Income Inequality and Stock Market Returns*

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Abstract

We study the relationship between income inequality and stock market returns. We develop a general equilibrium model that relates shifts in labour and capital income inequality to stock market outcomes and investigate in how far these shifts can explain the recent fall in equity premium. The shifts in income shares drive the amount of consumption risk borne by capital owners and impact the required equity premium. We calibrate our model to match the empirical size of shifts in income distribution over the last five decades. The model predicts an equity premium below the historical value by 0.79 percentage points, in line with the data trend. The reason is that, capital owners benefited from a faster growth in their non-risky labour income share relative to the risky capital income share. If both capital and total income shares of top decile would continue growing at the historical rate between 1970 and 2014, the equity premium would continue decreasing to 6.11% in 2030, 0.92 percentage point lower than historical equity premium of 7.03%. If instead only the capital share of income continues to grow, the equity premium would be higher than the historical average by 0.57 percentage point.

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1 Introduction

Because equities are predominately held by households at the top of the income distribution, changes in their labor and capital incomes will impact the equities' prices dynamics.[1] Using a general equilibrium model, this paper shows that the drop of the equity premium from 9% during the 1950s and 1960s to 6% since the 1970s can be related to the increase of labor and capital shares of the richest U.S. households.[2]

The model extends the standard RBC setting used in the production-based Consumption Capital Asset Pricing Model (CCAPM) literature by allowing for heterogeneity of agents, who differ in their ability to hold financial assets and their labor shares of income. The top income group (capital owners) owns the economy's financial wealth—a setup that roughly approximates the highly-skewed distribution of U.S. financial wealth.[3] The rest of the economy is populated by workers who consume their labor income and income from risk-free government and corporate bonds.

This set-up is similar to Greenwald, Lettau, and Ludvigson (2016) but we deviate from their framework in one crucial dimension. Our model mirrors the empirical composition of income and, in addition to capital income, capital owners earn wage income.[4] This modification is essential to quantify the joint impact of shifts in income shares because they predict the opposite movements in the equity premium. An increase in the share of risky capital in income and, hence, in consumption of capital owners predicts a higher equity premium, while the opposite is true when the share of non-risky labor income in their total income rises. Models ignoring capital owners' income form labor therefore tend to overestimate the equity premium and predict its recent growth. Our set-up turns out sufficient to broadly match both, stock market and real economy statistics, and we use it to evaluate the net impact of the recent changes in income distribution on the equity premium.

The source of macroeconomic risk in the model is a standard technology shock. The model delivers a high mean equity premium and a realistic Sharpe ratio via a combination of three factors. First, to generate a high price for risk, we introduce high and time-varying coefficient of risk-aversion in capital owners' utility function, similar

[1] Chen and Stafford (2016) argue that even fewer than 20 percent of households own stock directly.

[2] The total share of income of top decile in the U.S. increased from 32% to 47% between 1970 and 2014 as shown in Figure 1, top panel. Top decile capital share and labor share in the total labor share of income in the U.S. increased during this period as shown in Figure 2.

[3] The share of total financial wealth owned by the top 10% of households is around 80% in the sample period (Wolff, 2010).

[4] Saez and Zucman (2016) show that in 2012 the top 0.1% of wealth holders earned 31 times the average labor income and their pre-tax income share almost tripled between 1960 and 2012.

to Greenwald, Lettau, and Ludvigson (2016). Second, capital is subject to adjustment costs in the spirit of Uhlig (2007) and Jermann and Quadrini (2012). Finally, financial leverage of firms increases the quantity of risk borne by capital owners thus helping to generate a realistic Sharpe ratio. Careful calibration of these channels allows for precise matching of the mean and standard deviation of the equity premium, which has proven a challenge in models that use other mechanisms. Additionally, introducing financial leverage pins down the non-zero rate of risk-free savings on the side of consumers, which increases the realism of the model.

We calibrate the model to the U.S. post-war economy where the equity premium of S&P500 shares reached 7.03%. In order to gauge the quantitative impact of changes in income inequality on the equity premium, we study model economies which differ by the degree and the source of income inequality.

First, we consider an economy where only capital share of income has increased. The increase in the top decile's risky share of income of the size observed in the data, from 28% to 34% generates the mean equity premium that is 0.43 percentage points higher than the historical average. Second, we study an economy where only capital owners' labour share of income increases from 3.5% to 13%, and keep capital share of income at its initial value in 1970 of 28%. We show that this increase in the capital owners' labour share between 1970 and 2014 should have exercised a strong downward pressure on the equity premium. In fact, the model predicts that if there was no increase in capital income inequality, but only in labour income, the equity premium would have been lower by 1.64 percentage points than historical average. Finally, we consider a model economy where, as in the data, capital owners experienced the increase in both income sources. We show that the net effect on the equity premium is negative, in line with what has been observed in the S&P500 series. The reason is that, capital owners benefited from a faster growth in their non-risky labour income share relative to the risky capital income share bringing the equity premium below the historical value by 0.79 percentage points. Our model economy with capital and labor income distribution observed in 2014 displays the equity premium of 6.25% and we observe an equity premium of 6% on S&P500 shares, since 1970.

Our quantitative model allows us to carry out a set of predictive exercises given hypothesized income inequality paths. We assume two different trends in future income inequality and feed them into the model to derive the equity premium response in 15 years ahead. If capital and labor income shares of top decile keep on growing at the historical rate between 1970 and 2014, the equity premium would continue dropping until 6.11% in 2030, 0.92 percentage point lower than the historical average. If the labour share of income of capital owners stabilizes and only capital share of income continues to increase, total income of top decile would amount to half of the income in the U.S. economy. The equity premium would be higher than the historical average by 0.57 percentage point.

The model developed here builds on the literature embedding risky asset markets into RBC models, similar to the work of Jermann (1998), Boldrin, Christiano, and Fisher (2001) and Danthine and Donaldson (2002). Guvenen (2009) and Guvenen and Kuruscu (2006) introduce into an otherwise standard RBC framework two types of consumers, which differ by their elasticity of intertemporal substitution, which, in this paper, is assumed to be the same.

From the modelling perspective, our paper is closely related to Lansing (2015) who develops a production-based asset pricing model with high concentration of productive capital and "redistributive shocks" to the shares of income. The focus of Lansing's paper is on high post-war level of equity premium and the model can match up to two thirds of it. Our focus, instead, is on the longer-term, structural shifts in income shares and resulting long-term trends and in particular recent decline in equity premium. Further, in Lansing (2015), the high equity premium is primarily driven by distribution shock raising dividends' volatility while in this paper, to obtain a high excess return, we assume a time-varying risk-aversion in capital owners' utility function in spirit of Greenwald, Lettau, and Ludvigson (2016). Unlike in Greenwald, Lettau, and Ludvigson (2016), however, in our model capital owners are also labour income earners. The latter element turns out to be crucial for explaining a part of the observed downward trend in the average equity premium.

Several recent papers study the link between income and wealth inequality and equity premium. Walentin (2009) argues that an increase in stockholders' share of aggregate labour income reduces the covariance between stockholders' total income growth and dividend growth and therefore leads to the lower equity premium. In an incomplete markets OLG framework, Favilukis (2013) shows that the observed rise in wage inequality, decrease in participation costs, and loosening of borrowing constraints can jointly explain substantial increases in wealth inequality and stock market participation, a decline in interest rates and the expected equity premium, as well as a prolonged stock market boom. Toda and Walsh (2019) show, theoretically and empirically that, an increase in the wealth share of stock-holders reduces the equity premium. Gomez (2019) documents that when stock returns are high, inequality increases but higher inequality predicts lower stock returns.

By studying the link between income shares and asset returns, we also contribute to the fast-growing literature emphasizing the importance of wealth dispersion and resulting capital income inequality in the U.S. and other developed economies. Kacperczyk, Nosal, and Stevens (2018) show that capital income inequality is large and growing fast, accounting for a considerable portion of total income inequality in the U.S. In addition, Saez and Zucman (2016) demonstrate an increased correlation between top labor and top capital incomes in the U.S. data. Our framework is motivated by these recent empirical observations and therefore models capital owners also as high labor income earners.

