

# Entrepreneurs, Managers and Inequality\*

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## ABSTRACT

Since the 1970s, the U.S. has seen a monotonic increase in the share of income earned by the top 1 percent. However, the share of wealth held by the top 1 percent has followed a U-shaped pattern. I argue that this can be accounted for by occupational shifts caused by the decline in tax progressivity. To show this, I construct a dynamic general equilibrium model of occupational choice which distinguishes between entrepreneurs, who run their own firms, and managers, who run publicly owned firms. Collateral constraints induce entrepreneurs to hold more wealth, while managers earn higher wages as a result of competitive assignments to firms. Feeding observed tax policy changes from 1970 to 2000 into the model, I find that progressive taxation can account for (i) half of the increase in the relative mass of managers and capital held by the corporate sector and (ii) more than one-third of the increase in the wage levels of top managers relative to the average wage, which in turn explains (iii) all of the increase in the share of wages earned by the top 1 percent and (iv) 20-25% of the increase in the share of income earned by the top 1 percent. As managers replace entrepreneurs at the top, the share of wealth held by the top 1 percent initially drops as entrepreneurs decumulate wealth, then rises again as managers accumulate wealth. These simultaneous changes result in a utilitarian welfare gains of 1%-9% in consumption equivalent terms. In a counterfactual analysis, I show that even less progressive taxation can lead to a drop in the concentration of wealth.

**JEL Classifications:** *C68, E21, E62, J3*

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# 1. Introduction

Wealth is much more concentrated than income in the United States. For most of the latter half of the 20th century, the top 1% of the wealthiest households held approximately 30% of aggregate wealth. In contrast, the top 1% of the highest income households earned approximately 10% of aggregate income.<sup>1</sup> At the same time, income has become much more concentrated toward rich households since the 1970s compared to the previous post-war era, with the highest income percentile earning 7.8% of aggregate income in 1970 and 16.5% in 2000. Most of this can be accounted for by wages: both the share of wages earned by the top wage earners, and the wage component of the highest income households, have risen throughout the same time frame (figure 1). In contrast, wealth concentration has either been flat (according to the Survey of Consumer Finances), or, according to [Saez and Zucman \(2014\)](#), was initially high but then followed a U-shaped pattern, surpassing previous levels sometime around 2000 (figure 2).<sup>2</sup> In short, the richest 1% households work more and are richer than before the 1970s, and their saving propensities have changed since.

Two questions beg explanation: first, what has been the driving force of the dramatic increase in wage income concentration? And second, why was this pattern not mirrored in wealth concentration? To answer these questions, I present a heterogeneous household model where the income sources and savings behavior of households differ depending on their occupations. Feeding observed tax policy changes from 1970 to 2000 into the model, I find that progressive taxation can account for all of the increase in the share of wages earned by the top 1% and a quarter of the increase in the share of income earned by the top 1 percent. The transition path demonstrates that the share of wealth held by the top 1 percent initially drops then rises again.

The novel component of the model is the distinction between entrepreneurs and managers. It is often difficult to differentiate the two, and most models often treat them identically.<sup>3</sup> Theoretically, these models are missing a market for managers or talent. As a first step toward differentiating the two and incorporating the missing market, I take a simple approach where entrepreneurs are constrained to use their own assets to run a firm, while managers are hired by firms in which they need not invest (e.g., a publicly held firm of which the executive does not hold the majority of shares). This also leads to a natural distinction between corporate and non-corporate firms, as we can consider those firms run by entrepreneurs “private firms” and those run by managers, “corporate firms.” While both occupations comprise the bulk of the richest income groups, there is a trade-off between becoming an entrepreneur or a manager: the former faces collateral constraints but retains the entire surplus, while the latter is unconstrained but must be hired by public investors in a frictional market and split the surplus with them. Moreover, managers earn most of their income in the form of wages, while entrepreneurs earn relatively more from business or capital income.

As in most entrepreneurial models, the collateral constraints create a strong concentration of wealth. In addition, competitive assignment between corporate firms and managers implies that managerial compensation is proportional to the size of the firms they run (up to a constant). Therefore, managerial compensation will increase with the mass of corporate firms in the economy, leading to superstar wages for the managers who run the largest firms.<sup>4</sup> When managers replace

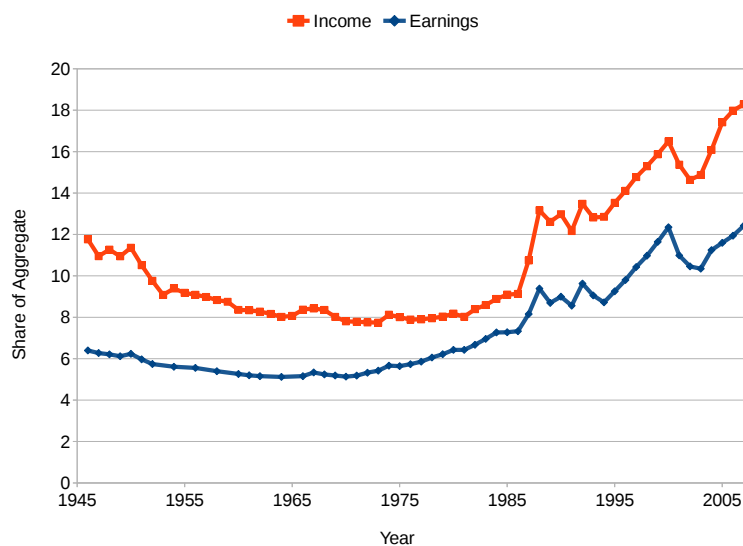
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<sup>1</sup>In a standard life-cycle model of precautionary savings, it is natural that wealth should be more concentrated than income due to idiosyncratic uncertainty and intergenerational transfers. However, numerous studies have found that these by themselves cannot quantitatively explain the degree of wealth concentration that is observed in the data. See [Cagetti and De Nardi \(2008\)](#) for an excellent review.

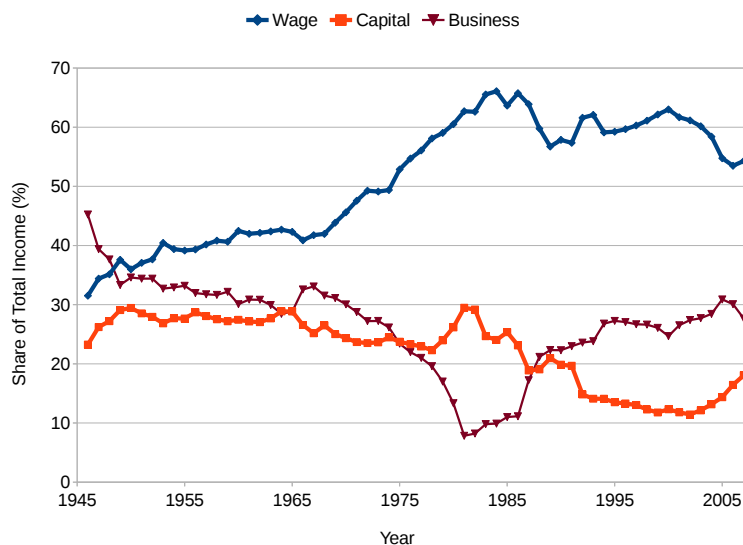
<sup>2</sup>Furthermore, they document that the recent increase is almost entirely explained by the uber-rich (0.1%).

<sup>3</sup>As an example, macroeconomic models with entrepreneurs typically exploit [Lucas \(1978\)](#), which was originally proposed as a model to explain the general equilibrium effects of an economy with *managers*.

<sup>4</sup>[Gabaix and Landier \(2008\)](#) build a theoretical model that shows that the size of the corporate sector can explain the



(a) Top percentile share of total and wage incomes



(b) Income decomposition of top (total) income percentile

Figure 1: Top percentile statistics, 1946-2007.

All data is from [Piketty and Saez \(2003\)](#) based on income and estate tax returns as reported to the IRS. They first order all tax units by the size of their total or wage incomes, and then compute how much the highest percentile earns as a fraction of the aggregate. So the top 1 percent tax units in subfigure 1(a) for total and wage incomes are not the same. In subfigure 1(b), we only look at the highest percentile tax units in terms of total income, and compute the shares of three source of income. For all computations, capital gains are excluded.

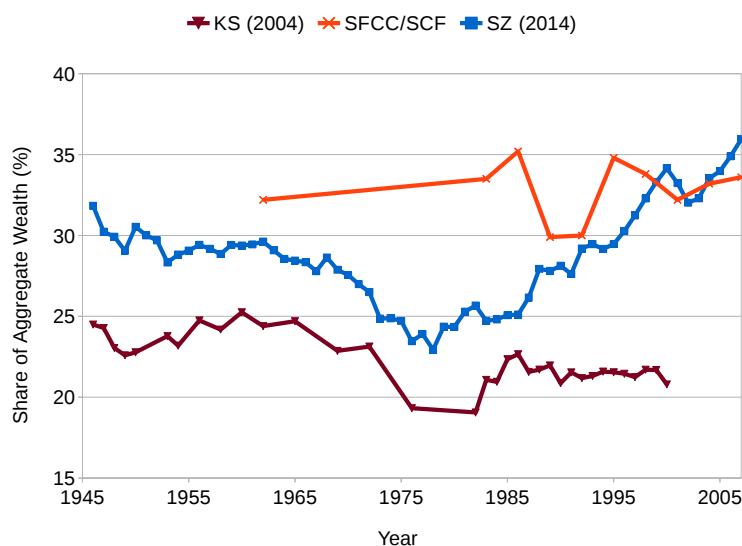


Figure 2: Top percentile wealth shares, different authors.

The 1962/63 Survey of Financial Characteristics of Consumers and Survey of Changes in Family Finances (SFCC/SCFF) was the precursor of the Survey of Consumer Finances (SCF). Since 1983, the SCF has been collected every three years. I use the variable NET WORTH to compute top percentile shares for 1963 and all available years on and between 1983-2007. [Kopczuk and Saez \(2004\)](#) use estate tax returns as reported to the IRS. [Saez and Zucman \(2014\)](#) impute wealth by a capitalization technique using interest rates implied from matching capital income reported in tax returns to the Federal Funds accounts. Dashed lines are the simulated series.

entrepreneurs at the high end of the income distribution, income becomes more concentrated because managers have higher earnings.<sup>5</sup> Because managers have a weaker savings motive than entrepreneurs, wealth concentration initially drops. But as the top managers continue to crowd out the top entrepreneurs, wealth concentration eventually rises again because while the managers may have a lower savings propensity than entrepreneurs, they save out of a higher income. This is in line with the explosive increase in managerial compensation since the 1980s and the rise in earnings concentration being the main culprit for the rise in income concentration, which led to “the working rich replacing the traditionally rich” ([Piketty and Saez, 2003](#)). It is also consistent with the U-shaped trend of wealth concentration documented by [Saez and Zucman \(2014\)](#).

My quantitative results show that such an occupational shift can be induced by a decline in tax progressivity. Taxes are modeled as an exogenous policy variable and I numerically compute the response of the economy to historical policy changes. Federal income taxation has become much less progressive, with the highest income groups paying as much as 70% of their income in taxes in the 1970s as opposed to 35% today.<sup>6</sup> In section 2.4, I argue that most of this decline must fall on earnings being taxed less progressively. Hence, because managerial compensation is accounted for as earnings, lower taxes on high levels of managerial compensation increase the mass of managers in equilibrium, which in turn reduces the relative measure of entrepreneurs versus managers at

huge increase in managerial compensation. The analytical form used in my model is motivated by theirs, which was first derived by [Tervio \(2008\)](#).

<sup>5</sup>In the paper, I use interchange between “wages” and “earnings” to refer to wage income, and “income” to refer to total income.

<sup>6</sup>Corporate income taxes have also become less progressive, which is also in favor of higher managerial compensation since a large share is paid out in the form of stock options and grants.

the high end of the income distribution. To be sure, most entrepreneurs also face the progressive schedule, since most of their income is still reported as earnings. What is important to note here is that the occupational shift occurs *in equilibrium*: a rich, high ability individual does not choose to become a manager because *after-tax* managerial compensation is high, but because the *pretax* compensation becomes higher when there is a larger mass of managers.

Given these results, I then analyze the utilitarian welfare consequences of the simulated model. Due to the lower savings propensity at the top, the steady state level of capital drops massively, by 46%. However, because the collateral constraints faced by entrepreneurs are much less efficient than the inefficiency that arises in the process of hiring managers, steady state output drops by only 4%. Combined, this leads to a 3.1% increase in average steady state consumption, since although less is produced, less is invested. However, the associated increase in income concentration that comes with less savings at the top leads to an increase in consumption inequality. This implies larger jumps in the expected equilibrium consumption plan, which is undesirable for the risk averse agents. This dominates the increase in average consumption, resulting in a consumption equivalent welfare loss of only 8.7% across steady states. However, this loss is made up for along the transition path, given that capital must be decumulated and is used for additional production and consumption. The final result is that the model predicts a 1%-9% increase in consumption equivalent welfare gains, depending on the timing of the aggregate shocks.

Because the main objective of this paper is to present a positive explanation of historical trends, not a normative theory of taxation, I do not conduct any additional welfare analysis. However, the model highlights some mechanisms at work that are important for policymakers when designing tax policies. For example, from the 2000 benchmark, flattening the tax structure even more leads to an increase in earnings and income concentration but a drop in wealth concentration. This and other implications for different tax policies are discussed in the conclusion.

**Related Literature** This paper is closely related to the macroeconomic literature on income and wealth inequality. Quantitative explorations of inequality typically employ Bewley-type incomplete market models with heterogeneous households. Most of these models attempt to explain the high degree of wealth concentration observed in the data.

Aiyagari (1994) shows that incomplete markets alone come far from accomplishing this. In a similar model but with aggregate uncertainty, Krusell and Smith (1998) find that aggregate uncertainty is also insufficient. However, by adding small differences in the subjective discount factor that vary stochastically with the aggregate state, they find that the wealth distribution in their model comes close to that of the U.S. Krueger and Perri (2006) replace the incomplete market friction with limited commitment, but find that this generates more risk-sharing than observed in the U.S. data. While not a focus of their study, their model cannot explain the degree of wealth concentration in the data, as more risk-sharing would imply less accumulation of wealth. Castañeda et al. (2003) add an additional source of earnings heterogeneity, the labor-leisure choice, and find that a model with endogenous labor supply and taxes can almost exactly match the earnings and wealth inequality moments in the data.

In all of these models, the main source of uncertainty is the idiosyncratic labor shock. In this sense, all individuals are identical in that they are wage workers but with stochastic abilities. As such, the sole source of inequality in this class of models is labor efficiency. Though they deliver valuable insights and may be a good approximation of the U.S. economy as a whole, most of these models do poorly at the high end. Indeed, Castañeda et al. (2003) are able to achieve their results only after assuming an extremely high shock that occurs with very small probability.

Instead of assuming that some workers happen to be extremely efficient by chance, models

with entrepreneurs use a [Lucas \(1978\)](#)-type “span of control” mechanism with collateral constraints to endogenously explain why some individuals generate higher income and also exhibit higher savings behavior. This class of models has been more successful in matching inequality moments, particularly at the high end. [Quadrini \(2000\)](#) shows that a model with stochastic projects, collateral constraints and entrepreneurial risk can explain income class mobility as well as the wealth distribution in the U.S. [Cagetti and De Nardi \(2006\)](#) use a parsimonious overlapping generations model of occupational choice between becoming a worker or an entrepreneur, and show that endogenous collateral constraints together with bequest motives can generate a realistic wealth distribution. Conceptually, both models are adding a small fraction of entrepreneurs into a model otherwise identical to [Aiyagari \(1994\)](#). These models are suitable for analyzing the behavior of entrepreneurs and how they interact with the macroeconomy, but are subject to the criticism that the large role played by private firms (which are run by entrepreneurs) is not very representative of the U.S.

However, all the models above will not be able to explain rising income concentration concurrently with a U-shaped evolution of wealth concentration. The reason they are able to create a strong concentration of wealth is because the high income earners have an unusually large savings motive compared to the average, whether it be because they face a different income process or they have different occupations. Hence, an increase in income concentration will necessarily lead to an even higher concentration of wealth, contrary to what we observe in the data.<sup>7</sup>

I draw from various lines of literature to build a stylized model that can explain U.S. inequality facts. The first is entrepreneurial models of development. A growing literature explores the role of entrepreneurial collateral constraints in the course of economic development, e.g. [Buera et al. \(2011\)](#); [Buera and Shin \(2013\)](#); [Moll \(2014\)](#). In contrast, I build a model of an already developed economy by adding a new high income earning occupation, a manager, that competes with entrepreneurs. Using this model, I explore how fiscal policy shifts can change the distributions of income and wealth in the U.S. The creation of the managerial occupation is accomplished by technology transfers. In my model, potential entrepreneurs choose between running their own business or selling it. This component of the model can be viewed as a simplified version of [Holmes and Schmitz \(1990, 1995\)](#). In recent work, [Silveira and Wright \(2010\)](#) generalize their setting and add various frictions to focus on the transfer process. Instead, I interpret this “transfer of ideas” as a mechanism that brings a business to the disposal of public investors and simplify the process so that it can be embedded in a general equilibrium framework. This simplification is done by borrowing from managerial assignment models in the business literature, e.g. [Tervio \(2008\)](#), [Gabaix and Landier \(2008\)](#).

In my framework, the occupational choices and incomes of households are determined in a dynamic general equilibrium. High income groups display different characteristics depending on the relative ratio of entrepreneurs versus managers that comprise those groups. When there are more entrepreneurs, the model behaves more similarly to an entrepreneurial model with collateral constraints, and when there are more managers, it behaves more similarly to a competitive assignment model with superstar earnings. Thus, a shift in occupational choices alters the savings behavior of different income groups and the dynamics of their sources of income. I numerically compute the resulting equilibrium distributions of income and wealth in response to shifts in an empirically calibrated tax code along with the welfare costs and benefits of such shifts.

