review*, vol. 92 (1), pp. 345–62.

——————(2011). "Owner-Occupied Housing: Life-Cycle Implications for the Household Portfolio," *American Economic Review*, vol. 101 (3), pp. 609–14.

Gagnon, Etienne, Benjamin K. Johannsen, and David López-Salido (2021). “Understanding the New Normal: The Role of Demographics,” *IMF Economic Review*, vol. 69 (2), pp. 357–90.

Geppert, Christian, Alexander Ludwig, and Raphael Abiry (2016). “Secular Stagnation? Growth, Asset Returns and Welfare in the Next Decades: First Results,” SAFE Working Paper No. 145. Frankfurt am Main: Goethe University, Sustainable Architecture for Finance in Europe.

Goldin, Claudia, and Lawrence F. Katz (2007). “Long-Run Changes in the Wage Structure: Narrowing, Widening, Polarizing,” *Brookings Papers on Economic Activity*, vol. 38 (2), pp. 135–68.

Gordon, Robert J., and Ian Dew-Becker (2007). “Selected Issues in the Rise of Income Inequality,” *Brookings Papers on Economic Activity*, vol. 38 (2), pp. 169–92.

Gottschalk, Peter, and Robert Moffitt (1994). “The Growth of Earnings Instability in the U.S. Labor Market,” *Brookings Papers on Economic Activity*, vol. 25 (2), pp. 217–72.

Gouveia, Miguel, and Robert P. Strauss (1994). “Effective Federal Individual Tax Functions: An Exploratory Empirical Analysis,” *National Tax Journal*, vol. 47 (2), pp. 317–39.

Guvenen, Fatih, Gueorgui Kambourov, Burhanettin Kuruscu, Sergio Ocampo-Diaz, and Daphne Chen (2019). “Use It or Lose It: Efficiency Gains from Wealth Taxation,” NBER Working Paper Series 26284. Cambridge, Mass.: National Bureau of Economic Research.

Guvenen, Fatih, Fatih Karahan, Serdar Ozkan, and Jae Song (2021). “What Do Data on Millions of U.S. Workers Reveal About Lifecycle Earnings Dynamics?,” *Econometrica*, vol. 89 (5), pp. 2303–39.

Hasanhodzic, Jasmina, and Laurence J. Kotlikoff (2013). “Generational Risk - Is It a Big Deal?: Simulating an 80-Period OLG Model with Aggregate Shocks,” NBER Working Paper Series 19179. Cambridge, Mass.: National Bureau of Economic Research.

Hoffmann, Florian, David S. Lee, and Thomas Lemieux (2020). “Growing Income Inequality in the United States and Other Advanced Economies,” *Journal of Economic Perspectives*, vol. 34 (4), pp. 52–78.

Holston, Kathryn, Thomas Laubach, and John C. Williams (2017). “Measuring the Natural Rate of Interest: International Trends and Determinants,” *Journal of International Economics*, vol. 108 (S1), pp. 59–75.

Huggett, Mark (1996). “Wealth Distribution in Life-Cycle Economies,” *Journal of Monetary Economics*, vol. 38 (3), pp. 469–94.

Huggett, Mark, and Juan Carlos Parra (2010). “How Well Does the U.S. Social Insurance System Provide Social Insurance?,” *Journal of Political Economy*, vol. 118 (1), pp. 76–112.

Jones, Callum (2023). “Aging, Secular Stagnation, and the Business Cycle,” *The Review of Economics and Statistics*, vol. 105 (6), pp. 1580–1595. ISSN: 0034-6535.

Kaplan, Greg (2012). “Inequality and the Life Cycle,” *Quantitative Economics*, vol. 3 (3), pp. 471–525.

Kaplan, Greg, Benjamin Moll, and Giovanni L. Violante (2018). “Monetary Policy According to HANK,” *American Economic Review*, vol. 108 (3), pp. 697–743.

Kara, Engin, and Leopold von Thadden (2016). "Interest Rate Effects of Demographic Changes in a New Keynesian Life-Cycle Framework," *Macroeconomic Dynamics*, vol. 20 (1), pp. 120–64.

Karahan, Fatih, and Serdar Ozkan (2013). "On the Persistence of Income Shocks over the Life Cycle: Evidence, Theory, and Implications," *Review of Economic Dynamics*, vol. 16 (3), pp. 452–76.

Kasa, Kenneth, and Xiaowen Lei (2018). "Risk, Uncertainty, and the Dynamics of Inequality," *Journal of Monetary Economics*, vol. 94 (C), pp. 60–78.

Katz, Lawrence F., and David H. Autor (1999). "Changes in the Wage Structure and Earnings Inequality," in Orley Ashenfelter, and David Card, eds., *Handbook of Labor Economics*, vol. 3. Amsterdam: Elsevier, pp. 1463–1555.

Kaymak, Barış, and Markus Poschke (2016). "The Evolution of Wealth Inequality over Half a Century: The Role of Taxes, Transfers and Technology," *Journal of Monetary Economics*, vol. 77 (C), pp. 1–25.