The paper is organized as follows. In Section 2, we describe a set of stylized facts on changes in income inequality and equity premium. In Section 3, we describe the model and its main intuition. Specifically, we explain the mechanisms generating high equity premium and Sharpe ratio and how they respond to shifts in income shares. In this section, we also describe our calibration strategy. Section 4 evaluates the quantitative performance of the model in both macroeconomic and financial dimensions. In Section 5, we carry out a set of counterfactual exercises which allow us to assess the quantitative impact of the recent increase in income inequality on the equity premium. In this section, we also implement a number of scenarios for future behavior of equity premium based on the income inequality predictions. Section 6 concludes.

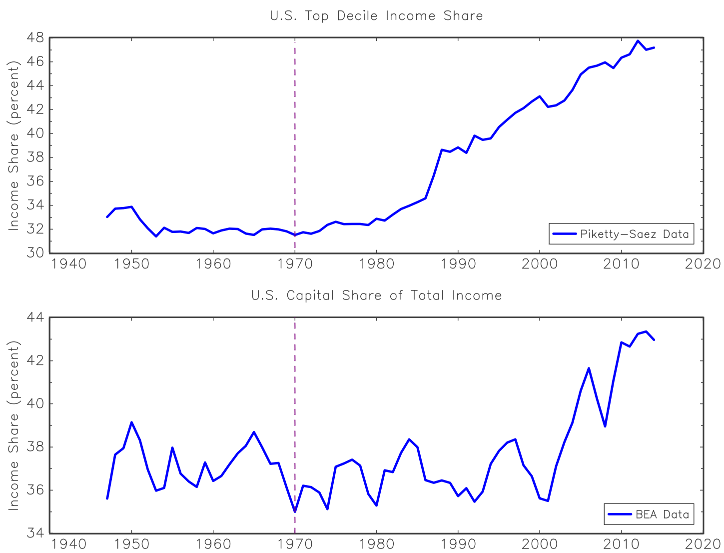
2 Income Inequality and Asset Pricing Variables in the Data

2.1 Capital and labor shares of income

The recent increase of income inequality has been accompanied by rising capital share of income. Karabarbounis and Neiman (2014) show that the labour share of income has significantly declined since the early 1980s in the large majority of countries, including the U.S.

Figure 1 plots increase in the top decile and capital shares of income in the U.S. between 1970 and 2014. There is a clear positive trend in both series. Between 1970 and 2014, capital share of income increased from 35% to 43% and, during the same period, the top decile income share raised from 32% to 47%. Given that the capital stock is concentrated in hands of a relatively small group of wealthy households, the

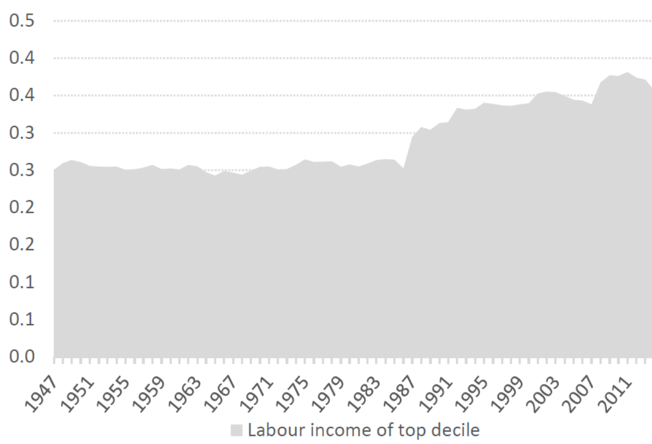
Figure 1: Top decile income share and capital share of income in the U.S.



Top decile income share series comes from the World Inequality Database at https://wid.world/. Capital share of income is computed from Bureau of Economic Analysis database as 1-compensation of employees.

observed increase in capital share of income directly implied an increase in income inequality. While total labor share of income declined in the U.S. in the recent

Figure 2: Top decile income share and its composition between 1970 and 2014



The grey area shows labor share of income of top decile which includes wages and salaries, bonuses, exercised stock-options, and pensions. The figures are computed as shares of total U.S. income. Income share data is described in Atkinson et al. (2011) and can be found at https://wid.world/

decades, the labor share of top incomes increased as well. Figure 2 plots the labor share of income of the top decile in the U.S. between 1947 and 2014. Its share increased from 25% in 1970 to 36% in 2014 of total income in the U.S. economy but remained stable before 1970.

We decompose the top decile population into three different groups: 91th to 95th percentile, 96th to 99th percentile, and top 1% and we plot their labour income shares between 1979 and 2013 in Figure 5 in the appendix. Between 1979 and 2000, the increase in labor income share of the top decile was largely driven by top 1 %. However, since 2000, top 1% labour share remained stable in contrast to 96th to 99th whose labour income share grew from 7% in 1979 to 9% in 2013. This is important because in our quantitative model we assume an increase in labour share of the top decile in contrast to top 1%.

2.2 Equity premium

While income inequality has increased during the last five decades, the average equity premium has dropped. Many studies including Blanchard (1993), Claus and Thomas

(1999), Jagannathan, McGrattan and Scherbina (2000), Fama and French (2002), Pastor and Stambaugh (2001) and more recently Kacperczyk, Nosal, and Stevens (2018) document a reduction of the equity premium. The sample varies across studies but they all show a declining trend in the equity premium towards the end of the 20th century. In Figure 3 we plot 10 year rolling EP and shaded NBER U.S. recessions between 1947 and 2015. Although the EP is procyclical and displays a significant correlation coefficient with U.S. GDP growth of 0.3, its mean is much lower in the second part of the sample.[5] Also there seems to be a structural shift in the mean in the beginning of the seventies so we cut our sample in two in 1970 and report the corresponding equity premia and Sharpe ratios in Table 1. Two different regimes in mean equity premium and Sharpe ratios are also present if we split the sample at alternative dates.[6]

Figure 3: 10-year rolling Equity Premium and U.S. recessions

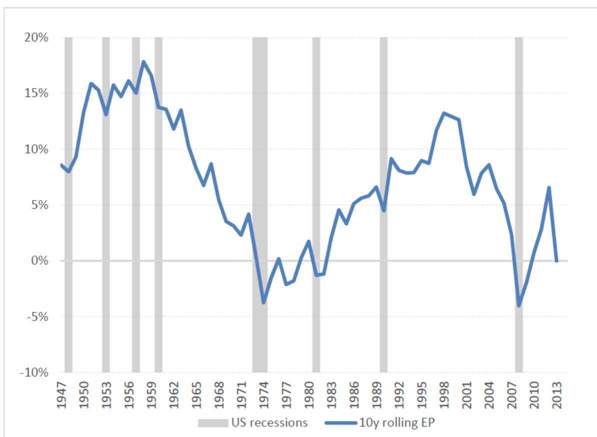


Figure plots 10-year rolling equity premium computed form Goyal's website: http://www.hec.unil.ch/agoyal/ accompanying Goyal and Welch (2008). The grey areas correspond to the NBER dated U.S. recessions.

The first column of the table denotes the period over which the statistic was computed. In the second column, we show the values for the equity premium (EP) and in the third column for Sharpe ratios (SR). The first row shows that the equity premium equals, on average, 8.5% during the entire post-war period while Sharpe

[5] Lustig et al. (2012) and Gómez-Cram (2020) among others study the dynamics of the equity premium over the business cycle.

[6] We split the sample at different dates between 1960 and 1975.

Table 1: **Equity premium and Sharpe ratio for SP500**

	EP	SR
1947 – 2014	8.5%	0.49
1947 – 1970	10.6%	0.59
1971 – 2014	7.5%	0.44

EP stands for equity premium and SR for Sharpe ratio. Both statistics are computed using the annual data from Goyal's website. Stock returns are the continuously compounded returns on the S&P 500 index, including dividends and equity premium is computed as the difference between the return including dividends on S&P 500 and the risk free rate is 6 months rolled commercial paper rate.

ratio was equal to 0.49 during the same period.

The following two rows report the statistics for the period before 1970 and after 1970. The equity premium before 1970 was a third higher than after 1970. A similar pattern is displayed by the Sharpe ratio statistics, reported in the last column of the table.