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<sup>7</sup>[Poschke \(2010\)](#) develops a model of skill-biased change in entrepreneurial technology to explain historical U.S. and cross-country data on entrepreneurship and firm size. But his model lacks any endogenous dynamics, and does not differentiate between earnings, income, and wealth. Moreover, his model is again subject to the criticism that the U.S. economy cannot be represented solely by entrepreneurial activity. At least for the U.S., I can explain a richer set of facts while also not relying only on entrepreneurship or an abstract notion of technological change.

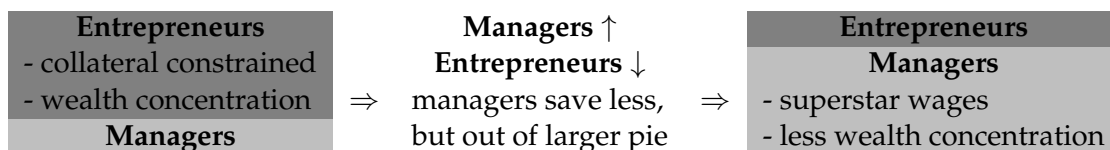


Figure 3: Mechanism of the model

An exogenous change that induces the top income group to be composed by more managers as opposed to entrepreneurs will deliver the observed empirical shifts in the distribution.

The paper is also closely related to the empirical public finance literature. These papers I discuss in the next section while summarizing the empirical facts that form the basis of my quantitative study. Section 3 presents the benchmark model and its properties. Section 4 describes the calibration strategy and the numerical policy experiment. Section 4.2 discusses the results and the quantitative mechanisms of the model, and Section 5 concludes.

## 2. Empirical Facts

This section presents in detail the empirical facts outlined in the introduction, namely:

1. Large increase in income concentration since the 1980s that was not accompanied by a corresponding increase in wealth concentration
2. Concurrent explosion of the number and compensation of managers.
3. Progressive taxation in the U.S.
4. Aggregate evidence of non-earnings income-shifting.

Figure 3 shows how the model uses facts 3. and 4. to explain facts 1. and 2. presented in this section. The collateral constraints generate strong wealth concentration due to the entrepreneurial savings motive. Managers earn the highest wages due to competitive assignments. Progressive taxation affects mainly earnings, because high income groups can avoid high taxation on non-earnings income. Less progressive taxation then allows managerial compensation and the mass of managers to grow in equilibrium, who crowd out entrepreneurs in the high income groups. This leads to higher earnings and income concentration, but wealth concentration need not necessarily increase monotonically if managers have a lower savings propensity than entrepreneurs, even if they are saving out of a larger pie. In addition, even as tax rates become lower for high income groups, they pay a higher share of taxes because their earnings become disproportionately larger than low income groups.

### 2.1 U.S. Income and Wealth Distribution

Figure 2 plots the time series for the top 1% share of wealth from the SCF. I account for wealth as “NET WORTH” as defined in the SCF. My results are similar to Scholz (2003) and Kennickell (2009), the designer of the SCF.<sup>8</sup> The graph shows that the top percentile wealth share has no

<sup>8</sup>Scholz (2003) excludes 1986 due to concerns of spurious reporting, while Kennickell (2009) only analyzes 1989 onward. I include all available years when the SCF was conducted (every three years from 1983 to 2007), along with older data from the 1962 Survey of Financial Characteristics of Consumers and 1963 Survey of Changes in Family Finances (SFCC/SCFF).

specific trend over the years the SCF data were collected. While it does seem to display a slight increase in the early 1990s, this trend was reversed afterward. Furthermore, the increase is nowhere near the level of the increase in top income shares, which has continually increased.

The figure also plots wealth data based on estate tax returns from [Kopczuk and Saez \(2004\)](#) and a capitalization technique from [Saez and Zucman \(2014\)](#). Similarly to the SCF, the former finds that top wealth shares have been more or less stable with a dip in the 1970s. Notwithstanding that more data are available for a historical analysis, it is difficult to draw conclusions about wealth from estate tax returns as it is subject to major tax avoidance issues. [Saez and Zucman \(2014\)](#) work around such concerns by imputing wealth using a capitalization technique that matches capital income reported in tax returns to the Federal Funds accounts. Unlike previous studies, they find sizable increases in recent years. However, potential issues with the capitalization technique aside, the question still remains why the trend is U-shaped and why this happened only within the top 0.1%, as they find.

[Piketty and Saez \(2003\)](#) document that top income shares have grown dramatically since the 1980s, and that they show a strong correlation with top earnings shares.<sup>9</sup> Figure 1(a) plots their time series of the top percentiles of total income and earnings (wage income). The figures show that top income shares are closely tracked by top earnings shares, suggesting that the increase in total income concentration is caused by wages and salaries. This visual trend is confirmed in table A1 in the appendix, where I have tabulated the size distributions of wealth, earnings and incomes in the SCF.

Along with these facts, they also observe that over time, the share of income that comes from earnings has become higher for top income groups. After dividing total income into three sources—capital, wages and business—figure 1(b) plots these shares for the top income percentile, replicated from [Piketty and Saez \(2003\)](#). The peculiar trends of the early 1980s are typically attributed to anomalous tax reporting episodes around the time of the 1986 tax reform. During this period, business owners began to report corporate income as personal income to take advantage of the fact that personal income tax rates fell below corporate income tax rates for the first time in history, while the actual sources of income remained unchanged. For the same reasons, more options were exercised, and shareholders realized large amounts of their capital gains. Regardless, the long-run trend is that the wage share of income has increased and that the capital and business shares have decreased, as also confirmed in table 8 in the appendix. This indicates the “crowding out” story of this paper, that the “savings rich” (entrepreneurs) have been replaced by the “earnings rich” (managers).<sup>10</sup>

## 2.2 Entrepreneurs vs Managers

As noted in [Cagetti and De Nardi \(2006\)](#), a large fraction of the rich people are entrepreneurs. The main definition of an entrepreneur that they use are active, self-employed business owners according to the SCF. According to this definition, 7.6% of the population are entrepreneurs, they own 33% of total wealth, and comprise 54% of the top wealth percentile (Tables 1, 2, and 3, respectively, in [Cagetti and De Nardi \(2006\)](#)) in the 1989 SCF. It is quite clear that entrepreneurs own a significant amount of total wealth, but as they also ask, who are the other rich people?

Recent trends indicate that a significant portion of these other rich people may be managers. In

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<sup>9</sup>They use tax returns data published annually by the Internal Revenue Service (IRS), based on income as reported by a tax unit (single or married couple).

<sup>10</sup>However, the increase in the wage income share for top income groups happens earlier than the surge of top earnings and income shares. [Piketty and Saez \(2003\)](#) conjecture that shifts in social norms may also have played a role, which may also explain the different timings and also the quantitative moments not explained by this paper.



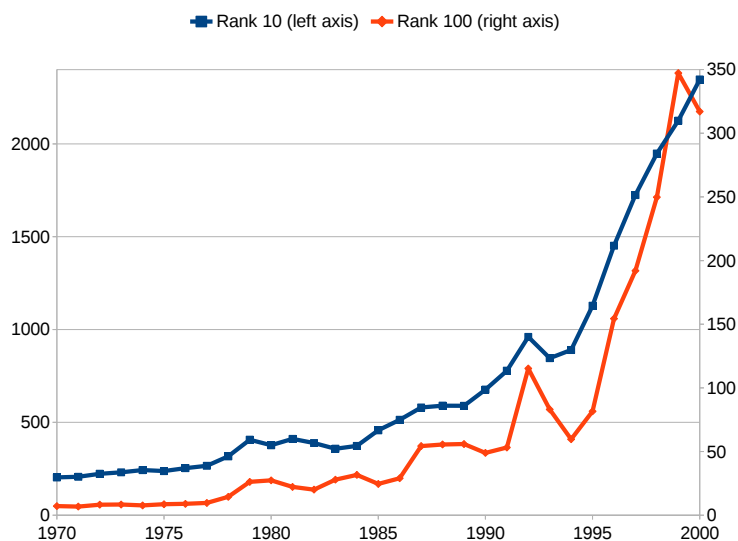


Figure 4: Executive compensation over average annual wage, 1970-2000

Average annual wages are computed from NIPA. Executive compensation is either the top 10 rank (left axis) or top 100 (right axis) rank CEO pay from the Forbes survey.

my model, a manager is an individual who runs a publicly owned company on the owners' behalf. Accordingly, the top managers in my model correspond to CEOs of large corporations. [Gabaix and Landier \(2008\)](#) find that CEO compensation has increased nearly 6-fold since the 1980s, which coincided with a 6-fold increase in market capitalization. [Piketty and Saez \(2003\)](#) also conjecture that the relative rise in executive compensation compared to the average wage may have caused the rise in income and earnings concentration. Figure 4 plots the relative increase in the top 10 and top 100 ranked CEO as published in Forbes Magazine, against the average annual wage from the National Income and Product Accounts (NIPA), from 1970 to 2000.<sup>11</sup> The relative increase is visually clear for both measures.

In figure 5, I show that the increase in the mass of managers and top executive compensation coincides not only an absolute increase in the size of the corporate sector, but also with the relative size of the corporate sector compared to the non-corporate sector. The graph is based on the Federal Flow of Funds accounts, from which I compute the growth of the capital held by non-financial corporate and non-corporate business.<sup>12</sup>

Taken together, it may seem natural to conclude that executives running large corporations are sitting at the top of the income and earnings distributions, in particular since the 1980s. However, there is still the caveat that some non-corporations are run by managers (such as limited liability companies) and some corporations are run by self-proprietors (such as S-corporations). Hence

<sup>11</sup>[Frydman and Saks \(2010\)](#) track the three highest paid executive officers of the largest 50 firms in 1940, 1960 and 1990. In addition to going farther back into the past, it has the additional favorable feature that option grants are evaluated at grant-date. Their analysis confirm the explosive increase in compensation after the 1980s.

<sup>12</sup>Financial businesses are excluded since they play a special role in recent years, and also to show that the growth of the corporate sector was not solely due to the emergence of large financial companies. Other entities (mainly the households) I exclude as it is unclear whether their assets should belong to the corporate or non-corporate sectors. To construct these series, I follow [Quadri \(2000\)](#)'s approximation of productive capital and include plant and equipment, inventories, land at market value and residential structures.

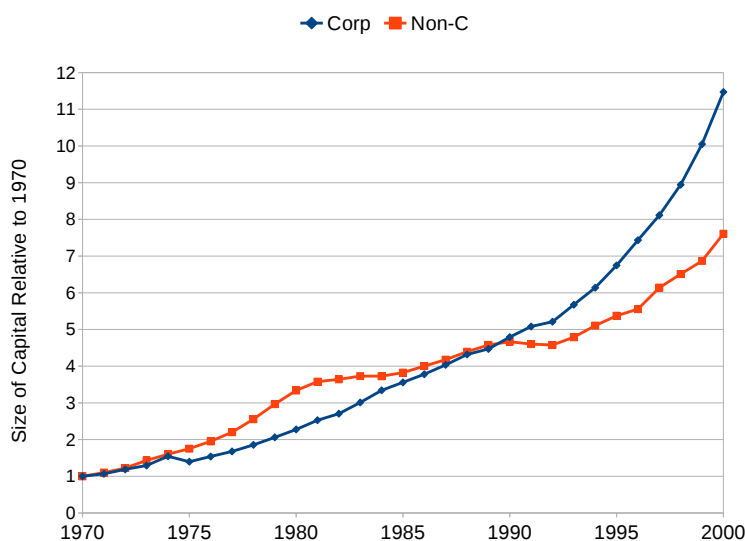


Figure 5: Capital held by corporate and non-corporate businesses.

The size of the capital of each sector is normalized to 1 in 1970, at which time the corporate businesses held approximately 47% of the capital of both combined. By 2000, the ratio grows to 67%.

to link the increase in the relative size of corporate capital to top executive compensation in a span-of-control model, we need direct evidence on the population share of managers. Unfortunately, the only survey that properly represents the high end of the distribution, the SCF, does not include a clear classification for managerial occupations. This makes it difficult to conduct a direct comparison between the income and wealth levels of entrepreneurs and managers.

Nonetheless, there is ample evidence that the population share of managers in the entire population has grown relative to entrepreneurs. I present one such piece of evidence from the Integrated Public Use Microdata Series of the Current Population Survey March supplement<sup>13</sup> in Figure 6. As in Feyrer (2009), I compute the fraction of households where a household member is categorized as “Managers, Officials, and Proprietors” under the 1950 census occupational coding. The ratio of households involved in management increases from approximately 13% to 18% from 1970 to 2000. From this group of households, I drop those households who are self-employed and with positive business income—the entrepreneurs according to Cagetti and De Nardi (2006)’s definition. It is clear that the increase in the share of households involved in management is due to those who are *not* entrepreneurs. Indeed, the fraction of entrepreneurs in the March CPS is relatively stable throughout this time span at approximately 2.5%.<sup>14</sup> The figure also plots the share of entrepreneurs among the households classified as management, which declines from approximately 25% percent in 1970 to 15% in 2000.

### 2.3 Tax Progressivity

The 1980s Reagan era was characterized by a series of tax reforms. While it is arguable how much of the distributional trends are attributable to taxes, federal income tax rates decreased quite

<sup>13</sup>King et al. (2010), <http://cps.ipums.org/cps/>.

<sup>14</sup>This figure is most likely small compared to those computed from the SCF as the CPS may miss business incomes.

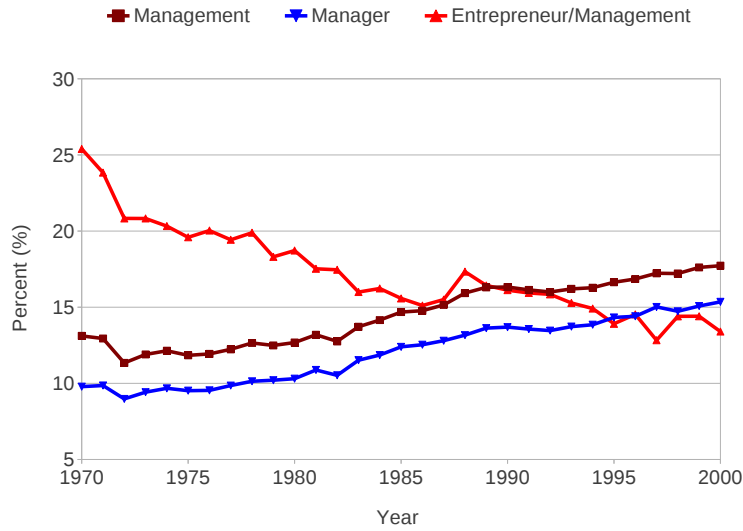


Figure 6: Manager-entrepreneur occupation ratios

Fraction of households involved in management, managers, in accordance with [Feyrer \(2009\)](#), and entrepreneurs, defined as self-employed business owners. In red is the fraction of entrepreneurs among households involved in management. From IPUMS CPS March, 1970-2000.

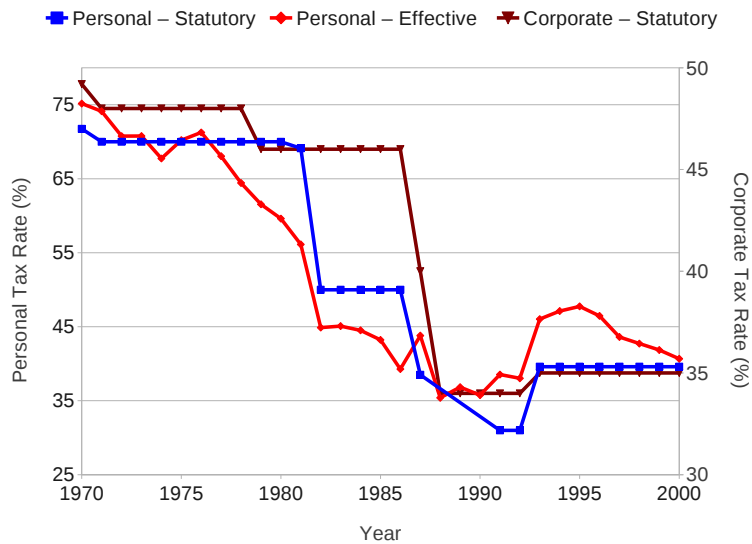


Figure 7: Top marginal tax rates, 1970-2000.

Personal effective top marginal tax rates are proxied by the effective tax rates of the top .01 percentile richest households, computed in [Piketty and Saez \(2007\)](#). The other series are publicly available from the IRS.

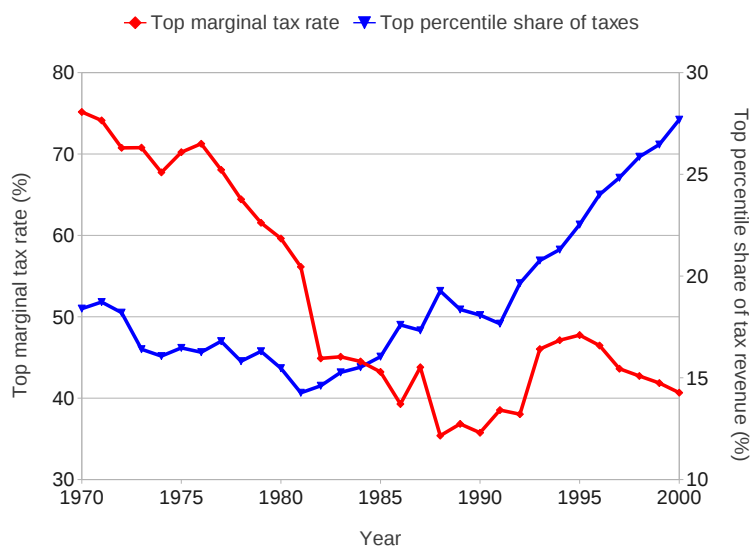


Figure 8: Top marginal tax rate and top percentile share of taxes paid, 1970-2000.