King, Mervyn, and David Low (2014). "Measuring the 'World' Real Interest Rate," NBER Working Paper Series 19887. Cambridge, Mass.: National Bureau of Economic Research.

Kopecky, Karen, and Richard Suen (2010). "Finite State Markov-Chain Approximations to Highly Persistent Processes," *Review of Economic Dynamics*, vol. 13 (3), pp. 701–14.

Krueger, Dirk, and Alexander Ludwig (2007). "On the Consequences of Demographic Change for Rates of Returns to Capital, and the Distribution of Wealth and Welfare," *Journal of Monetary Economics*, vol. 54 (1), pp. 49–87.

Krusell, Per, and Anthony A. Smith Jr. (1998). "Income and Wealth Heterogeneity in the Macroeconomy," The University of Chicago Press, *Journal of Political Economy*, vol. 106 (5), pp. 867–96.

Larrimore, Jeff, and David Splinter (2026). "Income Mobility of the Top One Percent," Finance and Economics Discussion Series 2026–015. Board of Governors of the Federal Reserve System (U.S.)

Lemieux, Thomas (2006). "Increasing Residual Wage Inequality: Composition Effects, Noisy Data, or Rising Demand for Skill?," *American Economic Review*, vol. 96 (3), pp. 461–98.

Madsen, Jakob B., Md. Rabiul Islam, and Hristos Doucouliagos (2018). "Inequality, Financial Development and Economic Growth in the OECD, 1870–2011," *European Economic Review*, vol. 101 (C), pp. 605–24.

Marx, Magali, Benoit Mojon, and François R. Velde (2021). "Why Have Interest Rates Fallen Far Below the Return on Capital," *Journal of Monetary Economics*, vol. 124 (Supplement), S57–S76.

Moffitt, Robert, and Sisi Zhang (2018). "Income Volatility and the PSID: Past Research and New Results," *AEA Papers and Proceedings*, vol. 108, pp. 277–80.

Organisation for Economic Co-operation and Development (2014). *Does Income Inequality Hurt Economic Growth?*, Focus on Inequality and Growth (December 2014). Directorate for Employment, Labour, Social Affairs, Organisation for Economic Co-operation, and Development.

Paz-Pardo, Gonzalo (2024). "Homeownership and Portfolio Choice over the Generations," *American Economic Journal: Macroeconomics*, vol. 16 (1), pp. 207–37.

Peterman, William B. (2013). "Determining the Motives for a Positive Optimal Tax on Capital," *Journal of Economic Dynamics and Control*, vol. 37 (1), pp. 265–95.

Poghosyan, Tigran (2018). "How Do Financial Cycles Affect Public Debt Cycles?," *Empirical Economics*, vol. 54 (2), pp. 425–60.

Pora, Pierre, and Lionel Wilner (2020). "A Decomposition of Labor Earnings Growth: Recovering Gaussianity?," *Labour Economics*, vol. 63 (C), p. 101807.

Pugh, Thomas (2018). *Wealth and Mobility: Superstars, Returns Heterogeneity and Discount Factors*, Mimeo.

Quadrini, Vincenzo (2000). "Entrepreneurship, Saving and Social Mobility," *Review of Economic Dynamics*, vol. 3 (1), pp. 1–40.

Sabelhaus, John, and Jae Song (2010). "The Great Moderation in Micro Labor Earnings," *Journal of Monetary Economics*, vol. 57 (4), pp. 391–403.

Saez, Emmanuel, and Gabriel Zucman (2016). "Editor's Choice Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data," *The Quarterly Journal of Economics*, vol. 131 (2), pp. 519–78.

Stachurski, John, and Alexis Akira Toda (2019). "An Impossibility Theorem for Wealth in Heterogeneous-Agent Models with Limited Heterogeneity," *Journal of Economic Theory*, vol. 182 (C), pp. 1–24.

Toda, Alexis Akira (2019). "Wealth Distribution with Random Discount Factors," *Journal of Monetary Economics*, vol. 104 (C), pp. 101–113.

Wolff, Edward N., and Maury Gittleman (2014). "Inheritances and the Distribution of Wealth or Whatever Happened to the Great Inheritance Boom?," *The Journal of Economic Inequality*, vol. 12 (4), pp. 439–68.

Xavier, Inês (2021). *Wealth Inequality in the US: The Role of Heterogeneous Returns*, Mimeo.

Yum, Minchul (2018). "On the Distribution of Wealth and Employment," *Review of Economic Dynamics*, vol. 30, pp. 86–105.

Online Appendix

A Correlation between labor income and risky asset return deviations in the PSID

Our baseline model calibration embeds the assumption of no correlation between labor income and risky asset returns. In this appendix, we show that the corresponding empirical correlation in the PSID is small, though data limitations and measurement error in the survey complicate precise inference.

The PSID includes information on a panel of households surveyed annually from 1968 through 1997, and every other year since then. The main portion of the survey collects a range of demographic and socio-economic information about households, including labor and capital income. Household wealth and other balance sheet information, which is needed to calculate household-specific rates of returns on savings, has been collected since 1984 with the addition of the Wealth Supplement to the survey. This supplement was administered every five years through 1999, and then every other year subsequently.[1] Together, the main questionnaire and the Wealth Supplement allow us to construct a measure of risky asset returns in every wealth supplement year and calculate its correlation with labor income.