3 Model

As our analytical tool we build on the model by Lansing (2015) and Lansing and Markiewicz (2018). The model extends the standard RBC setting used in the production-based Consumption Capital Asset Pricing Model (CCAPM) literature allowing for two types of agents differing by their ability to hold financial assets and who face different output elasticities of the labor they provide. The introduced households' heterogeneity lets us trace the impact of the shifts in inequality from capital and labor on the stock market price behavior and, in particular, on the mean equity premium.

There are several additional elements of the model worth emphasizing. The high mean equity premium and realistic Sharpe ratio obtained in our setting are due to a combination of three factors. First, following Greenwald, Lettau, and Ludvigson (2016), we assume the time-varying coefficient of risk aversion, which increases the price of risk in the economy. Already Campbell and Cochrane (1999) showed that, to fit historical data, asset pricing models require large fluctuations in the aggregate risk aversion. In a recent study, Guiso, Sapenza, and Zingales (2018) provide direct evidence that both qualitative and quantitative measures of risk aversion exhibited large increases following the financial crisis of 2008.

Two other channels help the model to match high equity premium: (i) capital adjustment costs and (ii) financial leverage, which both increase the quantity of risk borne by the agents investing in stocks. Careful calibration of these channels allows for precise matching of the Sharpe ratio, which has been a challenge in models that use other mechanisms to generate high equity premium.[7] Additionally, introducing financial leverage pins down the non-zero rate of risk-free savings on the side of consumers, which increases the realism of the model.[8]

3.1 Workers

Workers, of mass $1-\eta$, maximize a discounted sum of utility over consumption, c_t^w:

$$\max_{c^w, a^f, a^c} E_0 \sum_{t=0}^{\infty} \beta_t^w \frac{(c_t^w)^{1-\gamma^w}}{1-\gamma^w}, \tag{1}$$

where β_t^w is an individual worker's discount factor and γ^w is her coefficient of risk aversion. The maximization is subject to a budget constraint:

$$c_t^w + a_t^f P_t^f + a_t^{c,w} P_t^c = W_t^w n_t^w + a_{t-1}^f + a_{t-1}^{c,w}, \tag{2}$$

with W_t^w the wage rate received by workers, P_t^f and P_t^c the prices of zero-supply risk-free bonds and (risk-free) corporate bonds, respectively, and a_t^f and $a_t^{c,w}$ the respective positions taken by workers in these assets. Workers are assumed to incur a transaction cost for trading stocks which prohibits their participation in stock exchange.[9] Finally, $n_t^w = n^w$ is the constant supply of labor hours per worker.

Assuming the usual transversality condition, first order conditions for the worker's problem are standard:

$$\begin{aligned} (c_t^w)^{-\gamma^w} &= \lambda_t^w \\ 1 &= \beta_t^w E_t \frac{\lambda_{t+1}^w}{\lambda_t^w} R_t^f \end{aligned} \tag{3}$$

[7] This literature is too broad to be discussed here. For an early account of the puzzle in a framework with fully-fledged production see, e.g., Jermann (1998). It is worth emphasizing that there is typically a trade-off between fitting the asset market and real-economy statistics and that it is not possible to fit exactly both sets of statistics in our model. This observation is of general nature, however, and holds for many modern production-based CCAPMs (e.g. Guvenen, 2009).

[8] As is well known, in this class of models, due to the Euler equation that does not contain quantities, the prevailing risk-free rate of return is consistent with an arbitrary asset portfolio composition. A zero-risk-free saving rate is, therefore, usually assumed in these models.

[9] In contrast, they are assumed to have full access to risk-free saving vehicules such as bank deposits (a_t^f) and corporate bonds (a_t^c). It is possible to assume $a_t^c \equiv 0$ without undermining the results of the paper.

$$1 = \beta_t^w E_t \frac{\lambda_{t+1}^w}{\lambda_t^w} R_t^c \tag{4}$$

with λ_t^w the worker's marginal utility of consumption and E_t representing the mathematical expectation operator conditional on information at the end of period t. By definition, the returns on risk-free assets satisfy:

$$R_t^f = \frac{1}{P_t^f}$$

$$R_t^c = \frac{1}{P_t^c}$$

By construction we also have $R_t^c \equiv R_t^f$. Note that we implicitly assumed that firms do not default on their debt.

3.2 Capital Owners

Capital owners, of mass η, represent the top decile of income distribution. Similarly to workers, they maximize a discounted sum of utility over consumption, c_t^c,

$$\max_{c^c, a^{c,c}, a^s} E_0 \sum_{t=0}^{\infty} \beta_t^c \frac{(c_t^c)^{1-\gamma_t^c}}{1-\gamma_t^c}, \tag{5}$$

where β_t^c is the capital owners' discount factor and γ_t^c is their coefficient of risk aversion. The capital owners' coefficient of risk aversion is time-varying, as in Greenwald, Lettau, and Ludvigson (2016). In combination with technology shocks, shocks to the coefficient of risk aversion increase the price of risk that is, the return on the risky asset, net of risk-free return, per unit of risk.

The time-varying coefficient of risk aversion is defined as

$$\gamma_t^c = \frac{\gamma^c}{1 + \exp(x_{t-1})} \tag{6}$$

with γ^c being the maximum degree of risk aversion and x_t an autoregressive process of order 1 with mean μ^x: $x_t - \mu^x = \rho^x (x_{t-1} - \mu^x) + \varepsilon_t^x$ and ε_t^x an *iid* shock.

The maximization is subject to a budget constraint:

$$c_t^c + a_t^s P_t^s + a_t^{c,c} P_t^c = W_t^c n_t^c + a_{t-1}^s (P_t^s + d_t^s) + a_{t-1}^{c,c}, \tag{7}$$

with W_t^c the wage rate received by capital owners, a_t^s and $a_t^{c,c}$ the number of stocks and corporate bonds held by capital owners, respectively, P_t^s the stock price and d_t^s the (economic) dividend received by capital owners from holding stocks. $n_t^c = n^c$ is their constant supply of labor.

Assuming the usual transversality condition, first order conditions for the capitalist's problem are:

$$(c_t^c)^{-\gamma_t^c} = \lambda_t^c$$

$$1 = \beta_t^c E_t \frac{\lambda_{t+1}^c}{\lambda_t^c} R_{t+1}^s \tag{8}$$

$$1 = \beta_t^c E_t \frac{\lambda_{t+1}^c}{\lambda_t^c} R_t^c \tag{9}$$

with λ_t^c the marginal utility of consumption and R_{t+1}^s is the next period return on stocks:

$$R_{t+1}^s = \frac{P_{t+1}^s + d_{t+1}^s}{P_t^s}$$

The form of the above first order conditions is very similar to the standard first order conditions derived in the CCAPM literature. However, since risk-free assets are now held by two types of agents, whose consumption is allowed to display different dynamics, Euler equations of capital owners and workers associated with these assets are, in most general case, inconsistent with each other. To deal with this problem, we apply the definition of time-varying discount factors as in Greenwald, Lettau, and Ludvigson (2016):

$$\beta_t^c \equiv \beta \left[E_t \frac{\lambda_{t+1}^c}{\lambda_t^c} \right]^{-1}$$

$$\beta_t^w \equiv \beta \left[E_t \frac{\lambda_{t+1}^w}{\lambda_t^w} \right]^{-1}$$

where $0 < \beta < 1$. These definitions guarantee consistency of both sets of Euler equations. At the same time, we obtain a constant risk-free rate and hence deal with the standard problem of too volatile risk-free:[10]

$$R_t^c \equiv R^c \equiv \frac{1}{\beta}$$

[10] Another well-established solution to the volatility puzzle is disentangling the risk aversion and intertemporal elasticity of substitution coefficients, which are the reciprocals of each other in our model, by using the Epstein-Zin-Weil utility function (Epstein and Zin, 1989 and 1991; Weil, 1990). While this would solve the risk-free rate volatility problem, it would not, on its own, assure consistency between the arbitrage conditions.