Personal effective top marginal tax rates are proxied by the effective tax rates of the top .01 percentile richest households. Top percentile share of taxes is defined as the share of total tax revenues paid by the top income percentile. Both series are computed in [Piketty and Saez \(2007\)](#).

dramatically during this period. Refer to Figure 7 for historical series of personal and corporate top marginal statutory tax rates.<sup>15</sup> Of course, statutory tax rates do not immediately translate into effective marginal tax rates. While statutory personal tax rates have become less progressive, it is not clear whether effective tax rates have become less progressive as lower tax rates induce high income individuals to receive more of their income in taxable form. Corporate income taxes are also hard to interpret, especially because different types of corporate entities have different ways to avoid the “double taxation” issues, i.e., both the corporation and shareholders being taxed. In order to cope with these issues one would need to look at not only the effective marginal tax rates faced by each income group, but how much of each income source is being taxed: a herculean task when one takes into account the full complexity of the tax code.

Nonetheless, [Piketty and Saez \(2007\)](#) report that the U.S. tax system has become less progressive in recent decades. Figure 7 plots the effective average tax rate faced by the top 0.01 percentile richest households from [Piketty and Saez \(2007\)](#) against the statutory tax rates, from which one clearly sees that top effective rates closely track top statutory rates. While the effective average tax rate for all households rose from 23.3% in 1970 to 27.4% in 2000, the tax rate for the top income percentile fell from 47.2% to 38.6%. Furthermore, they find that while there have been large changes at the top income percentile, there are relatively small changes below that. Interestingly, while the effective tax rate has fallen for this group, the share of taxes they have been paying has increased, from 18.4% to 27.7%, consistent with the huge increase in their share of aggregate income. This is visually contrasted against the effective average tax rate of the top 0.01 percentile richest households in Figure 8.

<sup>15</sup>While ignored in the quantitative analysis of this paper, corporate taxation will mainly affect individuals with a large number of shares and top level management. Therefore it may potentially play a large role in explaining the evolution of top income and wealth shares.

	B90 total	T1 total	B90 K-inc	T1 K-inc
1970	10%	33%	28%	49%
2000	8%	30%	16%	44%

	Realized Kgains (% GDP)	ATR Kgains	Max Rate (Long-Term)
1970	2.01	15.2	32.21
2000	6.47	19.8	21.19

Table 1: Average tax rates on total income, capital income and capital gains.

B90 and T1 stand for the bottom 90 and top 1 percentiles, respectively, when tax units are ordered by the size of their total income. The first two columns of the first panel uses data from [Saez and Zucman \(2014\)](#) and shows the average tax rates on total income—the fraction of total income paid as taxes—for each group. The next two columns show the average tax rates on capital income. The second panel from the Office of the Treasury shows the size of net capital gains as a fraction of GDP, the average tax rate on capital gains—the fraction of realized capital gains paid as taxes—and the effective top marginal tax rate on long-term capital gains.

In addition to the direct effects coming from tax reporting, there are other indirect ways through which high incomes, in particular top executive compensation, can be affected by the tax code. When income taxes are progressive, not only does the manager occupation become less desirable for the individual, but also for the firm. This is because high marginal income tax rates require huge pretax compensation that firms may simply not be able to meet with salary and stock grants ([Frydman and Saks \(2005\)](#)). Lower personal income taxes for high income brackets enable firms to pay out higher after-tax salaries. Lower corporate income taxes and favored tax treatment for capital gains can also indirectly affect executive compensation. These allow the firm to compensate the manager in the form of stock options or other forms of compensation that are more lightly taxed. Accordingly, [Frydman and Saks \(2010\)](#) find that option grants have been on a steady rise since the 1950s.

## 2.4 Aggregate Evidence of Non-earnings Income-shifting

Following [Piketty and Saez \(2003\)](#)'s division of individual income into three sources, my model also specifies three sources of income: capital, wage and business. As the model addresses neither tax avoidance or evasion nor double taxation issues, I make some specific exogenous assumptions to capture the data. Specifically, although in the U.S. the progressive income tax schedule is levied on adjusted gross income (AGI) after deductions, in the model I compress all progressivity on earnings, while assuming that entrepreneurs also report most of their income as earnings. This ensures that both top managers and entrepreneurs are subject to progressive taxation. Second, I assume flat rates on capital and business incomes and capital gains, where for entrepreneurs, business income is defined as entrepreneurial profits minus earnings. This is to capture the fact that most high income earners are able to deduct large amounts of their capital and business incomes, allowing them to side step the progressive schedule. Third, I assume that entrepreneurs exogenously report some of their business income as capital gains, thereby receiving preferential tax treatment.

On the one hand, this is to elucidate how shifts in the relative effective tax rates on different sources of income can alter the equilibrium: my experiments focus only on changing the progres-

sivity of the earnings tax schedule while keeping all other tax rates fixed. Furthermore, earnings still is the dominant source of income for households in all income groups up to the top 1 percent, so any changes in a generic income tax schedule would affect earnings the most. On the other hand, in this section I present evidence that most high-income earners deduct large amounts of their capital and business incomes, and shift income between business incomes and capital gains to change the effective tax rates they face, so that the above assumptions are not unrealistic.

First, the relative drop in the average tax rate of capital income—the fraction of capital income paid as taxes—for the top income percentile compared to the bottom 90% is modest compared to the drop in the average tax rate of total income, the fraction of total income paid as taxes. In table 1, I show these rates for the years 1970 and 2000; the entire series available from the appendix data of [Saez and Zucman \(2014\)](#) confirm that all these numbers show a monotonic trend, so there is nothing special about the two years.

There are several things to note. Even as tax progressivity has declined during this period, not much is visible up to the top income percentile: the drop in the average tax rate of total income is similar for both the bottom 90% and top 1%. This is because the bulk of the decline comes from even higher income fractiles, as evidenced in figure 7. More relevant for this paper, the average tax rate on capital income has also dropped for both groups, but the drop is much larger for the bottom 90%. This suggests that taxation of capital has in fact become *more* progressive. Since statutory income were much higher in earlier years, it must be that much of capital income was not subject to taxation then. Hence, when understanding the change between 1970 and 2000, progressive taxation on capital income does not seem to play a role.

Second, as seen in the lower panel of table 1, even as the maximum tax rate on capital gains has declined, the amount of taxes collected from realized gains has steadily increased as a fraction of total capital gains.<sup>16</sup> This means that very few capital gains were subject to the maximum rate in the 1970s, despite the much higher rate. Combined with the fact that the absolute amount of realized gains was smaller while the capital income of the top 1% was less progressively taxed than lower income groups, this again implies that a large fraction of top percentile incomes were not subject to taxation, possibly through deductions or credits.

Since most deductions or tax credits available for earnings are for median or low income households (e.g., the earned income tax credit), the above evidence seems to imply that the rich take advantage of the many loopholes in the tax code for capital and business incomes that taxpayers can easily exploit to their advantage. In order to confirm this conjecture, we need to look at how much of income is deducted, and especially for the higher income groups.

[Gruber and Saez \(2002\)](#) have shown that the taxable income of high income households that itemize are the most sensitive to changes in tax policy in a three year horizon. In figure 9, I show that this holds in the longer run. Using data in the annual Statistics of Income (SOI), publicly available from the IRS, I plot the fraction of taxable income over AGI by income percentile (ordered by AGI) for every 10 years from 1970 to 2000. For ease of comparison I only plot the top income decile. Not only has total taxable income increased monotonically as a fraction of total AGI, but this is especially true in the top percentile and higher.<sup>17</sup> Moreover, [Goolsbee \(2000\)](#) finds using Execucomp data that the effect of tax policy on the taxable income of executives is transitory at best. This is because while there are changes in the timing of compensation to exploit differential tax rates, executive compensation of all forms—including stock grants and options—are ultimately reported as salary and wages. This validates my modeling assumption that while

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<sup>16</sup>The top 1% earns more than 70% of total capital gains, which comprises approximately 20% of their total income ([Piketty and Saez, 2003](#)). So as far as capital gains are concerned, we can focus on aggregate rather than relative numbers by income percentile.

<sup>17</sup>More detailed data on taxable income and itemized deductions based on the SOI data is available upon request.

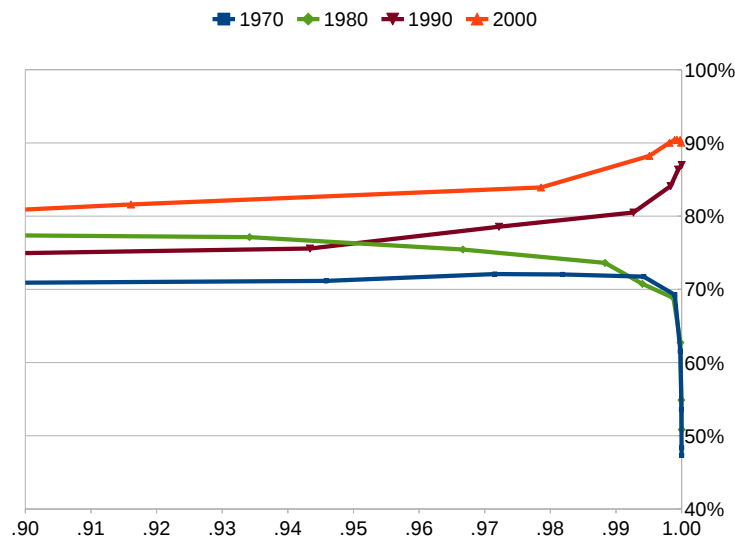


Figure 9: Fraction of taxable income by AGI percentile.

Using SOI tables publicly available from the IRS, I order groups by AGI and plot the share of AGI that is taxable. Overall, taxable income as a fraction of AGI has increased in the overall population throughout 1970-2000, and as shown in the figure especially for the top AGI percentile and higher.

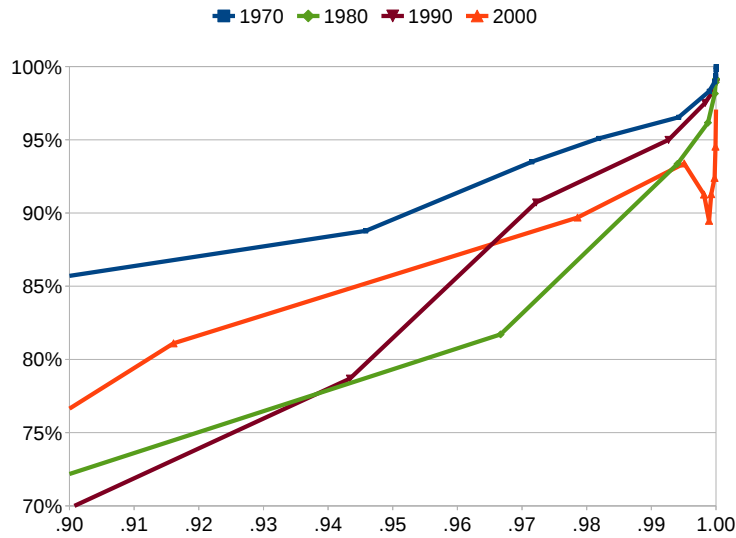
capital and business *owners* can avoid high tax rates on their incomes, managers cannot.

In figure 10, I show suggestive evidence that the increase in the taxable incomes for top AGI percentiles may be due to the decline in itemized deductions. Figure 10(a) shows no clear trend for lower income groups, but the fraction of itemizers in the top AGI percentile shows a declining trend. More importantly, figure 10(b) shows that while there is again no clear trend even up to the top percentile, the size of itemized deductions as a fraction of AGI has dropped dramatically for groups above the top 0.5 percentile.

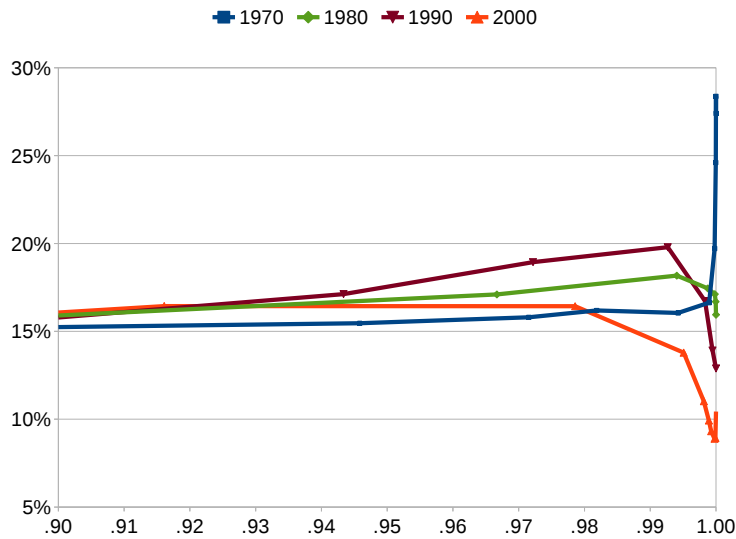
The last piece of evidence I present is what the top AGI percentile actually itemizes. In figure 11, I compute the amount of each itemized category as a fraction of total itemized deductions, both for the entire population and the top AGI percentile, in the years 1980 and 2000.<sup>18</sup> Two trends are important for my purposes. First, deducting taxes paid (these are state and municipal taxes) is important for both the population and top percentile. But not only is it relatively more important for the top percentile, it has become even more important for them in recent years. A sizable fraction of state taxes are property taxes (about one third across all states in 2000), which is especially relevant for the rich. Properties are illiquid but interest-generating assets, and while the rates are low, capital owners have some leverage over which statutory income bracket they fall in by investing in property. Second, investment and contributions are important deductions for the top percentile relative to the population, and the relative importance of contributions has increased in recent years. This can be interpreted as less business income being deducted in comparison to capital income, which is consistent with self-run business owners being crowded out by rich managers.

In my quantitative exploration, I show that holding all other tax rates fixed, less progressive earnings taxation can account for a significant amount of the changes in the distributions of income

<sup>18</sup>I plot 1980 because investment deductions are not available for earlier years.



(a) Fraction of itemizers by AGI percentile



(b) Fraction of AGI itemized by AGI percentile

Figure 10: Number of itemizers and itemized amounts by AGI percentile.

Using SOI tables publicly available from the IRS, I order groups by AGI and plot the fraction of the returns that are itemized, and the size of itemized deductions as a fraction of AGI. Overall, the total number of itemized returns as a fraction of total returns have decreased, while the total amount of itemized deductions as a fraction of AGI has remained relatively stable. However, both have a declining trend for very high AGI percentiles.



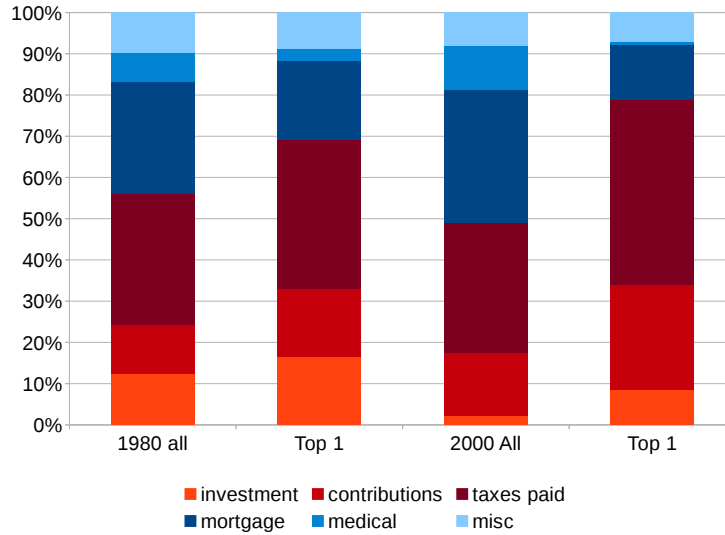


Figure 11: Itemized categories.

Using SOI tables publicly available from the IRS, I compute the amount of each itemized category as a fraction of total itemized deductions, for the entire population and the top AGI percentile. I compare 1980 with 2000 because investment deductions are not available for earlier years.

and wealth, but not all. In the conclusion I discuss how letting the other tax rates vary may improve the explanatory power of the model.

### 3. Model

I use a dynamic version of [Lucas \(1978\)](#)'s "managerial span of control" technology, which is standard for quantitative models with entrepreneurs, e.g. [Cagetti and De Nardi \(2006\)](#), [Buera and Shin \(2013\)](#). The novel component of my model is differentiating entrepreneurs from managers. Entrepreneurs are subject to collateral constraints while managers are not. This is meant to capture the fact that investors that outsource their managers have more operational funds than the single entrepreneur. Potential entrepreneurs decide whether or not to sell their "projects"<sup>19</sup>, where a sale leads to a change of ownership as in [Holmes and Schmitz \(1990, 1995\)](#). But unlike their model, these decisions can be made in every period, as the project fully depreciates within a period.

In addition to the collateral constraint faced by entrepreneurs, another critical element of the model is the competitive assignment between projects and managers. In any given period, the within period equilibrium displays competitive assignment between projects and managers as in [Tervio \(2008\)](#), so that the returns to managerial talent is increasing in talent.

#### 3.1 Setup

Time is discrete,  $t = 0, 1, \dots$ , with a unit measure of individuals. Individuals live forever and are heterogeneous with respect to projects  $q$ , managerial abilities  $m$ , wealth  $a$ , and wage worker efficiency  $\epsilon$ . Projects are assumed to be drawn from a binary set  $q \in \{0, 1\}$  according to the Markov

<sup>19</sup>In terms of constructing a model, different authors call this an "opportunity," "idea," or "business."

transition matrix  $\Omega$  with associated stationary distribution  $G$ . If  $q = 1$ , individuals own a project - specifically, they have access to an economy-wide technology that depends on managerial ability, and capital and labor inputs as specified below. The project can be implemented, sold or simply forgone. If  $q = 0$ , it implies that the individual does not have a project, that is, does not have access to the technology. If the process governing project shocks is stationary, there is a mass  $g(1)$  of projects at any point in time.