Specifically, we define risky assets as the sum of net business equity, stocks, primary housing, and other real estate for which we observe the self-reported value in wealth supplement years.[2] Because the PSID tracks households over time, we can define capital gains as the change in the value of asset holdings reported by a household between wealth supplements, net of any reported purchase or sale of assets. We define capital income as the sum of business and farm income, interest income, dividend income, and trust or royalty income in all years between wealth supplements. This definition allows us to compute annualized asset returns on risky assets between wealth supplement years as the sum of capital income and capital gains returns. As is standard in the literature, we focus on households that belong to the national sample drawn by the Survey Research Center. To limit the risk of measurement error driving the regression results, we drop observations (that is, combinations of a household and wealth supplement year) whose reported annualized risky asset returns since the previous wealth supplement year are either larger than 300 percent or less than negative 66.7 percent (equivalently, for which risky assets grew over threefold or fell to less than one-third of their original value at an annualized rate).

To estimate the correlation between labor income and risky asset returns, we follow the methodology in the literature that estimates labor income risk (for example, Kaplan (2012)). We first regress log labor income for the household head on a cubic age polynomial, education dummies, and

[1] We refer to years including a wealth supplement module as "wealth supplement years." These years are 1984, 1989, 1994, 1999, and every subsequent odd year through 2023. Asset returns can be calculated for all these years except 1984.

[2] This definition excludes self-reported cash and liquid assets, annuities and individual retirement accounts, motor vehicles, and other assets such as life insurance policies, valuable collections, trusts, etc.

time dummies to remove the common, aggregate components of labor income. The residuals provide a measure that combines permanent, persistent, and idiosyncratic deviations (α_i, $\nu_{i,t}$, and $\theta_{i,t}$) from mean labor income. We similarly remove the aggregate component of risky asset returns by regressing the risky asset returns of households on supplement year dummies and utilizing the residual as a measure of idiosyncratic deviations to risky asset returns ($\delta_{i,t}$). Finally, we then measure the correlation between deviations in labor income with those in asset returns.

Figure A1 reports the deviations in log labor income and risky asset returns for each combination of a household and supplement year in the sample, along with a linear regression line. These data suggest a positive, but small, correlation of 0.018 (with an associated p value of 0.051) between the two types of deviations.[3] We cannot reject the hypothesis that the correlation coefficient is the same across supplement years. Thus, it seems unlikely that changes in this relationship are a significant driver of rising inequality in recent history. That said, the PSID's sample size is limited, particularly among high-wealth households, and the measurement of labor income and asset returns is inherently noisy. In addition, asset returns can be calculated in the PSID only since the late 1980's, by which time inequality measures were already rising steadily. To the extent that a small increase in the correlation has contributed to rising inequality, it is possible that this increase predates the start of our data.

B Definition of stationary competitive equilibrium

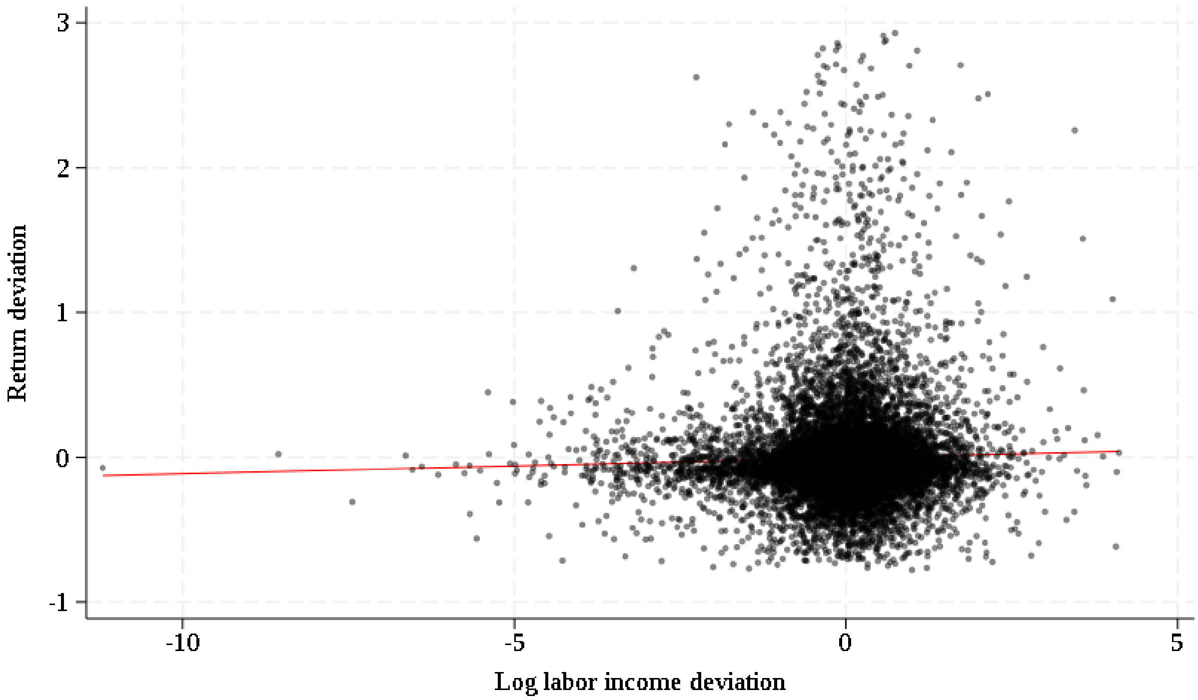
In this appendix, we define a stationary competitive equilibrium for the model. Household i's state variables in period t are its age (j_i), ability (α_i), persistent labor income shock ($\nu_{i,t}$), idiosyncratic labor income shock ($\theta_{i,t}$), holdings of risky assets ($a_{i,t}$), holdings of safe assets ($b_{i,t}$), and return to savings in risky assets ($\widetilde{r}_{i,t}$). We group these state variables into the vector x and let $\mu(x)$ be the measure of households in state x. For ease of notation, below we drop the dependence on x of the household's variables in the presentation of the optimization problem and in the aggregation across individuals. For a given set of exogenous demographic parameters, $(\{n, \Psi\})$, a government tax function $\left(\Gamma : \mathbb{R}_+^2 \to \mathbb{R}_+\right)$, social security benefits (ss), a production plan for the representative firm (N, K), and a household utility function $(U : \mathbb{R}_+ \to \mathbb{R}_+)$, a stationary competitive equilibrium consists of a household decision rule $\{c\}$ that is conditional on the state x, factor prices $(\{W, R\})$, accidental bequests (beq) received by surviving households, and the distribution of individuals across states $(\mu(x))$ such that the following holds:

1. Given prices, policies, accidental bequests, benefits, and that the labor income ω follows equation 2, the household maximizes equation 1 under rational expectations, subject to

$$c + a' + Pb' = W\omega h + (1 + \widetilde{r})a + b - \Gamma\left(y^l, y^s\right) + beq,$$

[3]This correlation estimate is computed after controlling labor income and asset returns for age, education, employment status, and marital status as well as year fixed effects. Unconditional correlations are slightly higher at 0.024 (p=0.010), and do not appear to vary over time.

Figure A1: Correlation between labor income and risky asset return deviations in the PSID



Note: The figure reports the deviation of annual labor income and annualized risky asset returns from their respective trends for all combinations of a household and wealth supplement year. The red line is a linear regression line.
Source: Authors' calculations using the national sample of the PSID drawn by the Survey Research Center.

for $j < j^{ret}$, and

$$c + a' + Pb' = (1 + \widetilde{r})a + b - \Gamma\left(y^l, y^s\right) + beq + ss,$$

for $j \geq j^{ret}$. Additionally, for all households,

$$c \geq 0,\ \ 0 \leq h \leq 1,\ \ a \geq 0,\ \ a_1 = 0.$$

2. Prices R and W satisfy the firm's first-order conditions,

$$R = \zeta\left(\frac{H}{K}\right)^{1-\zeta} = \widetilde{r} + \delta$$

and

$$W = (1 - \zeta)\left(\frac{H}{N}\right)^{\zeta}.$$

3. The social security policies satisfy

$$\tau_{ss} = \frac{\int\limits_{i \mid j_i \geqslant j^{ret}} ss \; di}{\int\limits_{i \mid j_i < j^{ret}} \min\{hw\omega, \overline{y}\} \; di}.$$

4. Accidental bequests are given by

$$beq = \int (1 - \Psi) a di.$$

5. Government balances its budget

$$G + (1 - P) B^g + SS = \int \Gamma \left(y^l, y^s\right) di.$$

6. The markets for capital, labor, and goods clear, with

$$K = \int a di + beq,$$

$$H = \int h\omega di,$$

and

$$\int c di + \int a' di + G = K^{\zeta} N^{1-\zeta} + (1 - \delta) K.$$

7. The distribution of $\mu(x)$ is stationary, that is, the law of motion for the distribution of individuals over the state space satisfies $\mu(x) = Q_{\mu}\mu(x)$, where Q_{μ} is a one-period recursive operator on the distribution.

C Trends in the return on safe and risky assets

The top panel of figure A2 shows time-series evidence of a decline in the (short-run) real risk-free real interest rate in the United States in recent decades.[4] All but one estimate are roughly flat from the 1960s through the 1980s, a period during which measures of wealth inequality were little changed, on net.[5] From the 1980s onward, estimates of the risk-free real interest rate are generally declining, on net, while measures of income and wealth inequality are rising steadily.

[4] The models are from Johannsen and Mertens (2018), Holston, Laubach, and Williams (2017), Lubik and Matthes (2015), Del Negro and others (2017), Hamilton and others (2016), and Christensen and Rudebusch (2019).