3.3 Firms

Identical competitive firms, of mass 1, maximize the present value of their future profits, D_t, discounted at the marginal rate of substitution, $\beta^t \frac{\lambda_{t+1}^c}{\lambda_0^c}$, of the firms' owners:

$$\max_{K, N^c, N^w} \sum_{t=0}^{\infty} \beta^t E_t \frac{\lambda_{t+1}^c}{\lambda_0^c} D_t \left(K_{t-1}, K_t, N_t^c, N_t^w\right)$$

where K_t is the end of period capital stock and N_t^c and N_t^w indicate demand for the capital owners' and workers' labor, respectively. Profits are defined as:

$$D_t \left(K_{t-1}, K_t, N_t^c, N_t^w\right) \equiv D_t = Y_t - W_t^c N_t^c - W_t^w N_t^w - I_t + P_t^b \mu K_t - \mu K_{t-1} \quad (10)$$

Above, Y_t is the current output, I_t is total investment and μ measures the degree of financial leverage of firms. When $\mu = 0$, the new capital of a firm is fully financed through retained earnings. It will be assumed that profits are redistributed via dividends to capital owners: $d_t^s = D_t$.[11]

Output is produced with Cobb-Douglas technology:

$$Y_t = A K_{t-1}^{\theta} \left(\exp\left(z_t\right) \left(N_t^c\right)^{\alpha} \left(N_t^w\right)^{1-\alpha}\right)^{1-\theta} \quad (11)$$

where θ is the capital income share, $\alpha(1-\theta)$ is the capital owners' share of labor income and $z_t = z_{t-1} + \mu^z + \varepsilon_t^z$ is a TFP shock with possibly non-zero growth rate, μ^z, and ε_t^z is zero-mean *nid*.

It is assumed that transforming investment I_t into capital K_t is costly, which allows the shadow price of installed capital to diverge from the price of an additional unit of capital. In specifying the capital adjustment cost, we follow Uhlig (2007) and Jermann and Quadrini (2012) so that the capital accumulation equation takes the form:

$$K_t = (1-\delta) K_{t-1} + G\left(\frac{I_t}{K_{t-1}}\right) K_{t-1} \quad (12)$$

with function $G(\bullet)$ such that

$$G\left(\frac{I_t}{K_{t-1}}\right) = \frac{a_1}{1-\frac{1}{\xi}} \left(\frac{I_t}{K_{t-1}}\right)^{1-\frac{1}{\xi}} + a_2$$

where a_1, a_2 are two positive constants. For $\xi < \infty$, adjustment costs become strictly positive.

[11] Note that, as is common in the literature, e.g. Lansing (2015), we use the concept of "macroeconomic dividends" in place of financial dividends.

Assuming transversality condition, first order conditions are as follows:

$$W_t^w = (1-\theta)(1-\alpha)\frac{Y_t}{N_t^w} \tag{13}$$

$$W_t^c = (1-\theta)\alpha\frac{Y_t}{N_t^c} \tag{14}$$

$$1 = \beta_t^c E_t \frac{\lambda_{t+1}^c}{\lambda_t^c} R_{t+1}^k \tag{15}$$

where return on capital, R_t^k, is defined as:

$$R_{t+1}^k = \frac{G'\left(\frac{I_t}{K_{t-1}}\right)}{1-G'\left(\frac{I_t}{K_{t-1}}\right)\mu P_t^b}\left(\theta\frac{Y_{t+1}}{K_t} - \mu + \frac{1-\delta+G\left(\frac{I_{t+1}}{K_t}\right)}{G'\left(\frac{I_{t+1}}{K_t}\right)} - \frac{I_{t+1}}{K_t}\right) \tag{16}$$

which can also be rewritten as

$$R_{t+1}^k = \frac{D_{t+1} + \frac{\left(1-G'\left(\frac{I_{t+1}}{K_t}\right)\mu P_{t+1}^b\right)}{G'\left(\frac{I_{t+1}}{K_t}\right)}K_{t+1}}{\frac{\left(1-G'\left(\frac{I_t}{K_{t-1}}\right)\mu P_t^b\right)}{G'\left(\frac{I_t}{K_{t-1}}\right)}K_t} \tag{17}$$

The return on capital has an intuitive interpretation, which will be presented below, where we focus on the definitions of the stock market variables.

3.4 Equilibrium market clearing conditions

In the equilibrium, all markets clear:

- Consumption goods market: $C_t^w = (1-\eta)c_t^w$, $C_t^c = \eta c_t^c$ and $C_t^w + C_t^c = C_t$
- Goods market: $C_t + I_t = Y_t$
- Labor market: $N^w = (1-\eta)n^w$, $N^c = \eta n^c$ and $N^w + N^c = N$
- Asset markets: $a_t^s = \eta^{-1}$, $a_t^f = 0$, $B_t^{c,w} = (1-\eta)a_t^w$, $B_t^{c,c} = \eta a_t^c$ and $B_t^{c,w} + B_t^{c,c} = \mu K_t$.

In the above, large-case-letters refer to aggregate (per capita) variables. Since, the share of corporate bonds held by capital owners (and workers) is not pinned down by the Euler equations, we make an additional assumption that $B_t^{c,w} \equiv \mu K_t$ or, alternatively, $B_t^{c,c} \equiv 0$. Any alternative assumption, including $B_t^{c,w} \equiv 0$ and $B_t^{c,c} \equiv \mu K_t$, produces results similar to those reported in the paper.

The whole list of equations, after having been stationarized (divided by $exp(z_{t-1})$) is shown in Appendix A).

3.5 Asset Pricing Variables

We compute a set of model-based financial variables and use their moments as targets in our calibration.

We define the equity premium as follows:

$$R^e_{t+1} = R^s_{t+1} - R^f_t$$

The unconditional Sharpe ratio is then defined as:

$$SR = \frac{E\left[R^e_t\right]}{\sigma\left[R^e_t\right]}$$

where E and σ stand for unconditional expectation and standard deviation, respectively. For the sake of completeness, we also define price-dividend ratio pd_t, the standard stock market diagnostic:

$$pd_t = \frac{P^s_t}{d^s_t}$$

Finally, it is worth interpreting the Euler equation associated with capital. Comparing arbitrage conditions (8) and (15), we see that they imply

$$P^s_t = \frac{\left(1 - G'\left(\frac{I_t}{K_{t-1}}\right)\mu P^b_t\right)}{G'\left(\frac{I_t}{K_{t-1}}\right)} K_t$$

In a model without frictions, stock price, P^s_t, would be simply equal to capital stock per capita, K_t. However, in our model, the price of installed and uninstalled capital differ. The adjustment term $G'\left(\frac{I_t}{K_{t-1}}\right)$ translates the value of installed capital into the uninstalled one. Moreover, stock owners own only a fraction $1-\mu$ of capital stock, as they have to borrow from workers the funds to cover the remaining part of capital. This is reflected in the $\left(1 - G'\left(\frac{I_t}{K_{t-1}}\right)\mu P^b_t\right)$ adjustment term (again, with a suitable adjustment due to the price difference between installed and unistalled capital).

4 Intuition of the model

4.1 Mechanisms generating high equity premium and Sharpe ratio

The source of macroeconomic risk in the model is a technology shock. To generate a high price for risk, following Greenwald, Lettau, and Ludvigson (2016), we introduce high and time-varying coefficient of risk-aversion in capital owners' utility function. In a standard 1-type of agents' model, high and time-varying risk aversion would, via the Euler equation on capital, have a very strong impact on the real side of the economy. In a set-up with two types of agents and a small number of capital owners in population, the impact of shocks to risk aversion on aggregate consumption is naturally smaller. This helps us generate real economy statistics that are similar to those in a baseline RBC model and reasonably close to their real-life counterparts. It is important to note that, although we improve on the in 1-type consumer set-up, our total consumption series still displays volatility somewhat higher than the data suggests. We discuss these statistics in detail in Section 4.1 and Table 4.

While high and volatile coefficient of risk aversion of capital owners makes it possible to produce almost arbitrarily high equity premium, it is not sufficient on its own to generate a realistic Sharpe ratio. Production-based CCAPMs tend to produce too small the quantity of risk, as measured by the unconditional standard deviation of excess returns. We introduce two mechanisms to deal with this problem. First, we assume that capital is subject to adjustment costs. This mechanism, via adjustment in the level of corporate investment, makes capital owners' consumption smoothing costlier, making them less keen on taking investment risks. Additionally, capital adjustment costs help us match the volatility of investment relative to output. Second, we also introduce a limited amount of financial leverage of firms in the form of risk-free corporate debt. This multiplies the risk taken up by capital owners per each stock held.