Managerial ability shocks also follow a Markov process. If today's managerial ability shock is  $m$ , the probability that tomorrow's ability  $m'$  is  $m$  is  $\chi$ . Otherwise,  $m'$  is newly drawn from a distribution  $F_m$  with non-negative, finite support.<sup>20</sup> The wealth state  $a$  denotes the individual's asset holdings, which is endogenously chosen by the forward-looking rational individuals. Worker efficiency  $\epsilon$  is a idiosyncratic labor earnings shock that only affects your productivity as a worker, and is independent of your project and manager shock. As is standard in Bewley-models, I assume  $\epsilon$  follows a discrete Markov chain with transition matrix  $\Gamma$ . Assume that the multivariate Markov process over  $(q, m, \epsilon)$  is ergodic and irreducible so that a stationary distribution is well-defined.

All states are assumed to be perfectly observable, and I do not explicitly model any information or bargaining problems that may arise when an individual sells a project, or when a project is matched to a manager that is not its original owner. Projects are rival and last for only one period. In other words, once an individual sells her project she cannot implement it on her own, and regardless of who owns the project, it is gone at the end of the period. Whenever the project is implemented, I call this a "firm."

In the benchmark, I assume that the economy is in a steady state, so we can ignore aggregate variables. Individuals enter each period with the state vector  $x = (q, m, a, \epsilon)$ . Individuals with  $q = 1$  have the choice of selling the project to intermediaries at a competitive price. Those who sell their project lose the chance to implement the technology. If an individual keeps her project and implements it, I call her an *entrepreneur*, and the firm *private*. If she sells it, she chooses to become a *worker* or *manager*. Individuals who discard their project or with  $q = 0$  choose between becoming a worker or manager as well.<sup>21</sup> I call a firm run by a manager a *public* or a *corporate* firm. In this sense, if an individual sells her project but chooses to become a manager, she can be viewed as an entrepreneur who has gone public.

Managers are hired in a manager market where the employers are the new owners of the projects (i.e., the intermediaries) sold by individuals. I assume that entrepreneurs have an advantage over managers, which is captured by the parameter  $\kappa \in [0, 1)$ . Specifically, managers can only utilize  $(1 - \kappa)m$  of their ability on a project, while entrepreneurs can use their whole  $m$ . This is tantamount to assuming that all else equal, the original owner of a project is better at implementing a project. The parameter  $\kappa$  may also include the cost of bargaining that arises when assigning projects to managers, as analyzed in [Silveira and Wright \(2010\)](#).<sup>22</sup> After all occupation choices are made, entrepreneurs and managers make their production decisions, and all individuals make consumption and savings decisions. The sequence of events is depicted in Figure 12.

**Preferences** Preferences are time-separable and identical across individuals. Given a history of states  $\{x^t\}_{t=0}^{\infty}$  and a state contingent consumption plan  $c^t = \{c_t, c_{t+1}, \dots\}$ , expected utility at time

<sup>20</sup>The analysis focuses on continuous ability types and binary project types, as this is what is done in the calibration. Assuming different cases would increase notation without adding any intuition, therefore I keep the set of possible project qualities as simple as possible. This is discussed in detail below.

<sup>21</sup>Depending on parameter values, we may have an equilibrium in which projects are in over-supply.

<sup>22</sup>This assumption is made mainly for quantitative purposes and does not affect the qualitative results of the model, as discussed in Section 3.4.

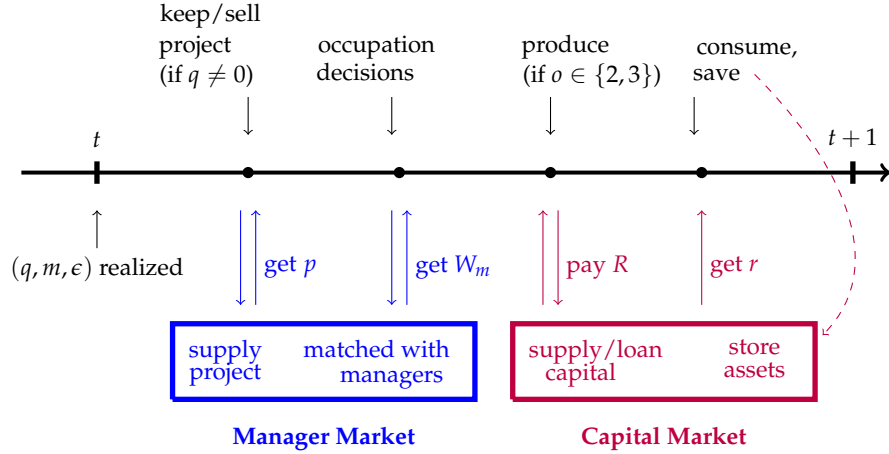


Figure 12: Manager and Capital Markets

In any given period  $t$ , all prices and decisions are simultaneously in equilibrium. The other side of both markets are competitive intermediaries.

$t$  is given by

$$U(c^t) = \mathbb{E}_t \left[ \sum_{s=t}^{\infty} \beta^{t-s} u(c_s(x^s)) \right]$$

where  $\beta$  is the subjective discount factor,  $u(\cdot)$  period utility, and the expectation is taken over the future realizations of  $\{x^s\}_{s=t}^{\infty}$  at time  $t$ .

**Technology** There is a single economy-wide technology only accessible by owners of projects, i.e., individuals with  $q = 1$  who have not sold their project or those who purchased a project. Production requires a project, a manager, capital, and labor. The manager makes all production decisions subject to the production function

$$f(\tilde{m}, k, l) = \tilde{m}^{1-\alpha-\nu} k^\alpha l^\nu,$$

where  $\tilde{m}$  is the effective ability of the individual implementing the project. If she is the owner of the project I call her an entrepreneur, and otherwise a manager. For entrepreneurs,  $\tilde{m} = m$ , while for managers,  $\tilde{m} = (1 - \kappa)m$ . The variables  $k$  and  $l$  are the amounts of capital and labor used in production, respectively, and  $\alpha$  and  $\nu$  represent factor income shares.

Since I later incorporate collateral constraints, it is useful to define the indirect profit function and factor decisions without collateral constraints. These are given by

$$\begin{aligned} \pi^*(\tilde{m}) &= \max_{k,l} \left\{ \tilde{m}^{1-\alpha-\nu} k^\alpha l^\nu - Rk - wl \right\} \\ &= (1 - \alpha - \nu) \tilde{m} \left[ \left( \frac{\alpha}{R} \right)^\alpha \left( \frac{\nu}{w} \right)^\nu \right]^{\frac{1}{1-\alpha-\nu}} \\ Rk^*(\tilde{m}) &= \alpha \tilde{m} \left[ \left( \frac{\alpha}{R} \right)^\alpha \left( \frac{\nu}{w} \right)^\nu \right]^{\frac{1}{1-\alpha-\nu}} \end{aligned}$$

$$wl^*(\tilde{m}) = v\tilde{m} \left[ \left( \frac{\alpha}{R} \right)^\alpha \left( \frac{V}{w} \right)^\nu \right]^{\frac{1}{1-\alpha-\nu}},$$

where  $R$  is the equilibrium rate of return of capital, and  $w$  the wage rate.

**Manager and Capital Markets** Since the manager and capital markets are competitive, we can assume that any arbitrary number of intermediaries behave as single representative entity. This representative intermediary buys projects from individuals wishing to sell them at a competitive price  $p$ . Managers are hired at a competitive compensation schedule  $W(m)$  to implement these purchased projects. These managers are not subject to any constraints since they are producing on behalf of the intermediary, who owns the capital.

All individuals can make deposits in a perfectly competitive financial market at the risk-free interest rate  $r$ , but I assume that borrowing is not allowed. For ease of exposition, I simply assume that the same representative intermediary who buys projects and hire managers holds these deposits at a competitive interest rate  $r$ , and uses the funds to supply capital for entrepreneurial or managerial production. Managers are not subject to any constraints since they are producing on behalf of the intermediary, who holds the capital. Assuming that  $\delta$  of capital is depreciated during production, the rate of return on capital used in production satisfies  $R = r + \delta$ .

Entrepreneurs can use only their own assets or make within-period loans from the intermediary for production. Specifically, capital loans are subject to a collateral constraint  $k \leq \lambda a$ , meaning that she can loan up to  $\lambda$  times of her own assets. This can be motivated by limited enforceability of lending contracts. Specifically, if  $\lambda = 0$  entrepreneurial production is impossible, if  $\lambda = 1$  the entrepreneur can only use her own funds to implement her technology, while if  $\lambda = \infty$  she is in fact not constrained at all.<sup>23</sup> This type of constraint has been used widely in the literature, e.g. [Kiyotaki and Moore \(1997\)](#); [Buera and Shin \(2013\)](#). Since a constrained entrepreneur will always rent up to her limit, her indirect profits and factor decisions are

$$\begin{aligned} \pi_c(m, a) &= (1 - v)m^{\frac{1-\alpha-\nu}{1-\nu}} (\lambda a)^{\frac{\alpha}{1-\nu}} \left( \frac{V}{w} \right)^{\frac{\nu}{1-\nu}} - R\lambda a \\ l_c(m, a) &= m^{\frac{1-\alpha-\nu}{1-\nu}} (\lambda a)^{\frac{\alpha}{1-\nu}} \left( \frac{V}{w} \right)^{\frac{1}{1-\nu}}. \end{aligned}$$

Hence the profits and factor decisions of an arbitrary entrepreneur can be written as

$$\{\pi(m, a), k(m, a), l(m, a)\} = \begin{cases} \{\pi^*(m), k^*(m), l^*(m)\} & \text{if } \lambda a \geq k^*(m) \\ \{\pi_c(m, a), \lambda a, l_c(m, a)\} & \text{if } \lambda a < k^*(m). \end{cases}$$

Since the manager market is competitive and there is only one type of project, the price of a projects  $p$  must equal the returns from buying any project,  $d$ . The role of the intermediary will be discussed in more detail along with the manager market in section 3.2.

**Individual's Problem** Individuals make occupation-consumption-savings decisions. Those with  $q = 1$  must also decide whether to sell, keep or discard their projects. If an individual sells her project, she earns  $p$ . Denote the individual's occupation decision as  $o \in \mathcal{O} = \{o_e, o_m, o_w\}$ , where

<sup>23</sup>I could instead be more explicit about the contractual structure of debt, which would imply an endogenous debt limit as in [Cagetti and De Nardi \(2006\)](#); [Buera et al. \(2011\)](#). However, I am more interested in the general equilibrium effects of the multiple occupation choices and modeling the endogenous debt limits would complicate the analysis and numerical algorithm without adding much insight.

$o_e, o_w, o_m$  is the choice of becoming a entrepreneur, manager or worker, respectively. Obviously, only individuals with  $q = 1$  can choose  $o = o_e$ .

The individuals' occupational choices determine their current period pretax income  $\phi(x)$ , which is state dependent. This is determined endogenously not only by the individual's occupation decision but also by  $\mu$ , the distribution over individual states. More precisely,

$$\tilde{\phi}(q = 1, m, a, \epsilon) = \begin{cases} w\epsilon + ra & \text{if } o = o_w \\ W(m) + ra & \text{if } o = o_m, \end{cases}$$

and

$$\tilde{\phi}(q = 0, m, a, \epsilon) = \begin{cases} w\epsilon + p + ra & \text{if } o = o_w \\ W(m) + p + ra & \text{if } o = o_m \\ \pi(m, a) + ra & \text{if } o = o_e. \end{cases}$$

These incomes are subject to taxes and transformed into after-tax incomes that are occupation- and project-dependent. For reasons discussed in section 2.4 and also to facilitate characterization of the manager market, I assume that all progressivity falls on earnings according to an after-tax earnings schedule  $T(\cdot)$  that is strictly increasing; capital income and project sales are taxed at the flat rates of  $(\tau_k, \tau_p)$ , respectively. Also in line with section 2.4, I assume some leverage in tax-reporting for entrepreneurs. First, even if an individual chooses to become an entrepreneur, the wage she would have earned as a worker or manager is subject to the same progressive schedule  $T(\cdot)$ . Of the remainder of her income, if any,  $\psi$  of her income is reported as capital gains, taxed at a rate of  $\tau_g$ , and  $1 - \psi$  as business income, taxed at a rate of  $\tau_b$ . To this end, define the function  $B(x)$  as

$$B(q, m, a, \epsilon) = q \cdot \max \left\{ 0, \pi(m, a) - \max \{ w\epsilon, W(m) \} \right\},$$

so  $B(x) = 0$  if  $q = 0$ .<sup>24</sup> Then, after-tax incomes can be written as

$$\phi(x) = T(\max \{ w, W(m) \}) + (1 - \tau_k)ra + \begin{cases} (1 - \tau_p)pq & \text{if } o \neq o_e \\ (1 - \tau_\psi)B(x) & \text{if } o = o_e. \end{cases}$$

where

$$\tau_\psi = \psi\tau_g + (1 - \psi)\tau_b,$$

the effective tax rate on business income.<sup>25</sup>

Individuals learn their individual states  $x = (q, m, a, \epsilon)$  at the beginning of each period. In the stationary distribution, aggregate states are irrelevant to the individual so the only source of uncertainty faced by the individual comes from next period's idiosyncratic states  $(q', m')$ . The individual's problem can be expressed recursively as follows. Given the price vector  $P = \{R, r, w,$

<sup>24</sup>In the calibration, the parameter  $\psi$  is exogenously set to the empirical ratio of capital gains and business income of the top income percentile.

<sup>25</sup>The conceptual mapping to the real world is as follows. Both wage income, which is reported on an employee's W-2 and recorded in their Schedule A tax returns, and business income, reported on self-proprietors' Schedule C returns, are taxed progressively. However, Schedule C income includes is subject to more business-related deductions which I want to capture by modeling  $B(x)$ .

$p, W(m)\}$ , an individual with the state vector  $x = (q, m, a, \epsilon)$  solves

$$\begin{aligned} V(x) &= \max_{a'} \{u(c) + \beta \mathbb{E} [V(x')|q, m, \epsilon]\} \\ \text{s.t. } c + a' &= \phi(x) + a \end{aligned}$$

where

$$\begin{aligned} &\mathbb{E} [V(x')|q, m, \epsilon] \\ &= \sum_{q'} \Omega(q, q') \cdot \Gamma(\epsilon, \epsilon') \cdot \left[ \chi V(q', m, a', \epsilon') + (1 - \chi) \int_{m'} V(q', m', a', \epsilon') F_m(dm') \right]. \end{aligned}$$

The occupation decision, which determines the state-dependent after-tax income  $\phi(x)$ , is explained in the next subsection.

### 3.2 Equilibrium

Given the setup, we can define a *stationary recursive competitive equilibrium (RCE)* as follows:

**DEFINITION 1** A stationary RCE is defined as a collection of prices  $P = \{R, r, w, p, d, W(m)\}$ , policies  $c(x), a'(x)$ , factor decisions  $k(x), l(x)$ , occupational choices  $o(x)$ , incomes  $\phi(x)$ , and a distribution  $\mu(\cdot)$  such that

1. given  $P$ , the policies, occupational choices and production decisions solve the individual's problem,
2. intermediaries earn zero profit,
3. the manager market clears:  $\int_{q=1, o \neq o_e} \mu(dx) \geq \int_{o=o_m} \mu(dx)$  with equality if  $p > 0$ ,
4. capital and labor markets clear:

$$\begin{aligned} \int a(x) \mu(dx) &= \int_{o \in \{o_m, o_e\}} k(x) \mu(dx), \\ \int_{o=o_w} \epsilon \mu(dx) &= \int_{o \in \{o_m, o_e\}} l(x) \mu(dx), \end{aligned}$$

and the goods market clears by Walras' Law, and

5.  $\mu$  is a fixed point:

$$\mu = \mathcal{H}(\mu).$$

where  $\mathcal{H}$  is the aggregate law of motion induced by  $\Omega, F_m, \Gamma$  and the individuals' decisions.

Condition 2 is what implies  $R = r + \delta$  and  $p = d$ . Given  $(r, w)$  and  $\mu$ , the price of projects, managerial compensation and occupation decisions are jointly determined in the manager and labor markets. In turn, given the individuals' occupation decisions,  $(r, w)$  and  $\mu$  are determined by the production-consumption-savings decisions in the capital, labor and goods markets.

The manager market is in fact an agglomeration of two markets: a project exchange market and a manager hiring market. However, since the intermediary will only purchase projects for which a manager will be hired, the demand for projects equals the demand for managers so that the two markets are linked by the single market clearing condition 3. Specifically, two things happen in the manager market. First, individuals with  $q = 1$  decide whether to keep or sell their

project given the price  $p$ , and the intermediary makes its purchases. Second, the intermediary hires managers and individuals make their occupation choices given the competitive wage  $w$  and managerial compensation schedule  $W(m)$ .

Since projects are assumed to completely depreciate after one period, we can separately analyze the manager market from the agents' dynamic decisions. In other words, given  $(r, w)$ , the manager market is static and all the dynamics are determined by the agents' consumption-savings decisions in the capital and goods market as in standard Bewley models. This is a great simplifying step of the model, as it not only allows separate analysis of the manager market but also simplifies the numerical problem. Whenever managers exist in a RCE, I will call this a *managerial equilibrium*. It turns out that any RCE is necessarily a managerial equilibrium as long as  $\kappa \in [0, 1)$ . I first characterize the managerial equilibrium to establish existence of the stationary RCE. This will also illustrate how the model can describe the empirical facts laid out in section 2.