[5] The exception is the model of Holston, Laubach, and Williams (2017), which imposes that the equilibrium real interest rate comoves one-for-one with the trend in real GDP growth. This identifying assumption may contribute to high estimates of the equilibrium real interest rate in the 1960s and 1970s, a period of high output and demographic growth, even though realized and expected risk-free real interest rates were low in those decades. See Wolff (2021) for estimates of income and wealth inequality going back to the 1960s.

By contrast, the lower panel shows no apparent trend decline in estimates of the return on productive capital over the post-war period based on estimates from Gomme, Ravikumar, and Rupert (2011). If anything, the post-tax return on capital has moved somewhat higher, on net, since the 1980s, accentuating the gap with the risk-free real interest rate. Together, these observations are consistent with a moderate widening of the equity risk premium over the period.

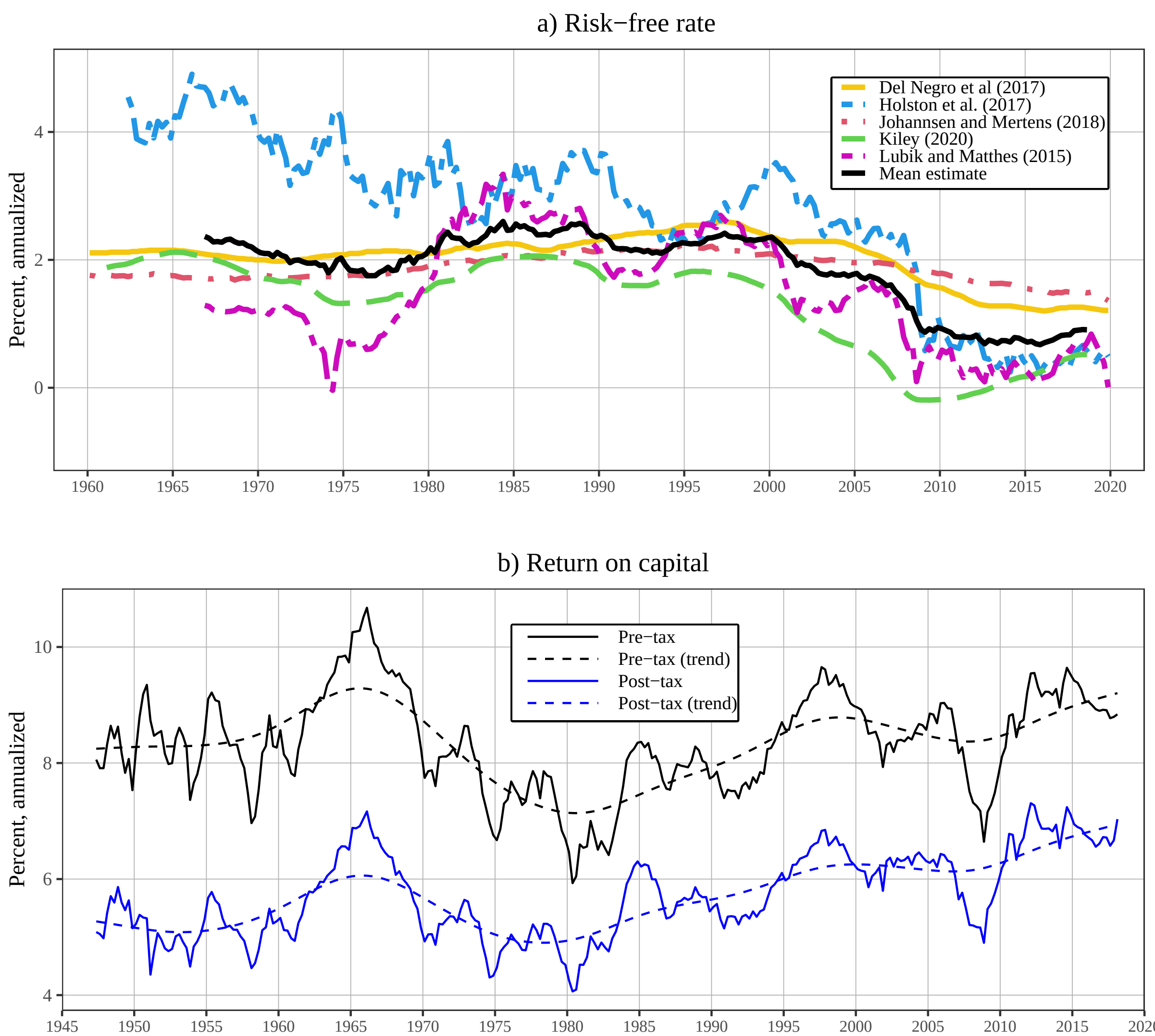
The panels are suggestive of a material and growing gap between the return on the risk-free asset and on risky capital. Whereas the risk-free rate is often defined in terms of the real federal funds rate (or, similarly, a real short-term government bond yield), the return on capital captures proceeds from only a portion of the risky assets in the economy, leaving out, for example, housing and private equity. For this reason, our baseline calibration seeks to match a gap between the risky and risk-free rates of about 4 percent, which is within the plausible range suggested by the empirical estimates by asset classes reported in Fagereng and others (2020).