4.2 Expected responses of equity premium to shifts in income shares

The objective of the paper is to examine the impact of shifts in income shares on the stock market variables and in particular on the equity premium. Using the model, we can make the following predictions. An increase in the capital income ratio, as governed by the production function parameter θ, will lead to an increase in the mean equity premium. The reason is that higher θ directly increases the volatility of return on capital, via (16), which raises the riskiness of investment in stocks and hence increases the required premium.

A shift in the labor income share of capital owners in total income, $\tilde{\alpha} = \alpha\,(1-\theta)$, has a less direct effect. Combining the capital owners' budget constraint (7) with the definition of dividends (10), we can write capital owners' consumption as:

$$c_t^c = \tilde{\alpha}\frac{Y_t}{\eta} + \frac{D_t}{\eta}. \tag{18}$$

The first term on the RHS of (18) represents the total labour income of capital owners.

This is a part of capital owners' income that is relatively less risky. The second term is simply capital income, equal to total dividends income. This is the relatively more risky part of their income. From the above, it is clear that an upward shift in $\tilde{\alpha}$ will decrease consumption risk faced by capital owners, by increasing the weight of the less risky component of capital owners' income. As a result, the volatility of the associated stochastic discount factor, $M_t^c = \beta_t^c \frac{\lambda_{t+1}^c}{\lambda_t^c}$, and the mean stock excess return will fall.

From the above reasoning, using definition $\tilde{\alpha} = \alpha(1-\theta)$, it is also clear that an increase in the capital share of income, θ, will have an additional indirect effect on the mean equity premium, by raising the relative weight of the riskier component in capital owners' consumption. This effect reinforces the direct effect of a shift in θ discussed earlier. Since we observe an increase in both shares of incomes in the data, we use a set of simulations of the model calibrated to the US economy to quantify the net effect of these two simultaneous shifts.[12]

5 Empirical strategy

Our key experiment is to compare two different economies (two steady states) which differ by level and composition of income shares. Because the recent increase in inequality appears to be mostly permanent, we abstract from all the transition dynamics. Using administrative micro-level data, DeBacker et al. (2013) show that for household income, most of the increase in inequality reflects an increase in the dispersion of the persistent income component. By no means, do we argue that there were no other developments affecting equity premium. In fact, among permanent changes affecting equity premium, Walentin (2010) studies an increase in stock market participation and Lustig et al. (2012) and Gómez-Cram (2020) show that equity premium fluctuates over the business cycle. Our strategy allows us to focus and isolate the impact of increasing inequality on the equity premium where we only alter parameters governing the income distribution between capital owners and workers, θ and α. We first calibrate the model to the initial steady state where, between 1947 and 1970, the shares of incomes were stable (see Figures 2 and 5). We then consider the second steady state where the top decile income share is higher and its

[12] An additional trend that could have been observed through the last decades was a steady increase in stock ownership among households. A seminal result in the literature is that limited stock market participation helps explain high excess returns observed on equities (Vissing-Jorgensen, 2002). By this token, the steady increase of stock ownership should have contributed to the falling equity premium. Our model, in its baseline version presented above, does not capture this insight.

composition is different.

5.1 Calibration

Our calibration strategy is as follows. We compute financial and real economy statistics for the period between 1947 and 1970 and calibrate the model to match the behaviour of the U.S. economy in this initial steady state. Table 2 reports all the paramater values in the calibration where some of them are set to match empirical moments and others are taken from existing literature. The share η of capital owners in the population is equal to the top income decile and a time period in the model represents a year. Total capital share of income between 1947 and 1970 was equal to 0.34 and the top decile owned 80% of it so that θ_0 is set to $0.27 = 0.8 \times 0.35$. From the average values of the total share of income of top decile, s_{10}, and their capital share of income, θ_0, over the 1947-1970 period, we compute $\alpha_0 = (s_{10} - \theta_0) / (1 - \theta_0) = 0.06$. Following Lansing (2015), we choose the value of demand for workers' labor such that the relative wage of capital owners to workers, $W_0^c / W_0^w = 2$, its value between 1947 and 1970.

We choose the value of the standard deviation of the TFP shock, σ^z, such that the volatility of output growth in our economy matches its empirical counterpart between 1947 and 1970, of 2.6% annually. The value of depreciation rate, δ, is set to a standard 8%, annually. The value of capital adjustment cost parameter, ξ, is selected to match the ratio of volatility of investment growth to volatility of output growth equal to 2. The remaining parameters in the capital adjustment cost function, α_1 and α_2, are specified so that the steady state investment to capital ratio equals the depreciation rate and the first derivative of this function in investment-capital ratio is equal to 1, as in Uhlig (2007) and Jermann and Quadrini (2012). Parameter β is calibrated to match the mean annual risk-free rate $E\left({R_t}^f\right) = 2\%$. Further, without a loss of generality, we set the demand for capital owners' labor in the model equal to 1.

The financial leverage, μ, is set to 0.24. Masulis (1988) reports that the leverage ratio of U.S. firms has varied between 13% and 44% from 1929 to 1986 and Guvenen (2009) sets it to 0.15. We simply take an average of these 3 numbers. This value is on the lower bound of what is usually assumed in the asset pricing models, where Jermann (1998) for instance sets the levarage ratio between 0.4 and 0.6 and Boldrin et al. (2001) sets it to 0.5. We study the importance of financial leverage for the level of equity premium later in the paper. We need a much lower maximum degree of capital

Table 2: **Calibration of the main parameter values**

Table 2: Baseline Parameter Values		
Parameter	Value	Description/Target
η	0.10	Capital owners = top income decile.
θ_0	0.27	Capital's share of income of top decile for 1947-1970 = 0.8×0.34
α_0	0.05	Top decile income share for 1947-1970 = 0.34
N_1^c/N_{19}^w	0.19	Mean relative wage = W_0^c/W_0^w= 2
μ^z	0.00	RW
σ^z		Output volatility for 1947-1970 = 2.6%
ρ^z	0.00	RW
δ	0.08	Annual depreciation rate = 8%
ξ	0.37	Ratio of volatility of investment to volatility of output $\frac{\sigma^{\Delta I}}{\sigma^{\Delta y}} = 1.8$
a_1	$2.2000e^{-4}$	Steady state investment to capital ratio equal to depreciation rate.
a_2	0.11	$G'(\frac{I_t}{K_{t-1}}) = 1$
β	0.98	$R_t^f = 1.02$
μ	0.24	Masulis (1988) and Guvenen (2009)
γ^c	83.5	Equity premium for 1947-1970 = 10.6%
$\min(\gamma_t^c)$	1	Greenwald (2016)
μ^x	-0.29	Sharpe ratio for 1947-1970 = 0.6
σ^x	0.23	Standard deviation of Δd for 1947-1970 = 7%
ρ^x	0.95	Long-horizon return regression coefficients = $(-0.23; -0.48; -0.67)$

owners' risk aversion than Greenwald, Lettau, and Ludvigson (2016), $\gamma^c = 89.12$, to match the equity premium between 1947 and 1970, equal to 10.6%. This also translates into a much lower mean degree of capital owners' risk aversion, which in our baseline calibration is $E(\gamma_t^c) = 37.5$. The main reason for this difference is the assumption of a moderate degree of financial leverage, absent in Greenwald, Lettau, and Ludvigson (2016). The mean of the shock process to the coefficient of risk aversion $\mu^x = -0.29$ is set to match Sharpe ratio and its variance, $\sigma^x = 0.23$, to replicate the empirical dividends' growth volatility. Finally, we set the AR(1) coefficient of the risk aversion shock, ρ^x, to 0.95 to match the well documented long-horizon predictability of equity premium, reported in Appendix B.[13]

For solving the model, we use a non-linear solution method based on Coleman and Fenyes (1992) implemented by Davig (2004) and Lendvai and Raciborski (2014).[14] The details of this procedure are described in Appendix A. In order to compute the statistical moments of macro and financial variables, for every model parametrization of interest we simulate the economy for 1.020.000. The moments reported are based on time series consisting of the last 1.000.000 observations.[15]

6 Quantitative Performance of the Model

We first simulate our model for the parameter calibration given in Table 2. We assess its quantitative performance by comparing a set of non-targeted model-based statistics with the data between 1947 and 2014. To study the impact of different sources of income on the equity premium, we first analyse model economies with either higher labour or higher capital share of income of the top decile. To capture the trends in the data, we consider the joint shifts in the capital and the labour shares of income. Finally, we derive a set of straightforward predictions of the model for income shares and consumption behaviour and bring them to the data. We test these predictions using macro cross-country and US micro level data.