**Managerial equilibrium** Given the price vector  $(r, w)$ , the price of projects and managerial compensation schedule  $(p, W(m))$  are determined in the manager market. In this market, individuals take prices  $(p, W(m))$  as given and make their occupation decisions, and those with  $q = 1$  also decide whether or not to sell their projects. The intermediary purchases those projects and hire managers to run them. Effectively, the intermediary is merely playing the role of a central auctioneer between project sellers and managers. Let  $Q$  denote the mass of projects purchased by the intermediary. For manager market clearing, the mass of managers hired  $M = Q$ . Clearly,  $Q > 0$  in a managerial equilibrium. I first assume this and then show when it holds, i.e. the conditions for the RCE to be a managerial equilibrium. In equilibrium, individuals sell their project only if  $p \geq 0$ . When  $p = 0$  they are indifferent between selling and discarding. So there are two possible types of equilibria:<sup>26</sup>

$$p > 0 \quad : \text{ no projects are discarded} \tag{1a}$$

$$p = 0 \quad : \text{ a non-negative mass of projects are discarded.} \tag{1b}$$

Since all projects are identical,  $p > 0$  in equilibrium implies that the demand for projects meets supply. If  $p = 0$ , individuals are indifferent between selling and discarding and some projects are discarded due to excess supply. Either case is possible depending on equilibrium managerial compensation.

Individuals who keep their project choose  $o = o_e$ , so they do not participate in the manager market. Hence the pool of available managers is  $\int_{\{q=0\} \cup \{q=1, o \neq o_e\}} \mu(dx) \geq M$ . These individuals have either never had or no longer own a project, and their asset levels are irrelevant to their decisions, i.e. their decisions only depend on  $m$ . The mechanism I use to assign managers to projects is equivalent to the one analyzed in [Sattinger \(1979\)](#), recently applied to CEO markets in [Tervio \(2008\)](#) and [Gabaix and Landier \(2008\)](#). The assumption that the progressive after-tax schedule  $T(\cdot)$  is levied only on earnings and is strictly increasing is useful here, since the decision between becoming a worker or manager does not depend on taxation and we need only focus on pretax earnings.

Perfect competition implies that the agents with the highest ability are hired as managers, as in the original Lucas span-of-control model. Hence there is an ability threshold  $\hat{m}$  such that  $o = o_w$  if  $m \leq \hat{m}$  and  $o = o_m$  if  $m > \hat{m}$ . At the threshold, it must be that  $W(\hat{m}) = w\epsilon_1$ , where  $\epsilon_1$  is the lowest possible realization of  $\epsilon$ . The only difference from the Lucas model is that the competitive

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<sup>26</sup>When  $p = 0$ , it does not matter who is discarding the project (it could also be that the transfer occurs, but the intermediary discards it), so long as it is not being used in production.

wage, which serves as the reservation wage for individuals who become managers, is multiplied by  $\epsilon_1$ . This is because the ergodicity assumption ensures that there always exists an individual with  $\epsilon_1$  for any level of  $m$ , and the manager market is not segregated by  $\epsilon$ . All other managers earn returns proportional to their contributions, hence

$$\begin{aligned} W(m) &= w\epsilon_1 + \int_{\hat{m}}^m \pi^{*'}((1-\kappa)\tilde{m})d\tilde{m} \\ &= w\epsilon_1 + (1-\kappa) [\pi^*(m) - \pi^*(\hat{m})], \end{aligned}$$

due to the linearity of  $\pi^*$ . The return the project generates for the intermediary,  $d$ , is determined at the threshold level:

$$d = p = (1-\kappa)\pi^*(\hat{m}) - w\epsilon_1. \quad (2)$$

The remaining task is to determine the threshold  $\hat{m}$ . First, individuals implement their project, or equivalently  $o = o_e$ , if their after-tax income is higher:

$$(1-\tau_\psi) \cdot B(x) \geq (1-\tau_p)p.$$

Second, from equations (1) and (2) above,  $(p, \hat{m})$  must satisfy

$$\begin{aligned} \text{if } p > 0: & \quad (1-\kappa)\pi^*(\hat{m}) = w + p \quad \text{and} \quad g(1) - \int_{o=o_e} \mu(q=1, dm, da, d\epsilon) = \int_{o=o_m} \mu(dx) \\ \text{if } p = 0: & \quad (1-\kappa)\pi^*(\hat{m}) = w \quad \text{and} \quad g(1) - \int_{o=o_e} \mu(q=1, dm, da, d\epsilon) \geq \int_{o=o_m} \mu(dx) \end{aligned}$$

where  $g(1)$  is the total mass of projects that is exogenously assumed. When  $p = 0$ , we are at a corner where individuals are indifferent between selling or discarding the project, and just enough projects are sold to clear the supply of managers.

The prices  $(p, W(m))$  and threshold  $\hat{m}$  jointly determine the individuals' occupation decisions and hence current period after-tax income  $\phi$ . When  $p > 0$ , we can now express the manager market clearing condition as

$$\int_{o=o_w} \mu(q=1, dm, da, d\epsilon) = \int_{\hat{m}} \mu(q=0, dm, da, d\epsilon), \quad (3)$$

i.e., the mass of individuals with  $q = 1$  that become workers must equal the mass of individuals with  $q = 0$  that become managers. Otherwise there is excess supply of projects and  $p = 0$ .

Individuals' occupation choices and  $\mu$  are depicted in figure 13, for any given level of  $\epsilon$ . The dark gray, light gray and gray regions are the individuals who choose  $o = o_w, o_m$  and  $o_e$ , respectively. Figure 13(b) is straightforward: individuals with  $q = 0$  discard their project and become a worker if  $m < \hat{m}$ , and become a manager otherwise. Next refer to figure 13(a). The lower threshold,  $\hat{\hat{m}}$ , is the managerial ability threshold such that conditional on being unconstrained, an individual with  $q = 1$  sells (discards) her project and becomes a worker, i.e.

$$\pi^*(\hat{\hat{m}}) = w + p.$$

For  $m \in [0, \hat{\hat{m}})$ , all individuals sell (or discard) their projects and become workers regardless of their asset levels. For  $m \in [\hat{\hat{m}}, \hat{m})$ , the asset threshold is decreasing in  $m$  because holding the level



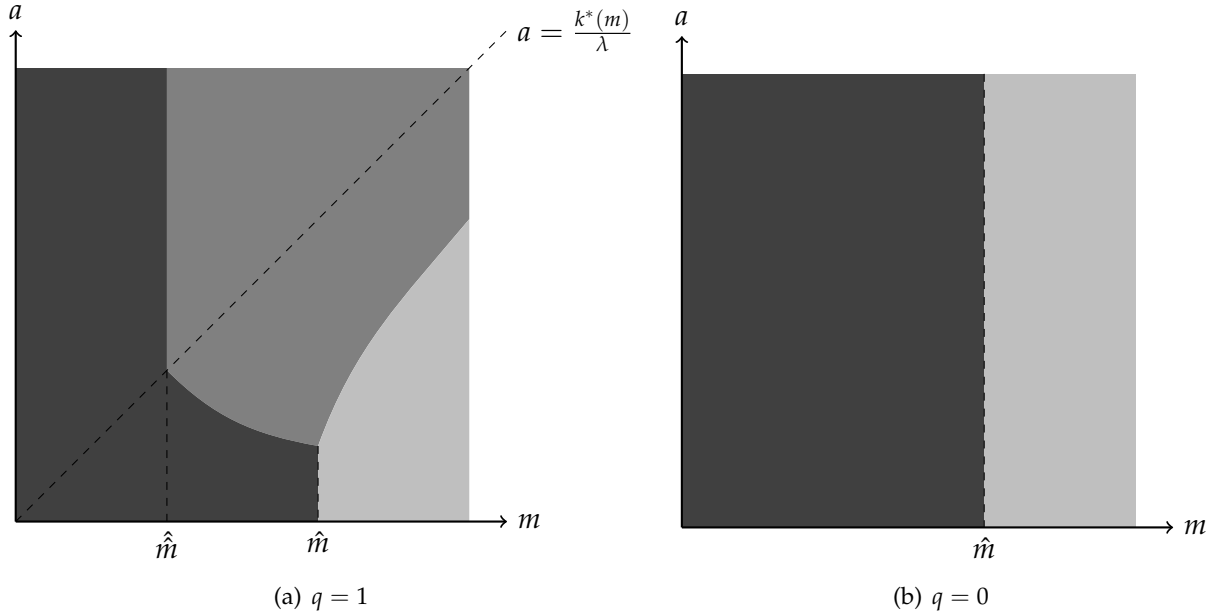


Figure 13: Occupation decision thresholds

of assets fixed, selling (or discarding) the project and becoming a worker gives a constant return while the returns from becoming an entrepreneur increase in  $m$ . However, for  $m \geq \hat{m}$ , managerial compensation increases more than would profits for a constrained entrepreneur. Hence the threshold is increasing in  $m$ .<sup>27</sup>

The manager market clearing condition (3) means that the mass of individuals in the dark gray region of Figure 13(a) (for all values of  $\epsilon$ ) must equal the mass of individuals in the light gray region of Figure 13(b) (for all values of  $\epsilon$ ).<sup>28</sup> Individuals in the light gray region of Figure 13(a) sell their project (supply) and become managers (demand), so this mass becomes irrelevant for market clearing. We can now show that managers must exist in any equilibrium:

**PROPOSITION 1** *Given any  $(r, w)$  and a distribution  $\mu$  over individual states  $x$ ,*

1. *As long as  $\kappa \in [0, 1)$ , managers exist in any RCE, i.e. any RCE is a managerial equilibrium.*
2. *Occupation decisions are such that*

$$o(q = 1, m, a, \epsilon) = \begin{cases} o_w & \text{if } m \leq \hat{m} \text{ and } (1 - \tau_\psi) \cdot [\pi(m, a) - w\epsilon] \leq (1 - \tau_p)p, \\ o_m & \text{if } m > \hat{m} \text{ and } (1 - \tau_\psi) \cdot [\pi(m, a) - W(m)] \leq (1 - \tau_p)p, \\ o_e & \text{otherwise,} \end{cases} \quad (4)$$

$$o(q = 0, m, a, \epsilon) = \begin{cases} o_w & \text{if } m \leq \hat{m} \\ o_m & \text{if } m > \hat{m}. \end{cases}$$

<sup>27</sup>The convexity of the asset thresholds depend on parameter values, and figure 13 is drawn according to the calibrated parameters.

<sup>28</sup>This does not mean that the areas depicted in the figures must be equal.

where

$$\tau_\psi = \psi\tau_g + (1 - \psi)\tau_b.$$

**Proof:** See Appendix A. □

If  $\kappa \geq 1$ , we revert to the case of standard entrepreneurial models - individuals become entrepreneurs if entrepreneurial profits are high enough given their collateral constraints, or discard their project and become wage workers otherwise. In either case, a stationary RCE uniquely exists. Stationary distributions are the object of interest in most Bewley-type models, and existence is guaranteed under quite general assumptions. These assumptions also apply to my case with slight modifications:

**PROPOSITION 2** *If  $u(\cdot)$  is CRRA, a stationary RCE exists.*

**Proof:** See Appendix A. □

Given that an equilibrium exists, I use numerical techniques to compute it and conduct quantitative policy experiments. Section 4 summarizes the numerical strategy and Section 4.2 discusses the results. Before turning to the numerical analysis, however, I point out several novel aspects of the model.

### 3.3 Accounting for Separate Sources of Income

The framework presented thus far is suitable for my purposes in many ways. First, by separating entrepreneurs and managers, I can separately account for wage and business incomes at the high end of the distribution. In addition, if there is only a small mass of corporate firms, managerial compensation is small regardless of firm size. Only when there is a large mass of corporate firms do we see large levels of compensation.

This is particularly important when individuals with  $q = 1$  and  $m > \hat{m}$  make their decision between becoming an entrepreneur or manager. Notice from (4) in proposition 1 that it is *not* the case that this decision directly depends on the progressivity of the earnings tax schedule. This is because regardless of the occupation choice, that amount is equally taxed progressively as earnings anyway. It is only when managerial compensation  $W(m)$  becomes higher *in equilibrium* that the occupational choice may switch. That is, the most important role of progressive taxation in terms of top occupations is whether it increases the mass of managers in equilibrium, increasing *pretax* managerial compensation, not that it affects the *after-tax* earnings.

For accounting purposes in the calibration, I divide the sources of income in the simulated model into four categories: capital, wage, business, and capital gains. Capital income in the model corresponds directly to interest income earned through savings, *ra*. All individuals, regardless of occupation, earn wage incomes of  $\max\{w\epsilon, W(m)\}$ . For entrepreneurs, only a portion  $1 - \psi$  of the remainder  $B(x)$  is accounted for as business income, while the rest is accounted for as capital gains. Because it is hard to find an empirical counterpart for the returns earned by selling a project, I also assume that the proceeds from selling a project, *p*, is accounted for as capital gains. This is the return from having been lucky enough to have a project, which could be interpreted as the returns to an “idea.” Since I assume it is capital gains, it is taxed at the capital gains tax rate  $\tau_p = \tau_g$ . Moreover, it is excluded when computing income shares which are based on pretax incomes excluding capital gains following the empirical work of Piketty and Saez (2003).

Now suppose that we are at an equilibrium given a certain level of taxes, and consider how a less progressive earnings tax policy would alter the equilibrium. Since managers are the ones

who potentially earn superstar wages, the supply of managers increases. This supply must be met by demand in equilibrium, so the size of the corporate sector increases, leading to a higher concentration of earnings. How much of this mechanism can account for historical shifts in the earnings, income and wealth distribution is the goal of the quantitative section.

### 3.4 Modeling Choices

Besides progressive taxation, the main mechanisms of the model are the entrepreneurial collateral constraints and the competitive assignment between projects and managers. Since output increases in managerial ability, when  $\kappa = 0$  the unconstrained planner's solution has the best managers running all the projects regardless of ownership, thus the competitive assignment component is efficient. On the other hand, even when  $\kappa > 0$  the economy is more efficient than one without a manager market, i.e. standard entrepreneurial models with collateral constraints. Hence, in terms of efficiency, my model with collateral constraints and a friction  $\kappa$  in the manager market falls somewhere in between the unconstrained planner's solution and previous entrepreneurial models.

Rather than an assignment friction,  $\kappa$  can also be viewed as an inefficiency in corporate production. Most relevantly, it may include corporate income taxation on corporate profits, which has also become much less progressive throughout the past half century, as already shown in figure 7. To the extent that most large corporations face the top marginal tax rate, any effect that may come from a declining rate would be indistinguishable from a drop in  $\kappa$ . Therefore, both because I let  $\kappa$  vary across years, and to maintain the focus on personal income tax policies, I do not separately model corporation income taxation.

One may also question why I do not incorporate multiple project qualities. For example, with a continuum of qualities the manager market becomes identical to those in [Tervio \(2008\)](#); [Gabaix and Landier \(2008\)](#) and others. This would add an additional dimension of inequality and, consequently, can generate higher concentrations of earnings, income and wealth. However, not only would this increase the "curse of dimensionality" in computation, but it also raises conceptual issues. The additional dimension of inequality would stem from the income earned from selling projects, and it then becomes unclear which source of income this corresponds to in the data. It also becomes undesirable to assume that projects are purely exogenous shocks. Pursuing this direction is left for further research.

In order to study inequality, ideally I should incorporate the individuals' labor supply decisions. I abstract from this for two reasons. The first is that endogenous labor supply can hardly explain the degree of income and wealth concentration we observe in the data (e.g. [Castañeda et al. \(2003\)](#)), and therefore would add little to the main focus of the paper. The second is that the focus of the paper is to study the occupation choices of a specific group of individuals typically at the high end of the distribution. While labor supply decisions are suitable for studying the behavior of the median agent, it seems reasonable to assume that the entrepreneur-manager choice at the top is relatively unaffected by the hours decision.<sup>29</sup>

## 4. Quantitative Analysis

I first obtain the benchmark model parameters by calibrating a stationary equilibrium to empirical moments from 1970. Then holding all other parameters at their 1970 values, I recalibrate only those

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<sup>29</sup>A third and obvious reason is, again, for simplicity - adding an additional choice variable would enrich the individual's problem, but the general equilibrium becomes intractable analytically and unnecessarily expensive numerically.

parameters that directly govern the mass of entrepreneurs and managers, and the progressivity of the earnings tax schedule, to match a subset of empirical moments from 2000. The reason I let some parameters other than tax progressivity vary is because the model mechanism depends entirely on the shift in the mass of entrepreneurs versus managers. By letting those parameters that directly govern the mass of occupations change simultaneously, I can verify whether it is indeed the change in tax policy that causes the change in the relative masses of occupations and not something else unrelated to tax progressivity. I explain how this is done in more detail below.

Continuing to hold all model parameters at their 1970 benchmark values, I conduct several counterfactual experiments. First, I tabulate results from a hypothetical stationary equilibrium with flat taxes to demonstrate the qualitative effects of changes in tax progressivity. This shows that while flatter taxes indeed lead to even higher income concentration than in the 2000 benchmark, wealth concentration is in fact lower. Second, I focus on the quantitative effects of varying the parameters  $\lambda$  and  $\kappa$ . In particular, I systematically set  $\kappa = 1$  (economy with only entrepreneurs) or  $\lambda = 0$  (economy with only managers). These results further illustrate that previous models would fail in delivering my quantitative results. In both economies, there is a positive correlation between the concentrations of earnings, income and wealth.

Lastly, I compute transition path from the 1970 stationary equilibrium to the new 2000 equilibrium with less earnings progressivity to show that the concentration of wealth follows a U-shaped pattern, and to compute the welfare gains (loss). For the latter, I also try several different scenarios for the timing of the shocks.

The numerical problem is nonstandard in the sense that there are three market clearing variables we must keep track of,  $\{r, w, \hat{m}\}$ . This is a challenging task, in particular when computing the transition. To deal with this, I apply a guessing method to [Ríos-Rull \(1997\)](#) to conserve on computation time. See appendices [C](#)-[D](#) for the details of the numerical procedure. When interpreting distributional moments, keep in mind that all computations are based on pretax income, both in the data and in the model.