D Specification of labor income process

As indicated in section 4.1, we pursue a discretization approach to jointly capture persistent and purely transitory shocks to labor income in the general population as well as the possibility that households could become top earners. We first use the Rouwenhorst method to approximate the AR(1) labor income process estimated by Kaplan (2012), which captures labor income dynamics in the general population. We then augment the resulting state space with an extra state for top earners. We further assume that there are equal numbers of individuals with low- and high-permanent ability types, with the persistent and transitory shocks creating deviations between the two levels of income.

In our implementation of the Rouwenhorst method, we assume that the persistent and i.i.d. component can take five values and two values, respectively. Thus, a household of a given ability can experience one of 10 possible labor income levels while in the general population. An eleventh state captures the household being a top earner, when labor income is markedly and persistently above that in the general population.

Figure A2: Estimates of the trend real risk-free real interest rate and real aggregate rate of return on capital



Note: The top panel shows selected time-series estimates of the trend real risk-free interest rate, along with the average of these estimates each period. The lower panel reports quarterly estimates of the economy-wide rate of return on all types of capital, both on a pre-tax basis and an after-tax basis, as calculated by Gomme, Ravikumar, and Rupert (2011). The dashed lines show low-frequency trends using a Hodrick-Prescott filter with a Lagrange multiplier of 25,000.

Source: Estimates based on Del Negro and others (2017), Holston, Laubach, and Williams (2017), Johannsen and Mertens (2018), Kiley (2020), Lubik and Matthes (2015), and Gomme, Ravikumar, and Rupert (2011); authors' calculations.

Let A_t be a vector collecting the probabilities that a household is in each of the eleven states in period t. The first five and next five states pertain to the persistent state conditional on the i.i.d. shock being low and high, respectively. The eleventh state is the share of top earners in the population. The probabilities of being in the various states evolves according to $A_t = MA_{t-1}$, where

$$M = \begin{bmatrix} M_1 & M_1 & M_3 \\ M_1 & M_1 & M_3 \\ M_2 & M_2 & M_4 \end{bmatrix}$$

and M_1 is a 5x5 symmetric matrix from the Rouwenhorst method; M_2 is a 5x1 vector whose entries are all λ_T^b; M_3 is a 5x1 vector of zeros, except for the middle element being $0.5(1-\lambda_T^r)$; and $M_4 = \lambda_T^r$. This specification embeds the assumption that individuals in the general population face the same constant probability of becoming a top earner, irrespective of their permanent ability type or of current and past labor income. Top earners revert to being part of the general population with probability $1-\lambda_T^r$. When the case, they are initially ascribed the median persistent state, with equal probabilities of experiencing either the low or high i.i.d. realizations. We similarly ascribe the median persistent type to new households. This initialization leads to growing dispersion across households as a function of age/experience, a feature also found in the data (see, for example, Altonji, Smith, and Vidangos (2013)).

E The effect of an increase in the persistence of labor income on uncertainty about future labor income

As explained in section 3.2 and further detailed in appendix D, we model workers' (log) labor income as a function of various exogenous shocks. The shock process is somewhat complicated but can be thought of as a Markov-switching process between a set of outcomes for the general population and a high state representing top earners. The labor income process for the general population combines an AR(1) process, a purely transitory shock, a top-earner shock, and forecastable level shifters in the form of permanent and age-specific productivity components.

This appendix considers the effect of an increase in the persistence of the labor income process, with a particular focus on uncertainty about future labor income conditional on current income. That conditional uncertainty affects household's saving motive, which, in turn, affects the asset composition of household portfolios as well as the risk-free and risky interest rates. Households with precautionary motives benefit from a lower conditional standard deviation of labor income.

For intuition, we focus on the AR(1) part of the labor income process, which yields more-easily interpretable analytic expressions. This AR(1) part is given by

$$\nu_{i,t} = \rho \nu_{i,t-1} + \sigma \epsilon_{i,t},$$

where $|\rho| < 1$ and $\epsilon_{i,t} \sim N(0,1)$. It is clear that an increase in persistence of the AR(1) parameter,

ρ, increases the unconditional standard deviation of $\nu_{i,t}$, which is given by

$$\sigma\sqrt{\sum_{j=0}^{\infty}\rho^{2j}}=\frac{\sigma}{\sqrt{1-\rho^2}}.$$

Given $\nu_{i,0}$, an increase in the persistence of the AR(1) parameter also increases the conditional standard deviation of $\nu_{i,t}$, which is is given by

$$\sigma\sqrt{\sum_{j=0}^{t-1}\rho^{2j}}.$$

For $\rho \geq 0$, the ratio of the standard deviation of $\nu_{i,t}$ conditional on $\nu_{i,0}$ to its unconditional standard deviation is decreasing in ρ.[6] That is, as the process becomes more persistent, the conditional uncertainty about labor income outcomes decreases relative to the unconditional level of uncertainty.