6.1 Baseline scenario

In Table 3, we contrast the moments non-targeted by the baseline calibration with the data. All the asset pricing statistics are based on the annual S&P500 series

[13] Note that our coefficients, reported in Appendix B, do not exactly match their empirical counterparts because we have one paramater and 3 values to match.

[14] Our codes are based on sample codes for the solution of a bare-bone RBC model provided by Troy Davig.

[15] The first 20 000 observations are burn-in.

coming from Robert Shiller's website and covering post-war period between 1947 and 2014. The real economy statistics are based on the series computed by U.S. Bureau of Economic Analysis and retrieved from the FRED at St Louis Fed.

The first two rows of Table 4 report log price-dividend ratio, $\ln\left(\frac{P_t^s}{D_t}\right)$ and its volatility, $\sigma^{\ln\left(\frac{P}{D}\right)}$. While the model is able to match the volatility of the ratio, it somewhat underpredicts its log-level.

Table 3: **Unconditional asset pricing and real economy moments in the model and the U.S. data**

Variable	Moment	Data	Model
Asset pricing moments			
$\ln\left(\frac{P_t^s}{D_t}\right)$	Log Price-Dividend ratio	3.41	2.34
$\sigma^{\ln\left(\frac{P}{D}\right)}$	Volatility of Log Price-Dividend ratio	0.45	0.55
Macro moments			
$\frac{\sigma^{\Delta c}}{\sigma^{\Delta y}}$	Ratio vol consumption growth-vol output growth	0.77	1.09
$\rho_{\Delta c,\Delta y}$	Correlation consumption growth-output growth	0.82	0.97
$\rho_{\Delta i,\Delta y}$	Correlation investment growth-output growth	0.64	0.35

This table reports unconditional sample moments generated from the simulated data of our benchmark model. Equity premium, Sharpe ratio and price-dividend ratio are computed using the annual data from Shiller's website: http://www.econ.yale.edu/~shiller/data.htm. Equity premium is computed as the difference between the return including dividends on S&P500 and the risk free rate. Risk free rate is 6 months rolled commercial paper rate. Price-dividend ratio is calculated for S&P500. Volatility is measured by standard deviation. Δx stands for growth rate in variable x. The real economy data is from FRED. Real output is proxied by real GDP, real investment by private non-residential fixed investment and consumption by real personal consumption expenditures. All the real economy variables are originally expressed in Billions of Chained 2009 Dollars and we compute their annual growth rates.

We are able to achieve this low aggregate consumption volatility relative to output because the model is populated by two types of agents whose consumption is derived from sources characterised by different variabilities. 90 % of the population derives its consumption from labour income while only 10 % is assumed to hold risky capital. This realistically large share of workers in the population translates also into the aggregate consumption series which are strongly correlated with output. The second last row of the table shows that correlation between consumption growth and output, $\rho_{\Delta c,\Delta y}$, equals to 0.97 in the model and 0.82 in the U.S. post-war data.

7 Income Inequality and Equity Premium

Our simple two types of agents' set-up turns out sufficient to broadly match both, stock market and real economy statistics. We now use it to study the impact of shifts in income distribution on the equity premium and we simulate the model economy with higher income inequality observed in 2014.

Table 4: **Income shares shifts and mean equity premium**

Scenario	Parameter values	Equity premium	Change vs baseline
Baseline	$\theta = 0.27; \alpha = 0.06$	10.6%	-
$\theta \Uparrow$	$\theta = 0.34; \alpha = 0.06$	11.3%	$+0.7pp$
$\alpha \Uparrow$	$\theta = 0.27; \alpha = 0.20$	9.0%	$-1.6pp$
θ and $\alpha \Uparrow$	$\theta = 0.34; \alpha = 0.20$	9.7%	$-0.9pp$

$\theta \Uparrow$ denotes an increase in capital share of income and $\alpha \Uparrow$ an increase in the labour share of income of capital owners. The equity premium in the model is computed over 1.000.000 simulated periods. All the parameters of the model except for the ones included in the table are set to their baseline calibration values reported in Table 2.

As explained earlier (section 3.6.2), we expect shifts in the capital income and labor income shares of capital owners to have opposite effects on equity premium. In order to test numerically this intuition, we first examine each income shift separately. First, we keep α at its average value between 1947-1970 but increase θ to match the 2014 value of the capital income share. Next, we do the opposite: we keep θ at its average value between 1947 and 1970, but increase α to its 2014 level. Finally, to assess the total, quantitative impact of the simultaneous trends in income shares observed in the data, we introduce both shifts together. The results of these exercises are reported in Table 4.

The first row shows the baseline model simulation outcomes where the equity premium equals 10.6% and the second row displays the results of the simulation with a higher capital income inequality as measured by increased θ. Increase in the share of income derived from the risky source, requires a higher return on the risky asset and translates into a higher equity premium. An increase in the capital share of income of 7 percentage points generates an increase in equity premium of 0.7 percentage points.

The third row reports the results of the counterfactual with θ kept unchanged at its initial value, and α set to its 2014 level. A 14 percentage points increase in α translates into a large drop in equity premium of 1.6 percentage points. Unsurprisingly, considered simultaneously the shifts generate a drop in equity premium. An economy with higher shares of income, as observed in the U.S. data, displays equity premium of 9.7%. The recent shifts in the income distribution and decomposition can therefore explain one third of the observed reduction in the U.S. equity premium. The reason for the lower equity premium is that, during the last five decades capital owners benefited from a higher average growth in their labor income relative to the capital income and, as a result, they currently derive more income from relatively less risky source.

7.1 Model predictions in the data

The model's intuition is that shifts in income shares drive the amount of consumption risk borne by capital owners and therefore impact the required equity premium. This mechanism delivers several predictions that can be tested in the data. First, higher capital share of income should predict higher equity premium both in cross section and over time. Second, higher capital share of income should be associated with higher consumption volatility. And finally, because in the data the labour share of income of capital owners increased by more than that of capital, volatility of capital owners' consumption should be lower in the recent periods.

7.1.1 Capital share of income changes and equity premium over time and across countries

First, as explained in section 3.6.2, a higher capital share of income in an economy should be associated with higher equity premium. We test this hypothesis across several countries and over time. To do it, we construct a dataset that draws on the long-run dataset on returns used in Jordà et al. (2017 and 2019) and on the data from Karabarbounis and Neiman (2014) on capital shares of income for 17 OECD countries. The sample period differs across countries but for most of them, it covers the period of growth in income inequality between 1980 and 2014. The equity premium is computed as a difference between total equity return and government bill rate.

Because, as in the model, we want to relate the long run shifts in equity premium to the shares of income, we compute 5 year moving averages for all the variables. We then regress the change in 5 year MA equity premium, $\Delta 5yEP_{i,t}$, on the 5 year change in the capital share of income, $\Delta 5y\theta_{i,t-j}$, and controlling for country's fixed individual characteristics, δ_i, and year-fixed effects, γ_t. Results of this exercise

Table 5: **Capital share of income growth and equity premium**

$\Delta 5yEP_{i,t}= \alpha\Delta 5y\theta_{i,t-j}+\delta_i+\gamma_t+\varepsilon_{i,t}$		
	$j=0$	$j=1$
α	0.48**	0.47**
	(0.15)	(0.16)
R^2	0.13	0.13
$N.\ obs$	402	401

Table reports results of estimation of the regression $\Delta 5yEP_{i,t}= \alpha\Delta 5y\theta_{i,t}+\delta_i+\gamma_t+\varepsilon_{i,t}$ where $\Delta 5yEP_{i,t}$ is the 5 year equity premium in country i and year t, computed as a difference between total equity return and government bill rate. $\Delta 5y\theta_{i,t-j}$ is a 5 year change in the capital share of income in country i and year $t-j$, where $j=0,1$. δ_i and γ_t are country- and year-fixed effects and $\varepsilon_{i,t}$ is the error term. Standard errors are reported in brackets. ** denotes significance at 5% level.

are reported in Table 5 report where the middle column reports contemporaneous correlation coefficients and the right column coefficient on one period lagged change in the capital share of income. In both cases the coefficients are positive, significant and of similar magnitude. They suggest that the increase in capital share of income is associated with higher equity premium.