## 4.1 Calibration

My approach is to use a parsimonious version of the model to reduce the number of parameters to be calibrated from the model and focus only on the data moments of interest. Before I discuss how the parameters are calibrated within the model, I first add some discipline to parametric forms and explain which parameters are exogenously taken as given.

**Preferences and Technology** The utility function is standard and parametrized as

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma}.$$

Relative risk aversion is fixed at  $\gamma = 2$ , which is in the range of values consistent with previous studies. The discount factor  $\beta$  is calibrated to an equilibrium interest rate of 4% in 1970.

Capital-labor income shares and the depreciation rate are taken from conventional values in the real business cycle literature and fixed at  $\alpha = 0.30$  and  $\delta = 0.06$ , respectively.<sup>30</sup> This leaves  $\nu$  as a parameter to calibrate from the model. The collateral constraint  $\lambda$  along with the friction

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<sup>30</sup>These values are identical to those in [Buera et al. \(2011\)](#). In their model, factor shares are approximately equal to factor elasticities when capital markets are perfect and the equilibrium mass of entrepreneurs is small (their proposition 2). My model is slightly different, but nonetheless, the capital share is close to  $\alpha = 0.30$  in the calibration.

Parameter	Value	Description
$\gamma$	2.00	Coefficient of Relative Risk Aversion
$\delta$	0.06	capital depreciation rate, <a href="#">Buera et al. (2011)</a>
$\alpha$	0.30	capital income share of total output, <a href="#">Buera et al. (2011)</a>
$\rho$	0.95	<a href="#">Storesletten et al. (2004)</a>
$\chi$	0.89	CEO turnover rate 1990-2000, <a href="#">Murphy and Zabojnik (2007)</a>
$s$	1.00	size distribution of firms, <a href="#">Axtell (2001)</a>
$g(1)$	0.13	population share of management, IPUMS CPS March 1970

Table 2: Fixed Parameters.

These seven parameters are fixed before calibrating the rest of the parameters to empirical moments in 1970. The last parameter, the fraction of management, is the only parameter allowed to change when recalibrating the model to 2000, of which value is shown in table 5.

parameter  $\kappa$  are critical parameters that affect the relative mass of entrepreneurs and, hence, the relative mass of managers in the high income groups; these are also calibrated from the model.

**Exogenous Processes** I assume that the  $q$  and  $m$  processes are independent, as assuming correlations of up to 0.5 did not have any visible effects. The Markov transition matrix for projects,  $\Omega$ , gives us two parameters to calibrate:

$$\Omega = \begin{pmatrix} \omega_0 & 1 - \omega_0 \\ 1 - \omega_1 & \omega_1 \end{pmatrix}.$$

Managerial ability  $m$  dictates the size of firms in the model, which corresponds to an establishment in the data. As the empirical distribution of establishments is well approximated by a Pareto distribution ([Axtell, 2001](#)), I assume that  $m$  is also drawn from a Pareto distribution as in [Buera and Shin \(2013\)](#). I assume a “shifted” Pareto distribution with shape parameter  $s$ :

$$F(m) = \frac{1 - (1 + m)^{-s}}{1 - (1 + \bar{m})^{-s}}$$

so that the lowest ability manager has zero productivity.<sup>31</sup>

My model focuses on the differentiation between entrepreneurs and managers, and particularly relevant are the equilibrium masses of each occupation. Along with the friction parameters  $(\lambda, \kappa)$ , the persistence parameters  $(\omega_0, \omega_1, \chi)$  and ability parameters  $(s, \bar{m})$  govern the distribution and the relative mass of different occupations. They also determine the sources of income within and relative income between different income groups. Since all firms come from projects, I fix  $g(1) = \frac{1 - \omega_0}{2 - \omega_0 - \omega_1}$ , the population share of management (entrepreneurs plus managers) in the model, at 13.1% in 1970 and 17.7% in 2000, the population share of management in the CPS.

The probability that  $m$  does not change,  $\chi$ , is fixed at 0.887 according to [Murphy and Zabojnik \(2007\)](#), who report that the average CEO turnover rate from 1990-2000 is 11.3%. The Pareto shape

<sup>31</sup>The ability of a manager is not to be confused with the ability of a worker. Models with human capital typically assume that workers have lognormal abilities. This is motivated by the assumptions that human capital has a fixed proportional relationship with abilities and that wages are proportional to human capital. Under these assumptions, abilities should follow the wage distribution, which is well approximated by a lognormal distribution. However, managerial abilities in my model represent the productivity of the firm, or establishment, not the worker. Hence managerial abilities should follow the establishment size distribution.

parameter  $s$  is fixed to 1, following [Axtell \(2001\)](#).<sup>32</sup> The maximum value  $\bar{m}$  is fixed at 1000. This means that I miss the top 0.1% of the highest abilities if  $F$  were instead an unbounded Pareto distribution. This value is chosen purposefully because the purpose of the model is to explain the behavior of the top 1% compared to the median; I do not claim that the model can explain the behavior of the top 0.1% compared to the top 1%. As well-documented in [Saez and Zucman \(2014\)](#) and elaborated in section 2.4, wealth accumulation patterns again diverge at the very top, and further assumptions would be needed to explain this behavior quantitatively.

The idiosyncratic labor efficiency shocks  $\epsilon$  do not play a major role in my model, but create realistic variation in the lower income groups and also facilitate numerical clearing of the labor market in the calibration. As such, I assume that idiosyncratic labor efficiency shocks are independent of the managerial ability shocks.<sup>33</sup> The Markov transition matrix for these shocks are a discretized version of the  $AR(1)$  process

$$\log \epsilon' = (1 - \rho)\mu_\epsilon + \rho \log \epsilon + \varepsilon,$$

where  $\rho$  is the persistence in labor efficiency,  $\varepsilon \sim \mathbb{N}(0, \sigma_\varepsilon^2)$  and  $\mu_\epsilon = -\frac{\sigma_\varepsilon^2}{1-\rho^2}$  so that mean labor efficiency is normalized to 1. The discretization is done according to [Rouwenhorst \(1995\)](#), which [Kopecky and Suen \(2009\)](#) show to be more accurate than the more commonly used quadrature-based method of [Tauchen and Hussey \(1991\)](#) for persistent processes. The persistence of labor efficiency,  $\rho$ , is fixed at 0.95. This is close to estimates from [Storesletten et al. \(2004\)](#).

This leaves us with one free parameter,  $\omega_1$ , to be calibrated within the model. I separately calibrate two different values of  $\omega_1$ , one each for the years 1970 and 2000. All the fixed parameters up to now are summarized in table 2.

**Tax Variables** While there are empirical tax functions calibrated to specific points in time, such as [Guner et al. \(2013\)](#); [Guvenen et al. \(2014\)](#), to the best of my knowledge, the only study which provides a time series of such functions is [Gouveia and Strauss \(1994, 2000\)](#). However, they only provide functions up to 1989. So for the progressive earnings tax schedule, I calibrate the parametrized average tax rate function of [Guvenen et al. \(2014\)](#) separately to 1970 and 2000, which, with the largest number of parameters among commonly used specifications ([Guner et al., 2013](#)), captures progressivity at the top very well. In particular, note that such a function should be calibrated *within* the model and not estimated separately from the data to be then applied to the model: since incomes are endogenous in my model, the latter method would lead to simulated average and marginal tax rates that are in fact different from the data.

The calibrated average tax rate ( $ATR$ ) function in year  $t$  is:

$$ATR^t(y) = \tau_0^t + \tau_1^t(y/w_t) + \tau_2^t(y/w_t)^{\tau_3^t},$$

where  $y$  is an individual's wage income, and  $w_t$  is the equilibrium competitive wage in the years  $t = 1970$  and 2000. In each year, the parameters are chosen to match

1. the average tax rate paid by the median tax payer is 21%, the average tax rate faced by the bottom 90% in [Piketty and Saez \(2007\)](#) for both years 1970 and 2000,

$$\tau_0^t + \tau_1^t + \tau_2^t = 0.21,$$

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<sup>32</sup>This is not very different from previous quantitative studies such as [Cagetti and De Nardi \(2006\)](#); [Buera et al. \(2011\)](#); [Buera and Shin \(2013\)](#) once we do the appropriate transformations of variables.

<sup>33</sup>[Allub and Erosa \(2014\)](#) find that the correlation between  $m$  and  $\epsilon$  are very weak in Brazilian data.

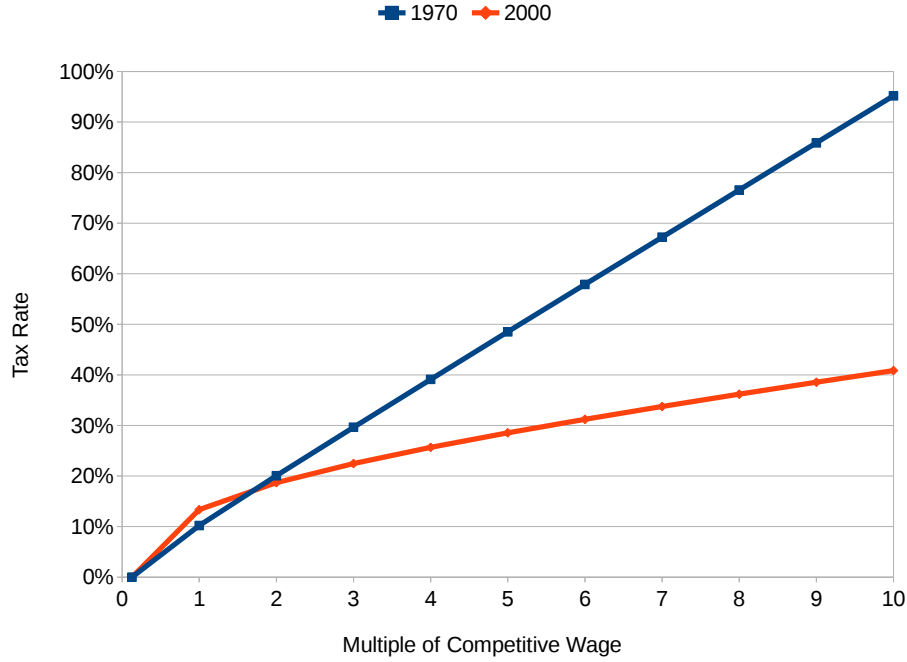


Figure 14: Calibrated earnings average tax rate functions, 1970 vs 2000.

- the marginal tax rate paid by the median tax payer is 20%, the average marginal tax rate in [Mertens \(2014\)](#) for both years 1970 and 2000,

$$\tau_0^t + 2\tau_1^t + \tau_2^t(1 + \tau_3^t) = 0.20,$$

- total taxes paid as a share of total income—not just wage income—equals 23.3% in 1970 and 27.4% in 2000 ([Piketty and Saez, 2007](#)).
- the share of total taxes paid by the top income percentile equals 18.4% in 1970 and 27% in 2000 ([Piketty and Saez, 2007](#)).

Since 1. and 2. give admits closed form expressions of  $(\tau_1^t, \tau_2^t)$  as functions of  $(\tau_0^t, \tau_3^t)$ , in practice I only calibrated the latter two to match 3. and 4. for the years 1970 and 2000, and let  $(\tau_1^t, \tau_2^t)$  adjust to satisfy 1.-2. Note that the average and marginal tax rates of the median tax payer are virtually the same in both years—not by assumption, but in the data. Also note that total taxes paid as a share of total income changes by only 4.1 percentage points between the years 1970 and 2000, so that government revenues are nearly neutral. Figure 14 plots these functions for the years  $t = 1970$  and 2000.

Since the time variation in equilibrium occupational choices will be affected by the relative taxes imposed on the different sources of income, I keep the the rest of the tax variables exogenously fixed as follows to isolate the effect of progressivity. Moreover, the aggregate average tax rates have only changed modestly compared to the top marginal tax rate, and as argued section 2.4, have not become more progressive.

Capital and business income tax rates  $(\tau_k, \tau_b)$  are taken from the effective marginal tax rates (EMTR) estimated by [Gravelle \(2007\)](#). I use the non-corporate EMTRs to tax business income

Parameter	Value	Description
A. Fixed outside the model		
$\tau_k$	0.36	tax rate on capital income, <a href="#">Gravelle (2007)</a>
$\tau_g$	0.26	tax rate on project sales income, average capital gains tax rate
$\tau_\psi$	0.24	effective tax rate on business income, see text
$\psi$	0.44	share of business income reported as capital gains, see text
B. Calibrated from the model		
$\tau_0$	0.11	total taxes paid as a share of total income = 23.3%
$\tau_1$	0.09	average tax rate of median tax payer = 20.5%
$\tau_2$	-0.10	marginal tax rate of median tax payer = 20.4%
$\tau_3$	-0.10	top income percentile share of taxes = 18.4%

Table 3: Tax Parameters.

The first four parameters are held fixed, while the latter four are calibrated to match four tax moments in 1970 as explained in the text. The latter four are also recalibrated to match tax characteristics in 2000, as show in table 5.

and total EMTR to tax capital income, both at their average values from 1970 to 2000. These are approximately 33% and 23%, respectively. Her estimates show that there has been some variation in the 1970s but not much since the 1980s.

Capital gains taxation is complex and so is its history, and while there is no particular time trend in the realized tax rates there is a high surge during the 1980s Reagan tax reforms. This is because an individual can leverage the tax rate she faces on her capital gains by timing its realization. Given that I do not explicitly model this behavior, I fix the capital gains tax rate  $\tau_g = \tau_p$  that is imposed on part of entrepreneurial profits and project sales for both 1970 and 2000. The average ex post realized tax rate from 1970 to 2000 is approximately 26%.

The parameter  $\psi$  which is included to match the ratio of capital gains and business income of the top 1%, of which average is 44% and changes by only 3-4 percentage points during the period 1970-2000 ([Piketty and Saez, 2003](#)). Consequently, the effective tax rate on  $B(x)$ , the entrepreneurs profits after accounting for her wage income, is  $\tau_\psi \approx 24\%$ . All the tax variables are summarized in table 3.

**Calibration Targets** The remaining six parameters are calibrated from the model so that the quantitative moments simulated from the model match six data moments from 1970, as summarized in table 4. The first four moments—the population share of managers, corporate share of capital, and top percentile shares of aggregate wealth and earnings—were discussed in section 2 and taken from those data sources. The first of two additional moments are the Gini coefficient of earnings, which I compute from the 1963 SCFF since a 1970 value is not available from any source. The value is slightly higher than what is found in other surveys (approximately 0.35-0.38), such as the Panel Study of Income Dynamics or the National Longitudinal Survey of Young Men which only begins in later years but also does not sample high income households. The annual interest rate of 4%, the commonly used value in the literature representing the average rate of return on all assets.

1. **Size parameters** ( $\omega_1, \kappa$ ). [Buera \(2008\)](#) shows how collateral constraints interact with the en-



Parameter	Value	Target	Data	Model
$\omega_1$	0.92	population share of managers (%)	9.8	8.7
$\kappa$	0.83	corporate share of capital (%)	47.7	47.7
$\lambda$	5.66	top percentile share of aggregate wealth (%)	27.6	27.6
$\nu$	0.47	top percentile share of aggregate earnings (%)	5.1	6.1
$\sigma_\varepsilon$	0.27	Gini coefficient of earnings (wage incomes)	0.44	0.44
$\beta$	0.97	annual interest rate (%)	4.0	4.0

Table 4: Parameters calibrated to 1970 moments

The first two parameters  $\omega_1$  and  $\kappa$  are recalibrated to match the population share of managers and size of corporate sector in 2000, as shown in table 5. The rest of the parameters are held fixed throughout the rest of the paper.

entrepreneurial savings motive in this class of models. Specifically, he shows the existence of a threshold where low ability entrepreneurs have no savings motive at all. In a similar environment, Moll (2014) shows that higher persistence in entrepreneurial ability leads to less capital misallocation, which implies higher degrees of wealth concentration. Given the fixed values of managerial ability persistence  $\chi = 0.887$  and population share of management  $g(1) = 13.1\%$ , this implies that a higher persistence in  $q$ —i.e. a large  $\omega_1$ —leads to more entrepreneurs. On the other hand, managers naturally have a larger span-of-control of capital with smaller assignment frictions  $\kappa$ . Hence these two parameters are calibrated to the equilibrium population share of managers and corporate share of capital.

- Collateral constraint and worker wage income share** ( $\lambda, \nu$ ). Since I want to explain the dynamic relationship between earnings and wealth concentration, it is important that the model captures their static magnitudes. The two parameters ( $\lambda, \nu$ ) are chosen to match the top percentile concentrations of earnings and wealth. The severity of the collateral constraint  $\lambda$  dictates the need for individuals to accumulate wealth to either start a business when they receive the project shock ( $q = 1$ ) or continue an already running business.<sup>34</sup> On the other hand, all individuals generate earnings in my model, but the size of entrepreneurial and managerial earnings are generated by the managerial ability shock  $m$ , while wage workers' earnings shares are determined by  $\nu$ . Since entrepreneurs and managers earn the highest earnings, smaller values of  $\nu$  increase the concentration of earnings. The calibrated values of  $\lambda$  and  $\nu$  are similar to Cagetti and De Nardi (2006); Buera and Shin (2013).
- Variance of labor efficiency shock** ( $\sigma_\varepsilon^2$ ). As discussed earlier, this parameter is not so important for the model per se, but creates some realistic variation among wage workers and facilitates labor market clearing in the quantitative implementation.

I find the above six parameters along with  $(\tau_0^{1970}, \tau_3^{1970})$  by a bounded local optimization routine developed in Powell (2009), a derivative-free algorithm using quadratic interpolation and trust regions, in the neighborhood of a set of parameters found by accelerated random search, which finds global optima. For each iteration,  $\beta$  is chosen so that the equilibrium interest rate equals 4%.