There is some complication due to the fact that households care about their labor income in levels, not in logs. However, for the size of the variance with which we work, this nonlinearity has little effect. Figure A3 displays the ratio of the standard deviation of $\exp(\nu_{i,t})$ conditional on $\exp(\nu_{i,0})$ to its unconditional standard deviation for $\rho = 0.95$ and $\rho = 0.96$, and for $\nu_{i,0} = -2\sigma(1-0.95^2)^{-1/2}$, $\nu_{i,0} = 0$, and $\nu_{i,0} = 2\sigma(1-0.95^2)^{-1/2}$. We pick these values of ρ because they are near our benchmark value. We set $\sigma^2 = 0.017$, which is our benchmark value. It is clear from the figure that, given the current value of $\exp(\nu_{i,0})$, a higher value of ρ is associated with a lower ratio over the next many periods. So, even when considering $\exp(\nu_{i,t})$, households with a high value of labor income benefit from a lower conditional standard deviation of future labor income relative to its unconditional standard deviation. Because figure A3 plots the ratio of standard deviations for $\exp(\nu_{i,t})$, rather than for $\nu_{i,t}$, the ratio is not necessarily uniformly lower for all h for a higher value of ρ (note the crossing of the dashed and solid blue lines). As h goes to infinity, the ratio of the conditional and unconditional standard deviations converges to unity.

[6]To see this result, take the first partial derivative of the ratio of the variances with respect to ρ, which is

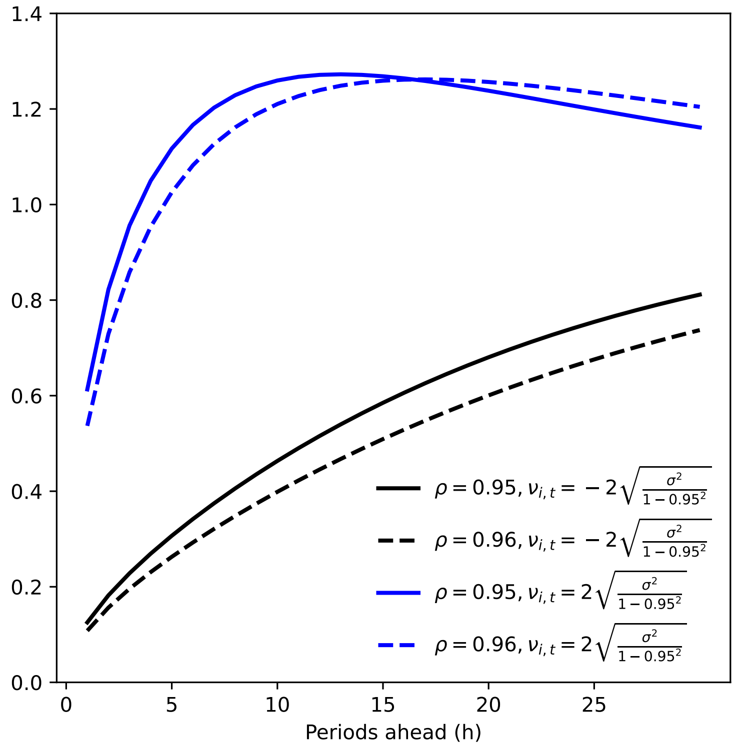
$$\frac{\partial\left(\sum_{j=0}^{t-1}\rho^{2j}\right)\left(\sum_{j=0}^{\infty}\rho^{2j}\right)^{-1}}{\partial\rho}=2\rho^{-1}\frac{\left(\sum_{j=0}^{\infty}\rho^{2j}\right)\sum_{j=0}^{t-1}j\rho^{2j}-\left(\sum_{j=0}^{t-1}\rho^{2j}\right)\sum_{j=0}^{\infty}j\rho^{2j}}{\left(\sum_{j=0}^{\infty}\rho^{2j}\right)^2}.$$

Noting that

$$\left(\sum_{j=0}^{\infty}\rho^{2j}\right)\sum_{j=0}^{t-1}j\rho^{2j}-\left(\sum_{j=0}^{t-1}\rho^{2j}\right)\sum_{j=0}^{\infty}j\rho^{2j}=-\frac{\rho^2}{(1-\rho^2)(1-\rho^2)^2}t\left(\rho^2\right)^{t-1}\left[1-\rho^2\right]<0,$$

the claim stated in the text is immediate.

Figure A3: Ratio of conditional and unconditional standard deviation



Note: The figure shows $\left(\frac{\text{var}(\exp(\nu_{t+h}))}{\text{var}(\exp(\nu_{t+\infty}))}\right)^{1/2}$.