7.1.2 Consumption volatility

Conditional volatility of aggregate consumption growth varies over time (see Kandel and Stambaugh (1990) and Bansal et al. (2005)). Tédongap (2013) shows that changes in consumption volatility are the key driver for explaining major asset pricing moments and Boguth and Kuehn (2013) show that beliefs about these shifts can predict aggregate quarterly excess returns. In our model, shifts in consumption volatility are driven by changes in the composition of income of capital owners. Because over the last four decades capital owners in the U.S. experienced a faster increase in their non-risky labour income, we should observe a recent reduction in their consumption volatility. Figure 4 plots 5-year rolling standard deviation of the consumption growth of U.S. top decile (black solid line) and bottom 90 % (grey dotted line) of income distribution. Figure 4 shows a clear but nonmonotonic decreasing trend in the volatility of the consumption of the top decile. The volatility of the bottom 90 % experiences a similar pattern but to a much lower extent. Interestingly, the volatility of consumption of the top 10 % stops decreasing and, in fact, displays a slight increase around

Figure 4: Consumption growth of the top decile and bottom 90 percent of the U.S. income distribution

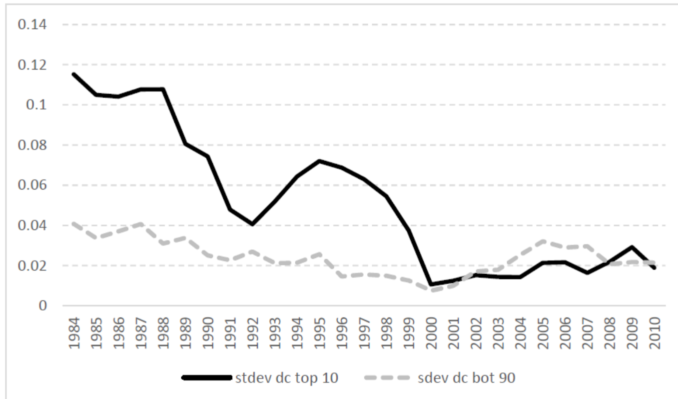


Figure plots consumption growth of the top decile (black solid line) and bottom 90 percent (dashed grey line) of the U.S. income distribution between 1980 and 2010. Consumption data comes from the U.S. Consumer Expenditure Survey (CES).

2000 when capital share of income started to surge (see Figure 1).

7.2 Counterfactuals

The role of (i) high and time-varying risk aversion of capital owners, (ii) capital adjustment costs, and (iii) financial leverage

The first row of Table 5 reports the figures for the asset pricing and real economy moments in the data and the subsequent rows document corresponding statistics in various model specifications. The baseline documents statistics generated by the simulations of the model calibrated to the initial steady state, with parameters described in Table 2. Alternative model specifications differ from the baseline only by the parameter values reported in the first column. Accordingly, the third row displays the statistics produced by the the model without financial leverage, $\mu = 0$. Elimination of financial leverage reduces equity premium by one third and Sharpe ratio by 17%. To match the empirical equity premium and Sharpe ratio in he model without financial leverage we need to increase risk aversion γ^c to 245 and reduce the mean of the shock to the risk aversion, μ^x, to -0.96 (fourth row).

Table 6: **Unconditional asset pricing and real economy moments in diffirent model specifications and the U.S. data**

	Targeted moments						Non-targeted moments			
Model/Moment	EP	SR	$\sigma^{\Delta y}$	$\sigma^{\Delta d}$	$\frac{\sigma^{\Delta I}}{\sigma^{\Delta y}}$	$\ln\left(\frac{P^s_t}{D_t}\right)$	$\sigma^{\ln\left(\frac{P}{D}\right)}$	$\frac{\sigma^{\Delta c}}{\sigma^{\Delta y}}$	$\rho_{\Delta c,\Delta y}$	$\rho_{\Delta i,\Delta y}$
Data	10.6%	0.6	2.6%	7%	1.8	3.41	0.45	0.77	0.82	0.64
Baseline	10.6%	0.6	2.6%	7%	1.8	2.34	0.55	1.09	0.97	0.35
$\mu = 0$	6.0%	0.5	2.6%	7%	1.8	2.60	0.44	1.10	0.97	0.37
$\mu= 0,\gamma^c= 245,\mu^x= -0.96$	10.6%	0.6	2.6%	7%	2.1	2.30	0.56	1.09	0.96	0.25
$\sigma^x= 0$	8.6%	1.3	2.6%	0.5%	0.6	2.26	0.07	1.05	0.99	0.99
$\gamma^c= 4, \sigma^x= 0$										

EP stands for equity premium, SR for Sharpe ratio, $\sigma^{\Delta y}$ volatility of output growth, $\sigma^{\Delta d}$ volatility of dividend growth, $\ln\left(\frac{P^s_t}{D_t}\right)$ for log of price-dividend ratio, $\sigma^{\ln\left(\frac{P}{D}\right)}$ for volatility of log price-dividend ratio, $\frac{\sigma^{\Delta c}}{\sigma^{\Delta y}}$ for ratio of consumption volatility to output volatility. $\rho_{\Delta c,\Delta y}$ and $\rho_{\Delta i,\Delta y}$ stand for correlation between consumption growth and output growth and investment growth and output growth respectiveley. ΔEP indicates the change in EP versus the baseline when $\theta = 0.34; \alpha = 0.20$.

8 Conclusion

In this paper, we study the relationship between income inequality and stock market returns. We develop a general equilibrium model with capital owners who own 100% of the economy's financial wealth and workers who consume their labor income and income from risk-free government and corporate bonds. Motivated by recent empirical observation on the high correlation between capital and labour top incomes, capital owners in our model earn high labor income. Since capital owners are the ones who price the risky assets, changes in their both income sources affect the stock market variables.

In the model, higher capital share of income increases the share of capital owners' consumption derived from risky source as well as the riskiness of investment. Both mechanisms generate higher equity premium. When the share of capital owners' income derived from the less risky source (labour) increases, the required risk premium drops and so does equity premium.

We calibrate the model to the post-war U.S. economy and simulate it with increased income inequality, as observed in 2014. We find that the impact of the labour share of income was quantitatively larger and therefore we observe a decrease in the equity premium both in the model and in the data.

We also use our set-up to carry out a number of counterfactual exercises. First, we extrapolate current inequality trends into the future and, using the model, predict the potential equity premium. Second, we compute the level and growth in income inequality needed for the equity premium to go back to its historical mean of the post-war period.

If both capital and total income shares of top decile will grow until 2030 at the same rate as between 1970 and 2014, namely 0.5% and 0.92%, respectively, the equity premium would continue decreasing to 6.11% in 2030, 0.92 percentage point lower than historical equity premium of 7.03%. If capital share of income continues to grow at the annual rate of 0.5% and the labour share of income of top decile remains unchanged, the equity premium would be higher than the historical average, by 0.57 percentage point.

If we assume that the labour income inequality stops increasing and if capital share of income was growing by 1.4% each year, we find that the historical equity premium would be reached by 2030.