Holding fixed the benchmark model parameters, I recalibrate i)  $\omega_1$  to match the equilibrium mass of entrepreneurs and managers, ii)  $\kappa$  to match the corporate share of capital, and iii) the earnings tax function parameters to match total taxes paid as a share of total income and the share of taxes paid by the top income percentile in 2000. In particular,  $\omega_1$  needs to be recalibrated

<sup>34</sup>In fact, I calibrate the model so that all entrepreneurs are constrained.

Parameter	Value	Target	Data	Model
$g(1)$	0.18	population share of management, IPUMS CPS March 2000		
$\omega_1$	0.95	mass of managers (%)	15.3	12.9
$\kappa$	0.80	size of corporate sector (%)	67.7	66.4
$\tau_0$	0.66	total taxes paid as a share of total income (%)	27.4	25.4
$\tau_1$	0.02	median average tax rate (%)	20.5	20.5
$\tau_2$	-0.55	median marginal tax rate (%)	20.4	20.4
$\tau_3$	-0.10	top income percentile share of taxes (%)	27.7	30.2

Table 5: Parameters recalibrated to 2000 moments

When the model is recalibrated to 2000, all other parameters are held fixed as described in tables 2-4. The population share of management,  $g(1)$ , is exogenously fixed, and only the remaining 6 are recalibrated.

because the population share of management  $g(1)$ , which is a function of  $(\omega_0, \omega_1)$ , is exogenous changed to its empirical value in the CPS so that without recalibrating, we would be implicitly changing the value of  $\omega_0$  for no reason. Since  $g(1)$  is changed exogenously and  $(\tau_1, \tau_2)$  are implicit functions of  $(\tau_0, \tau_3)$ , I only need to recalibrate the four parameters  $(\omega_1, \kappa, \tau_0, \tau_3)$ , for which I again use Powell (2009)'s bounded optimization routine.

The calibration performs well except that the population share of managers is slightly off. This is because when discretizing the model for numerical implementation, small increases in the total managerial ability of entrepreneurs and managers create discrete jumps in labor demand. This makes labor market clearing difficult, which I can work around by assuming the labor efficiency shocks. Instead, it becomes difficult to control the population split between entrepreneurs and managers in very small increments, which also hampers somewhat an exact calibration of the concentration of earnings.

## 4.2 Results

I show the main results from the model in a series of steady state comparisons (tables (6)-(9)). Figure 16 shows the trajectory of top percentile wealth concentration along the benchmark transition path, and table (10) shows the change in utilitarian welfare accounting for this transition.

**Top percentile concentrations.** Note that I do not directly target any (total) income statistics, nor the composition of the top income percentile, so the performance of the model can also be measured by how well it fits these moments. The first two columns of table (6) compares the top percentile concentrations of wealth, earnings and income in the data and the model. The model can explain almost all of these moments with the exception of the top income percentile share in 1970. Nonetheless, it still captures approximately 1/3-1/4 of its change from 1970 to 2000.

The model almost perfectly replicates the top percentile shares of wealth, earnings and income for 2000. This is not a trivial result: recall that for the 2000 calibration, I only target the population share of managers and corporate share of capital, not any distributional moments. In contrast, for 1970, the wealth and earnings concentration moments are targeted. The result is that top income concentration is too high compared to the data. This is not unexpected, since the changes come from rich entrepreneurs being replaced by rich managers in the top income percentile (this is further discussed below). Managers earn most of their income through wages while entrepreneurs

		1970	2000	no tax change	only tax change
Wealth	Data	27.6	34.1		
	Model	27.6	33.7	48.9	29.2
Earnings	Data	5.1	12.3		
	Model	6.1	11.9	6.0	11.8
Income	Data	7.8	16.5		
	Model	14.0	16.4	17.9	16.0

Table 6: Top percentile concentrations of wealth, earnings and income.

The data moments for wealth are from [Saez and Zucman \(2014\)](#), and for earnings and income from [Piketty and Saez \(2003\)](#). My calibration procedure targets the wealth and earnings moments, but not income. “No tax change” refers to the case when only  $(g(1), \omega_1, \kappa)$  are varied while the average tax function remains the same. “Only tax change” is the exact opposite.

also earn business income. Since some entrepreneurs who are relegated to lower income fractiles in 2000 still have higher capital and business incomes than the top managers who earn most of their income through wages (managerial compensation), the occupational shifts are more strongly reflected in a the concentration of earnings than total income.

In order to resolve this problem, I would need to assume multiple project qualities. This would push up the wages of managers through stronger assortative matching in the manager market (best managers get matched with better projects), while many entrepreneurs would be forced to use their own low managerial ability even if they have a high quality project (and vice versa). But since the calibration would still require that the entrepreneurs remain in the top income percentile for 1970 (otherwise the earnings concentration would be too high), the degree of income concentration would be lower. However, pursuing this direction creates other concerns as discussed in section 3.4, and is left for future research.

In the third column of table 6, I keep the parameters of the progressive average tax rate function on earnings  $(\tau_0, \tau_1, \tau_2, \tau_3)$  constant at their 1970 values, while only changing  $[g(1), \omega_1, \kappa]$  to their 2000 values. In the fourth column, I do the exact opposite. This is to confirm whether the shifts in top percentile concentrations are explained by a policy or environment change. The results are clear. Even with no change in the environment, less progressive taxation alone delivers the same qualitative picture observed in the data; in fact, it is almost identical to the model benchmark 2000 moments quantitatively as well. In contrast, if only the environment were to have changed, there would be virtually no change in earnings concentration associated with a massive increase in wealth and income concentration.

**Rise of managers.** Table 7 shows that the time trends in top percentile concentrations reflect the shift in occupations at the top. Of course, both the population share of managers and corporate share of capital were targeted in both years, so what is important in the first two columns is that this leads to an almost 4-fold increase in the size of the top manager’s compensation compared to the competitive wage,  $W(\bar{m})/w$ . This confirms that as managers become more prominent in the equilibrium, the competitive assignment mechanism pushes up their wages to the extent that they replace entrepreneurs at the top. However, both the levels (only 1/3 in 1970) and change (more than 10-fold increase in the data) are still small compared to the data. Again, having multiple

		1970	2000	no tax change	only tax change
Mass of Managers	Data	9.8	15.3		
	Model	8.7	12.9	12.7	9.1
Corporate K-Share	Data	47.0	67.0		
	Model	47.0	66.4	53.1	58.6
Top Manager vs Wage Worker	Data	29.7	342.2		
	Model	9.8	35.3	9.6	36.8

Table 7: Managers, corporate capital, and executive compensation.

The data for the population share of managers and corporate share of capital is from the CPS and Federal Flow of Funds accounts, respectively. In the model, the former is a result of the equilibrium occupation allocation. The latter is the share of capital operated by hired managers. The top manager-wage worker ratio in the data refers to the ratio between the compensation for the rank 100 CEO in the Forbes survey, and annual wage in the NIPA accounts. In the model, it is the ratio between the compensation for the highest ability manager (with  $\bar{m}$ ) and the competitive wage,  $w$ . "No tax change" refers to the case when only  $(g(1), \omega_1, \kappa)$  are varied while the average tax function remains the same. "Only tax change" is the exact opposite.

project qualities would potentially resolve this problem, as demonstrated in [Gabaix and Landier \(2008\)](#).

The effect is even greater when one recalls that all computations are based on pretax income and not after-tax income. In a partial equilibrium model with taxes, it is obvious that a decrease in taxes will lead to higher after-tax compensation. However, holding managerial ability fixed, lower taxes would result in *lower* levels of pretax compensation. This is depicted in figure 15, which visualizes the supply and demand for managers of a fixed ability. Partial equilibrium effects occur as movements *along* the supply and demand curves without the curves themselves shifting. But in this economy, the general equilibrium effects are such that both the supply and demand curves shift upward, so that even pretax compensation rises to higher levels with lower taxes. Therefore, even a small rise in  $W(m)/w$  can shadow a much larger increase in the mass of individuals who become managers for any given ability level. In figure 15, this is depicted as a small rise in pretax compensation,  $W_L^P - W_H^P$ , associated with a large increase in the equilibrium mass of managers,  $M_L - M_H$ , for a given managerial ability level.<sup>35</sup> The figure also illustrates that what matters for the model is not the marginal tax rates faced by an individual facing the decision between becoming an entrepreneur or manager—this was already seen in equations 4—but the equilibrium level of entrepreneurial profits vs managerial compensation.

The second two columns of table 7 show the moments when either keeping the policy or environmental parameters constant. Let us first focus on the last column. Consistently with table 6, the moments confirm that less progressive taxation generates an increase in the population share of managers and corporate capital share—even though the total mass of management,  $g(1)$ , and assignment friction,  $\kappa$ , are held constant at their 1970 levels—associated with a 4-fold increase in  $W(\bar{m})/w$ . In fact, the value is even larger than in the 2000 benchmark, meaning that the relative equilibrium prices of  $(w, r)$  are even more favorable for managers despite the smaller increase in their mass.

The third column is not as simple. On the one hand, we would expect a rise in  $g(1)$  and drop

<sup>35</sup>Of course, for such a thought experiment to work the chosen ability level must still lie above  $\hat{m}$ , the ability threshold for becoming a manager, in 1970.

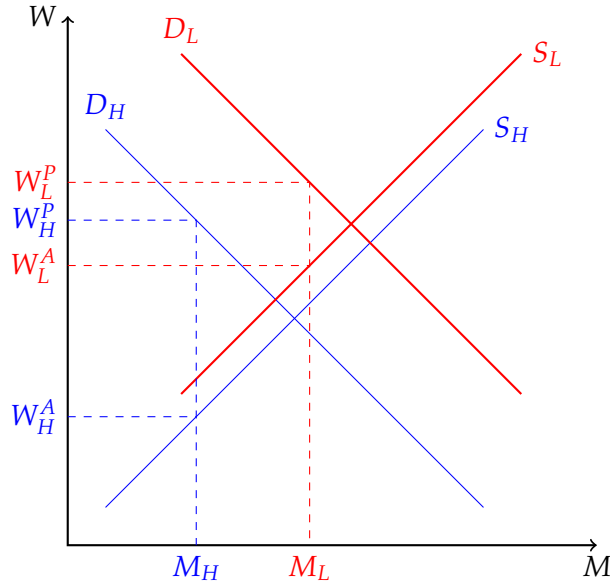


Figure 15: Equilibrium managerial compensation with lower taxes.

$M$  denotes the quantity of managers and  $W$  their compensation for a fixed level of managerial ability. When taxes are high, the equilibrium mass of managers is  $M_H$ , who earn pretax and after-tax compensations of  $W_H^P$  and  $W_H^A$ , respectively. With lower taxes, the equilibrium shifts to  $M_L$ , where managers earn pretax and after-tax compensations of  $W_L^P$  and  $W_L^A$ , respectively.

in  $\kappa$  to increase the population share of managers in absolute terms. On the other hand, the rise in  $\omega_1$  would decrease the share of managers relative to entrepreneurs. The results are confounded: the population share of managers do increase, but not as much as in the 2000 benchmark. The corporate share of capital also increases, but not only is it less than in the 2000 benchmark it is even less than when only the progressive tax parameters are changed. Most noticeably, top managerial compensation remains virtually unchanged compared to 1970 (in fact becoming lower), despite the rise in the mass of managers. This implies that the relative equilibrium prices of  $(w, r)$  are less favorable for managers, so that they are not represented in the top income percentile despite the increase in their population share.

While this confirms that the change in tax policy is what delivers the increase in managerial compensation, we still need to check to what degree top managers crowd out top entrepreneurs. In other words, we need more direct evidence that without the policy change, an environmental change cannot push managers to the top even if it increases their total mass.

**Income composition of the top income percentile.** Although I showed in figure 1 that the rise of income concentration coincided with a rise in the wage share of top percentile income, the calibration does not directly target any of this information. Table 8 shows the shares of wage, business and capital income for the top income percentile, which helps us understand to what the degree a change in the total mass of managers translates to an increase in the mass of managers in the top income percentile.

These moments are closely related to the occupations, and are much more sensitive to the tax change than the concentration moments. Let us first focus on the first two columns. The fall in the business income share of the top income percentile reflects the relative decrease in the mass of

		1970	2000	no tax change	only tax change
Wages	Data	45.6	61.7		
	Model	18.8	43.8	8.2	44.8
Business	Data	30.0	20.7		
	Model	57.7	20.0	33.1	27.8
Capital	Data	24.4	13.6		
	Model	23.5	36.2	58.7	27.4
Interest Rate		4.0	11.4	10.8	8.1

Table 8: Income composition of the top income percentile.

The data is from [Piketty and Saez \(2003\)](#). How I account for separate sources of income in the model is explained in section 3.3. “No tax change” refers to the case when only  $(g(1), \omega_1, \kappa)$  are varied while the average tax function remains the same. “Only tax change” is the exact opposite.

rich entrepreneurs, although both the level in 1970 (57.7 vs 30 percent) and drop are much larger than in the data (37.7 vs 9.3 percentage points). On the flip-side, the wage income share of the top income percentile reflects the relative increase in the mass of rich managers, which is also larger than in the data (25 vs 16.1 percentage points). The 1970 level of the wage income share is smaller since the business income share is so much larger, while the capital share of income is similar to the data.

Taken together, I deduce that while the qualitative directions of the wage and business income shares for the top income percentile are in line with the data, the magnitude of such changes are exaggerated because the initial level of the business incomes share is counterfactually high. This is again related to the fact that the incomes of entrepreneurs in the 1970 equilibrium are too high, for which multiple project qualities could be a remedy.

Nonetheless, these changes show that indeed, the change in the relative masses of entrepreneurs and managers we saw in table 7 are not only relevant for population shares but also at the top. In the last column of 8, we can again confirm that what drives the change between 1970 and 2000 in the model is the change in progressive taxation: the change in the income composition of the top income percentile is again qualitatively same and quantitatively close to the 2000 benchmark.

Surprisingly, observe that without a change in the tax policy—the third column of table 8—*both* the wage and business income shares are smaller. In this case, in fact, the rich are not earning their income from productive activities, but from capital (almost 60%). To the extent that managerial compensation is virtually unchanged, as we saw in table 7, this means that there are not many managers at the top despite the increase in their population share. The capital income share is so high for two reasons—not only is the concentration of wealth extreme at 48.9%, the interest rate is also very high at 10.8%. In fact, the equilibrium interest rate is even higher in the 2000 benchmark, an issue I return to when discussing the transition path below.

**Counterfactuals.** To highlight the effect of tax progressivity, I conduct an experiment where I fix the earnings tax at a flat rate equal to the average rate in the model, which is approximately 22.4% in the benchmark calibration for both 1970 and 2000. All other parameters are kept at their 2000 values. The results are contrasted with the benchmark calibration in the third row of table 9. Contrast this with the 2000 benchmark. By lowering progressivity to the extreme, the mecha-

	Benchmark		Flat Tax	$\kappa = 1$	$\lambda = 0$	$\lambda = 0,$ $\kappa/2$
	1970	2000				
Wealth	27.6	33.7	32.8	42.9	19.6	21.1
Earnings	6.1	11.9	15.3	3.9	6.4	6.4
Income	14.0	16.4	18.5	26.6	5.7	5.7

Table 9: Counterfactuals.

All counterfactuals are steady state comparisons. The flat tax rate on earnings is set so that the share of earnings paid as taxes is equal to the benchmark: 22.4% in both 1970 and 2000. Parameters are held at their 2000 benchmark values.  $\kappa = 1$  becomes a model with no managers and  $\lambda = 0$  becomes a model with no entrepreneurs. The last column is still with no managers, but when  $\kappa$  is set to half its value in 1970. All other parameters are held at their 1970 values but  $\beta$  is always recalibrated so that the equilibrium interest rate is 4%.

nisms investigated above—the rise of managers and the corporate sector—lead to higher levels of earnings and income concentration. What is important to note, however, is that despite this, the concentration of wealth is lower than in the 2000 benchmark: there is a disconnect between the incomes and savings behavior of the rich.

This is because the calibrated parameters are such that entrepreneurs have a higher savings propensity than managers. The next two columns in table 9 labeled  $\kappa = 1$  and  $\lambda = 0$  confirm this. For these two experiments and also the last column, I held the parameters at their 1970 values, except  $\beta$ , which I always recalibrate so that the equilibrium interest rate is 4%.<sup>36</sup> When  $\kappa = 1$ , no managers can exist in equilibrium; when  $\lambda = 0$ , no entrepreneurs can exist. Note that when there are only entrepreneurs at the top ( $\kappa = 1$ ), income concentration shoots up as does the concentration of wealth.<sup>37</sup> Conversely, when there are only managers at the top ( $\lambda = 0$ ), earnings, income and wealth concentration all become significantly lower. I conclude that the empire-building motive for entrepreneurs is much higher than the precautionary savings motive for managers in terms of wealth accumulation.

Hence, it is not surprising that even when managers are earning very high incomes in a flat tax regime, the concentration of wealth becomes lower than when taxation is somewhat more progressive (as in the 2000 benchmark), since there is no one-to-one relationship between the concentrations of earnings and wealth. This is also related to the results in table 8: since entrepreneurs have the higher savings propensity, it seems it should be the case that the concentration of wealth is higher only when the business income share of the top income percentile is high. However, because managers save out of a larger pie (income concentration is higher in the 2000 benchmark), wealth concentration can still increase when the wage income share is high.

The  $\kappa = 1$  and  $\lambda = 0$  counterfactuals also demonstrate that previous models cannot create such a disconnect between earnings, income and wealth concentrations. When  $\kappa = 1$ , the model reverts to one with only entrepreneurs à la [Buera and Shin \(2013\)](#). In terms of my model, what this does is make income concentration even higher than the 1970 benchmark (the parameters are held at their 1970 values). Since the 1970 equilibrium is already favorable for entrepreneurs, this exercise shows that making even more income concentrated on these top entrepreneurs makes wealth concentration even higher.