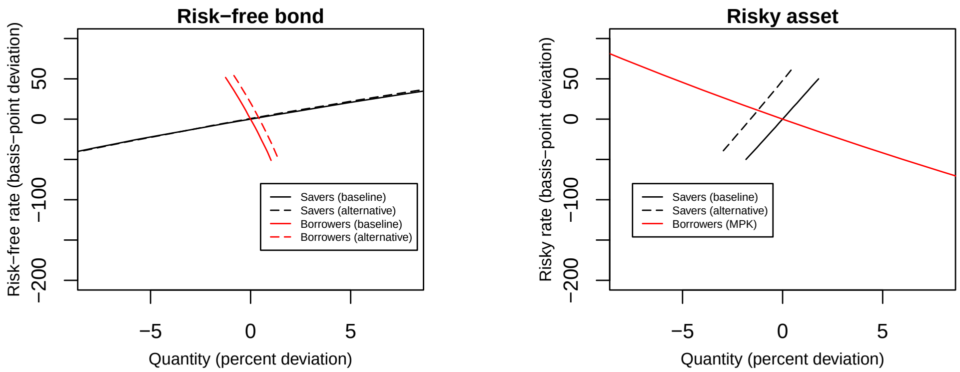
Source: Authors' calculations.

F Long-run asset supply and demand under increased risk aversion

Our analysis focuses on changes in inequality measures driven by heightened income volatility. Wealth could become more concentrated for a host of other reasons, however. In this section, we examine the macroeconomic implications of wealth becoming more concentrated in our model due to a possible change in household risk aversion. For comparability with the other drivers considered herein, we assume that the risk aversion parameter (γ) rises from 2 to 2.1929, inducing a 1-point rise in the Gini coefficient on net wealth.

As depicted in figure A4, when households are more risk averse, we find that the demand for the risky asset falls, consistent with households being more reluctant to bear risk. This fall leads to a 11 basis point increase in the risky return, along with a fall in the capital stock and output of 1.2 percent and 0.4 percent, respectively. All else equal, greater risk aversion also makes households more inclined to take on debt in bad states of the world, leading to a modest outward shift in borrowers' supply of the risky-free asset. The demand for the risk-free asset, by contrast, is little changed in the model. Intuitively, while risk aversion increases the desire to hold a risk-free asset relative to the risky asset, increased willingness to smooth adverse income shocks through borrowing decreases the demand for the risk-free asset in the context of zero net private supply. On balance, there is a small increase in the risk-free rate of 2 basis points—a move in the opposite direction than the changes induced when the increase in inequality is due to more variance in income. Nonetheless, on net, the gap between the risky return and the risk-free rate widens.

Figure A4: Long-run effects on asset markets: Greater risk aversion



Note: The panels show long-run supply and demand curves, in deviations from baseline equilibrium values, under a higher risk aversion coefficient. The alternative calibration induces a 1-point rise in the Gini coefficient on wealth. MPK is marginal product of capital.
Source: Authors' calculations.

Appendix References

Altonji, Joseph G., Anthony A. Smith Jr., and Ivan Vidangos (2013). "Modeling Earnings Dynamics," *Econometrica*, vol. 81 (4), pp. 1395–454.

Christensen, Jens H. E., and Glenn D. Rudebusch (2019). "A New Normal for Interest Rates? Evidence from Inflation-Indexed Debt," *The Review of Economics and Statistics*, vol. 101 (5), pp. 933–49.

Del Negro, Marco, Domenico Giannone, Marc P. Giannoni, and Andrea Tambalotti (2017). "Safety, Liquidity, and the Natural Rate of Interest," *Brookings Papers on Economic Activity*, vol. 48 (1), pp. 235–316.

Fagereng, Andreas, Luigi Guiso, Davide Malacrino, and Luigi Pistaferri (2020). "Heterogeneity and Persistence in Returns to Wealth," *Econometrica*, vol. 88 (1), pp. 115–70.

Gomme, Paul, B. Ravikumar, and Peter Rupert (2011). "The Return to Capital and the Business Cycle," *Review of Economic Dynamics*, vol. 14 (2), pp. 262–78.

Hamilton, James D., Ethan S. Harris, Jan Hatzius, and Kenneth D. West (2016). "The Equilibrium Real Funds Rate: Past, Present, and Future," *IMF Economic Review*, vol. 64 (4), pp. 660–707.

Holston, Kathryn, Thomas Laubach, and John C. Williams (2017). "Measuring the Natural Rate of Interest: International Trends and Determinants," *Journal of International Economics*, vol. 108 (S1), pp. 59–75.

Johannsen, Benjamin K., and Elmar Mertens (2018). "A Time Series Model of Interest Rates with the Effective Lower Bound," BIS Working Papers 715. Switzerland: Bank for International Settlements.

Kaplan, Greg (2012). "Inequality and the Life Cycle," *Quantitative Economics*, vol. 3 (3), pp. 471–525.

Kiley, Michael T. (2020). "What Can the Data Tell Us about the Equilibrium Real Interest Rate?," *International Journal of Central Banking*, vol. 16 (3), pp. 181–209.

Lubik, Thomas A., and Christian Matthes (2015). *Calculating the Natural Rate of Interest: A Comparison of Two Alternative Approaches*, Economic Brief 15–10. Richmond: Federal Reserve Bank of Richmond.

Wolff, Edward N. (2021). "Household Wealth Trends in the United States, 1962-2019: Median Wealth Rebounds... But Not Enough," NBER Working Paper Series 28383. Cambridge, Mass.: National Bureau of Economic Research.