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Appendix A: Numerical Simulation Procedure and Calibration

Baseline Simulation

The complete model consists of households' and firms' first order optimization conditions, the budget constraints, the production function, the capital accumulation equation, the transversality conditions and the definitions of returns. The solution method follows Davig (2004) and is based on Coleman and Fenyes (1992). It conjectures candidate decision and pricing rules which allow to reduce the system to a set of expectational first-order difference equations. In our case, due to consecutive substitutions, we are able to reduce the system to only one conjectured decision rule, that for total (per capita) investment, denoted $I_t = I_t\left(K_{t-1}, \Delta z_t, \gamma_t^c\right)$. Dividing all equations by $\exp\left(z_{t-1}\right)$ and denoting the so transformed variables with atilde: $X_t \rightarrow \tilde{X}_t$, the system of equations is as follows:

$$
\begin{gathered}
\tilde{C}_t^w = (1-\alpha)(1-\theta)\tilde{Y}_t + \tilde{B}_{t-1}^{c,w} - \left(\tilde{B}_t^{c,w}/R_t^f\right)\exp\left(\Delta z_t\right) \\
\tilde{C}_t^c = \alpha(1-\theta)\tilde{Y}_t + D_t + \tilde{B}_{t-1}^{c,c} - \left(\tilde{B}_t^{c,c}/R_t^f\right)\exp\left(\Delta z_t\right) \\
\tilde{C}_t = \tilde{Y}_t - \tilde{I}_t\left(\tilde{K}_{t-1}, \Delta z_t, \gamma_t^c\right) \\
\tilde{D}_t = \theta\tilde{Y}_t - \tilde{I}_t\left(\tilde{K}_{t-1}, \Delta z_t, \gamma_t^c\right) - \mu\tilde{K}_{t-1} + \mu\left(\tilde{K}_t/R_t^f\right)\exp\left(\Delta z_t\right) \\
\tilde{Y}_t = A\left(\left(N^w\right)^{1-\alpha}\left(N^c\right)^{\alpha}\right)^{1-\theta}\tilde{K}_{t-1}^{\theta}\exp\left((1-\theta)\Delta z_t\right) \\
\tilde{K}_t = \left(1-\delta+G\left(\frac{\tilde{I}_t\left(\tilde{K}_{t-1}, \Delta z_t, \gamma_t^c\right)}{\tilde{K}_{t-1}}\right)\right)\tilde{K}_{t-1}\exp\left(-\Delta z_t\right) \\
1 = \beta E_t\left(\frac{\left(\tilde{C}_{t+1}^c\tilde{C}_t^c\right)^{-\gamma_t^c}}{E_t\left(\tilde{C}_{t+1}^c\tilde{C}_t^c\right)^{-\gamma_t^c}}R_{t+1}^k\right) \qquad (19) \\
R_{t+1}^k = \frac{\tilde{D}_{t+1} + \frac{\left(1-G'\left(\tilde{I}_{t+1}\tilde{K}_t\right)\mu/R_{t+1}^f\right)}{G'\left(\tilde{I}_{t+1}\tilde{K}_t\right)}\tilde{K}_{t+1}}{\frac{\left(1-G'\left(\tilde{I}_t\tilde{K}_{t-1}\right)\mu/R_t^f\right)}{G'\left(\tilde{I}_t\tilde{K}_{t-1}\right)}\tilde{K}_t} \\
\tilde{P}_t^s = \frac{\left(1-G'\left(\tilde{I}_t\tilde{K}_{t-1}\right)\mu/R_t^f\right)}{G'\left(\tilde{I}_t\tilde{K}_{t-1}\right)}\tilde{K}_t
\end{gathered}
$$

$$R^s_{t+1} = \frac{\tilde{P}^s_{t+1}\exp\left(\Delta z_t\right) + \tilde{D}_{t+1}}{\tilde{P}^s_t}$$

$$R^f_t = \beta^{-1}$$

$$R^e_{t+1} = R^s_{t+1} - R^f_t$$

$$\tilde{B}^{c,w}_t + \tilde{B}^{c,c}_t = \mu\tilde{K}_t$$

$$\tilde{B}^{c,c}_t = 0$$

$$G\left(\frac{\tilde{I}_t}{\tilde{K}_{t-1}}\right) = \frac{a_1}{1-1\xi}\left(\frac{\tilde{I}_t\left(\tilde{K}_{t-1}, \Delta z_t, \gamma^c_t\right)}{\tilde{K}_{t-1}}\right)^{1-1\xi} + a_2$$

$$G'\left(\frac{\tilde{I}_t}{\tilde{K}_{t-1}}\right) = a_1\left(\frac{\tilde{I}_t\left(\tilde{K}_{t-1}, \Delta z_t, \gamma^c_t\right)}{\tilde{K}_{t-1}}\right)^{-1\xi}$$

This system is solved for every possible set of state variables over a discrete partition of the state space. The solution consists of a set of decision rules and pricing functions satisfying the above system. The solution method treats the state variables and the initially conjectured decision rules and pricing functions as given. Based on this, it is possible to compute the values of the remaining endogenous variables in any given state and for any realization of the shock. The expectations are computed by numerical quadrature. Given these, $\tilde{I}_t\left(\tilde{K}_{t-1}, \Delta z_t, \gamma^c_t\right) = \tilde{I}_t$ is treated as an unknown. The solution is then found by solving this equation[16] in 1 unknown using Chris Sims' non-linear equation solver code csolve.[17] The iteration procedure is repeated until the iteration improves the current decision rule at any given state vector by less than some tolerance level, which we set to 10^{-12}.

9 Appenxix B: Long-horizon predictability of equity premium

In addition to the unconditional moments we compute the long-horizon predictability of equity premium based on the price-dividend ratio. We estimate a specification of the following form:

$$\sum_{j=0}^{h} R^e_{t+j+1} = \beta\frac{P^s_t}{D_t} + \varepsilon_{t+1,t+h} \tag{20}$$

[16] Specifically, this equation is the capital Euler equation (19).

[17] Available at http://sims.princeton.edu/yftp/optimize.

where $\sum_{j=0}^{h} R^e_{t+j+1}$ is a cumulative excess return over $h+1$ years with $h = 0, 1, 2$, $\frac{P^s_t}{D_t}$ is price-dividend ratio at time t, and $\varepsilon_{t+1,t+h}$ is the error term. The results of the estimation of this specification for S&P500 series are reported in the top panel of Table 5 while their model-based counterparts are displayed in the lower panel of the same table. We find that, in line with existing evidence, a drop in current price-dividend ratio predicts increase in the future cumulative excess returns, both in the data and in the model. The absolute value of estimated coefficient β as well as R^2 increase in the horizon h.

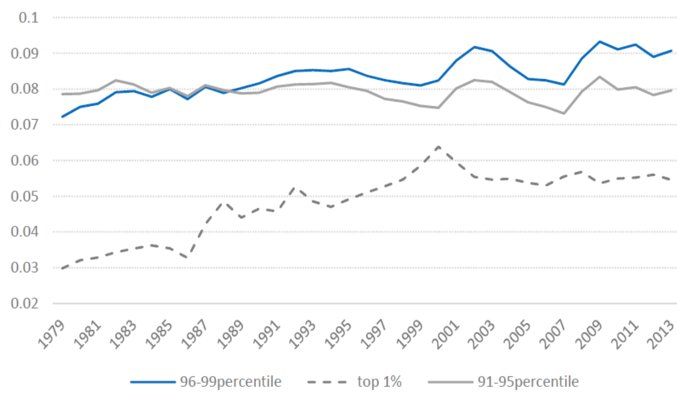
Table 7: **Long Run Return Predictability Regressions**

Long Horizon Return Regressions	$\sum_{j=0}^{h} R^e_{t+j+1} = \beta \frac{P^s_t}{D_t} + \varepsilon_{t+1,t+h}$	
	Data	
X_t:	$\frac{P^s_t}{D_t}$	R^2
h		
0	-0.23^{**}	0.05
	(0.11)	
1	-0.48^{**}	0.11
	(0.18)	
2	-0.67^{**}	0.16
	(0.22)	
	Model	
h		
0	-0.21^{***}	0.01
	(0.002)	
1	-0.41^{***}	0.02
	(0.002)	
2	-0.58^{***}	0.03
	(0.003)	

Table reports results of estimation of the regression $\sum_{j=0}^{h} R^e_{t+j+1} = \beta \frac{P^s_t}{D_t} + \varepsilon_{t+1,t+h}$ where $\sum_{j=0}^{h} R^e_{t+j+1}$ is a cumulative excess return over h+1 years with h=0,1,2. $\frac{P^s_t}{D_t}$ is price-dividend ratio at time t and $\varepsilon_{t+1,t+h}$ is the error term. The specification is estimated by OLS with Newey-West correction of the standard errors. Standard errors are reported in brackets.

10 Appendix C: additionnal figures

Figure 5: Decomposition of the labour income of the top decile income share between 1979 and 2013



The blue solid line plots the labour share of 96th to 99th percentile in the total U.S. income. The solid grey line plots the labour share of 91th to 95th percentile in the total U.S. income and the dashed grey line plots the labour share of top 1 %. The data comes from supplement information provided in CBO's report: The Distribution of Household Income and Federal Taxes (2013) and can be found at https://www.cbo.gov/publication/51361.