When  $\lambda = 0$ , the model reverts to one with only managers, or individuals with extremely

<sup>36</sup>It is unclear whether this is the correct comparison and instead of solving for a new interest rate, but the qualitative results are the same.

<sup>37</sup>In this case, earnings concentration is irrelevant since there are no managerial compensation.

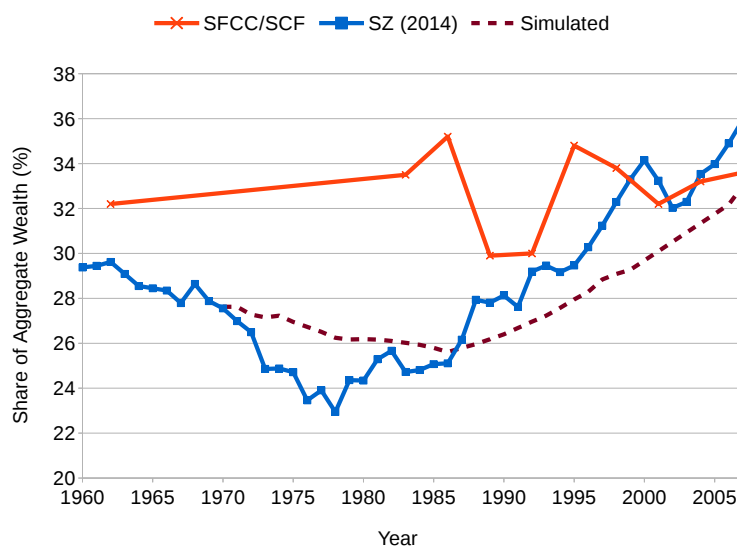


Figure 16: Top percentile share of aggregate wealth, data and simulated 1970-2007

The SFCC/SCF and Saez and Zucman (2014) series are identical to figure 2. The simulated series is under the transition scenario that all parameters change suddenly in 1971.

high earnings shocks (“superstar shock”) that occur with very small probabilities à la Castañeda et al. (2003). Compared to the 1970 benchmark, this experiment eliminates all income of the entrepreneurs, who sit at the top of the distribution, so does exactly the opposite of the  $\kappa = 1$  experiment: it makes income concentration lower. As expected, the exercise shows that this leads to a sizable drop in the concentration of wealth as well. In the last column, I keep  $\lambda = 0$  but change the value of  $\kappa$  to half its calibrated value in 1970. This makes the environment more favorable for managers in a world without entrepreneurs, since left of their compensation is lost: this is equivalent to increasing the “superstar shock” in extant models. Compared to the previous column, earnings and income concentration barely change, despite the newly gained advantage. Nonetheless, the advantage still manifests itself as a rise in the concentration of wealth.<sup>38</sup>

The fact that the concentration of wealth can move in the opposite direction of those of earnings and income demonstrates the strength of my occupational choice model in explaining the distributional changes at the top, for which previous models will fail. This mechanism is also what allows my model to generate the U-shaped evolution of wealth concentration figure 16 along the transition path, which is discussed below.

**Transition and welfare analysis.** For the benchmark transition, I assume that the distribution is at the 1970 steady state, and but that in 1971, all parameters in table 5, namely  $[g(1), \omega_1, \tau_0, \tau_1, \tau_2, \tau_3]$  change to those values in 1971. I also consider the cases when some or all of these parameters changed linearly over a time span of 30 years. I take the sudden shock scenario as a benchmark since when and how the agents learn the changes in the parameters are unclear, although it may help to bring the transition path closer to the data.

Figure 16 shows that the concentration of wealth follows a long, protracted U-shape pattern, as

<sup>38</sup>Alternatively, I could keep  $\lambda = 0$  or  $\kappa = 1$  and conduct a tax experiment. While not shown in the text, this has the same anticipated effects qualitatively.



in [Saez and Zucman \(2014\)](#). What is happening is that initially, the concentration of wealth drops as entrepreneurs become crowded out by managers at the top. But since these managers earn higher incomes and accumulate wealth along the transition path, eventually the concentration of wealth goes back up. Of course, it is not necessary that the terminal level has to be higher than the initial level, as I have demonstrated above. The only reason it does is because the parameters are calibrated as such.

In the benchmark transition with the sudden shock, all simulated moments (earnings and income concentration, wage and business income shares of the top income percentile) jump close to their 2000 values immediately, except for the top wealth percentile concentration, which is a stock. There are several ways I could prevent this: i) change the parameters incrementally for a long period of time, or ii) include adjustment costs for switching occupations so that individual cannot immediately choose their newly optimal occupations. Both methods would slow down the speed of transition, and because it turns out that the drop in steady state capital is quite large (table 10), the difference is not insignificant. I have confirmed that when the parameters change linearly over a 30 year period, the concentration of wealth still follows a U-shaped pattern, but over a protracted period of time.

Along these transition paths, I compute the utilitarian welfare gain (loss) of transitioning from the 1970 steady state to the 2000 steady state. The welfare trade-offs are explained in terms of contrasting the two frictions  $\lambda$  and  $\kappa$ . While the model lacks real world dimensions that would make it more suitable for an actual policy recommendation, the results indicate that less progressive taxation can have positive effects on welfare, contrary to previous studies.

Table 10 shows the percentage change in aggregate variables.  $AK$ ,  $AY$ ,  $AC$  denote the percentage change in aggregate capital, output, and consumption, respectively.  $TX$  is the percentage point change in the share of aggregate income paid as taxes between the 1970 and 2000 benchmark. Lastly,  $AW_{SS}$  and  $AW_{Tr}$  denote the consumption equivalent welfare gains by comparing steady states and incorporating transition costs, respectively.  $AW_{SS}$  is the percentage increase (decrease) of consumption at all individual states in the 1970 steady state required to obtain the utility levels in the 2000 steady state.

$AW_{Tr}$  is computed under several different scenarios in terms of the timing of the shocks. In the benchmark case with a sudden shock, agents are initially at the 1970 steady state. In 1971, they suddenly wake up to new tax and environmental parameters, which are identical to those from the 2000 steady state and that they now know will stay constant forever. Now,  $AW_{Tr}$  denotes the percentage increase in consumption required in the 1970 steady state to achieve the expected utility level in 1971, when the transition begins. Formally,  $AW_{Tr} \equiv \Delta$  such that

$$\int_{ss} \sum_{t=1970}^{\infty} \beta^{t-1970} u(c_t^{ss} \cdot (1 + \Delta)) \mu(dx) = \int_{ss} \sum_{t=1971}^{\infty} \beta^{t-1971} u(c_t^{tr}) \mu(dx).$$

The left-hand side of the equation is the average utility from increasing the 1970 steady state equilibrium consumption by  $\Delta$  percent, and the right-hand side is the average utility induced from equilibrium consumption along the transition path, both integrated over the 1970 stationary distribution.

Table 10 shows that across steady states, an unborn agent is -8.8% worse off under 2000 taxes in consumption equivalent terms. There are many mechanisms underlying this number, which is exemplified by comparing the changes in aggregate variables. As entrepreneurs drop out of production, steady state capital drops massively, by 46%. But because managerial production is more efficient, steady state output drops by only 4%. Since both entrepreneurial and managerial outputs are subject to frictions, this means that at the aggregate level, the friction  $\kappa$  is less inefficient

<i>AK</i>	<i>AY</i>	<i>AC</i>	<i>TX</i>	<i>AW<sub>SS</sub></i>	<i>AW<sub>Tr</sub></i>
-45.4%	-4.6%	3.3%	0.7 pp	-8.8%	1.0%~9.3%

Table 10: Aggregate impact of change in tax code

The reference point is 1970. *AK*, *AY*, *AC* refer to, respectively, the percentage change in aggregate capital, output and consumption. *TX* refers to the percentage point change in the amount of total taxes paid as a fraction of output. *AW<sub>SS</sub>* is the consumption equivalent welfare gains across steady states and *AW<sub>Tr</sub>* along the transition path. The lower bound 1.3% is when  $(g(1), \omega_1, \kappa, \tau_0, \tau_3)$  all change linearly for 30 years, and the upper bound is when all parameters change suddenly. The new steady state is assumed to be reached in 300 years.

than  $\lambda$ , so that less capital would be required for the same amount of aggregate production in 2000. Moreover, aggregate consumption increases by 3.1%, because although still less if produced, less is invested as well. By construction, tax revenues are almost equivalent in the benchmark 1970 and 2000 steady states.

In the 1970 steady state with more entrepreneurs, individuals have more incentive to save in anticipation of becoming an entrepreneur (transitioning from  $q = 0$  to 1), and entrepreneurs have more incentive to save in anticipation of losing a project (transition from  $q = 1$  to 0). As entrepreneurs are crowded out at the top, it is the rich managers that benefit from the increased consumption—they earn more but save less—consumption inequality is higher, so that overall, the steady state welfare loss is negative at -8.8%. Since risk averse agents prefer a flat consumption plan, this implies that consumption variation is high in the 2000 steady state, so that the increase in average consumption is countervailed by the utility loss in consumption variation.

However, since capital is less in the new steady state and production becomes more efficient, the additional capital available along the transition path is actually a gain rather than a cost. When the transition occurs fast as in the benchmark case, the welfare gains are quite large at 9.3%. In a more realistic scenario when the parameters change gradually (but still with agents having perfect foresight), the gains are small but still positive at 1%.

In addition to creating positive welfare gains, it is the massive drop in capital that makes the speed of transition slow and the interest high in the 2000 steady state. Because production is more efficient, more capital and labor is demanded, but the drop in capital forces the interest rate to be counterfactually high. In fact, in table 8, the capital income share of the top income percentile becomes higher in the 2000 benchmark compared to 1970 not because they hold so much more wealth, but because the returns are so high. I conjecture that properly modeling changes in the capital and business incomes and the capital gains tax would alleviate such problems, but leave this for future research.<sup>39</sup>

These results demonstrate the relationship with my model to the recent literature on “capital misallocation.” In an economy with only entrepreneurs, the economy is more production-efficient when wealth is more concentrated (e.g. Banerjee and Moll (2010)). In my environment with managers, although we also assume that the manager-project assignment process is also subject to frictions, production becomes more efficient when there are more managers, although it is associated with a drop in aggregate capital.

<sup>39</sup>I have also tried a reverse calibration in which I calibrate the model to 2000 and recalibrate a subset to 1970. In this case,  $\beta$  is calibrated so that the 2000 interest rate is 4%, and the equilibrium interest rate falls to approximately 2.4%, which is perhaps more realistic. However, except for the capital income share of the top income percentile, there are not any major differences in the quantitative results. For the purposes of this paper, it seemed more natural to calibrate the model 1970 and go forward rather than start from 2000 and go backward, which creates less confusion.

## 5. Conclusion

Standard models cannot simultaneously explain the evolutions of the U.S. income, earnings and wealth distributions. I instead construct a model of occupational choice where individuals choose to become entrepreneurs, managers or workers. The model can qualitatively replicate the steady increase in income concentration since the 1980s, which was driven by an increase in earnings concentration but accompanied by a U-shaped evolution in wealth concentration. Quantitatively, approximately half of this change can be explained by a change in the tax code. Specifically, this is due to high-income households choosing managerial rather than entrepreneurial occupations when tax conditions are more preferable for higher levels of managerial compensation. While the simulated transition path of wealth concentration closely tracks the U-shaped pattern in the data, I show that making taxation even flatter does not necessarily lead to higher wealth concentration in the long-run. My simulations indicate that utilitarian welfare increases by 1%-9% in consumption equivalent terms, depending on the transition scenario. The positive welfare gain contrasts with previous normative studies of progressive taxation.

This is because my main results rely entirely on changing the tax progressivity on earnings alone. I have presented evidence that capital and business income may have in fact become *more* progressive, and incorporating such changes can improve the model fit of the data. The reason is that if capital and business income taxation becomes even more progressive relative to wage income taxation than I have assumed in my model, the equilibrium would squeeze out even more entrepreneurs in favor of managers. For this, it is important for us to gain a better understanding of not only average and marginal tax rates faced by individuals, but also the variation in taxable income, available deductions, tax credits, etc.—especially at the high end—which effectively renders inference based on tax rates alone meaningless.

Also, I have assumed competitive assignment between projects and managers but assumed a single project quality. Assuming multiple qualities for projects would make earnings concentration even more sensitive to changes in the external environment, and may not only improve the model fit but also amplify the concerns raised by this paper regarding tax policy changes. Finally, it is important to understand how the timing of the environmental and tax parameters effect the transition path, both to understand what has happened historically and project how the economy may respond to future policy plans going forward. Such extensions are left for future research.

The model can be extended to international comparisons. Most continental European countries have more progressive taxes than the U.S. Just as I compare the U.S. in recent years to earlier years, I could compare the U.S. with other countries with different tax policies. In addition, I could explain why we only observe superstar CEOs in the U.S. and not in continental Europe.<sup>40</sup>

Finally, since the model is novel, it can also be used to revisit previous studies of financial development and capital misallocation that have been analyzed using entrepreneurial models with collateral constraints. In addition to the collateral constraint faced by entrepreneurs, the model introduces a new type of friction that arises during project transfers. When taking into account that not all production will always rely on entrepreneurs, especially in more developed countries, financial development can have different impacts on productivity growth and the persistence of capital misallocation depending on the relative importance of these two frictions.

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<sup>40</sup>Saez and Veall (2005) find that while inequality trends in Canada are similar to the U.S., major tax policy changes were absent. They suggest a “brain-drain” story in which the Canadian economy responded to U.S. policy to prevent the outflow of talent, even though there were no domestic policy shifts. Their story is corroborated by the fact that the francophone Quebec did not display the inequality trends observed in U.S. and Canada.

# Appendices

## A. Proofs

For the proofs, I make use of the fact that in the quantitative model,  $m$  is bounded above by  $\bar{m}$  and that  $\epsilon$  takes on a discrete number of values in the set  $E$ . Then I make the following assumption, which I show is satisfied in equilibrium.

**ASSUMPTION 1**  $a'$  is bounded above by  $\bar{a}$ , and  $\mu(q, m, da, \epsilon) > 0$  for all  $x \in \{0, 1\} \times [0, \bar{m}] \times [0, \bar{a}] \times E$ .

**Proof of Proposition 1** *Part (1)*. Suppose not, that there are no managers in equilibrium. With no managers, the economy is one where all production is carried out by self-employed entrepreneurs, and no project can sell at a positive price. But since  $\mu(\cdot, da) > 0$  for any  $(q, m, \epsilon)$  (by assumption 1), there is a positive mass of individuals with  $q = 1$  but sufficiently small  $a$  that they do not implement the project. Then for any  $e_1 \geq 0$ , intermediaries can purchase one of these projects at  $e_2 > 0$ , offer a compensation of  $(1 - \kappa)\pi^*(\bar{m}) - e_2 - e_1$  to a wage worker with managerial ability  $\bar{m}$  s.t.

$$(1 - \kappa)\pi^*(\bar{m}) - e_2 \geq w\epsilon$$

and still generate non-negative profit  $e_1$ . Such a manager exists since the exogenous Markov process is ergodic. Hence there must be at least one manager, a contradiction.

*Part (2)* then follows from the text.

**Proof of Proposition 2** The proof assuming stationarity is standard. Assume  $\beta(1 + r) < 1$ . The value function exists and attains the supremum of the sequence problem by Theorem 9.12 in [Stokey and Lucas \(1989\)](#). Note that once we assume incomes are stationary (or equivalently, that prices  $(r, w)$  are constant), the equilibrium determination of  $\phi$  does not matter and the individual's problem is identical to one where she receives a stochastic endowment depending on her individual state  $x$ . The only difference from a standard savings model is that the endowment is dependent on her current asset level when she is a collateral-constrained entrepreneur. The endowment of a constrained entrepreneur is uniformly bounded above by that of a non-constrained one, which is in turn assumed to be bounded above by  $W(\bar{m})$ . Since endowments are bounded above, once we assume CRRA preferences Proposition 4 in [Aiyagari \(1993\)](#) applies so that assets are also bounded above. Furthermore since  $(q, m)$  are exogenously ergodic, assumption 1 is satisfied. Existence and uniqueness of a stationary RCE is a straightforward application of Proposition 5 in [Aiyagari \(1993\)](#), from which we can also verify that  $\beta(1 + r) < 1$ , a standard implication of incomplete markets models.

## B. Tables

	Top 1%	Top 5%	Top 10%	Top 20%	Next 20%	Next 20%	Last 40%
Year	share of aggregate wealth:						
1963	32.2	52.3	64.1	78.1	14.5	6.3	1.2
1983	33.5	55.4	66.9	79.4	12.8	5.9	1.9
1986	35.2	55.3	66.0	78.6	12.9	6.0	2.6
1989	29.9	54.0	66.9	80.6	13.1	5.2	1.1
1992	30.0	54.4	67.0	80.1	13.2	5.4	1.3
1995	34.8	56.0	67.9	80.6	12.5	5.5	1.4
1998	33.8	57.1	68.5	81.4	12.4	5.1	1.1
2001	32.2	57.3	69.6	82.5	11.9	4.5	1.1
2004	33.2	57.4	69.4	82.9	11.8	4.4	1.0
2007	33.6	60.3	71.4	83.4	11.3	4.5	0.9
Year	share of aggregate earnings:						
1962	6.2	18.7	30.9	50.0	27.8	17.2	5.0
1982	9.6	23.5	35.9	55.1	26.4	14.8	3.7
1985	10.9	26.0	37.8	56.1	25.5	14.9	3.6
1988	10.6	26.9	39.9	58.8	25.0	13.4	2.7
1991	10.5	26.8	39.8	59.1	25.0	13.2	2.8
1994	12.0	28.0	40.5	59.1	24.6	13.3	2.9
1997	11.3	26.6	39.1	57.7	24.7	13.8	3.8
2000	15.5	30.7	42.7	60.4	22.8	12.7	4.1
2003	13.6	29.2	42.0	60.5	23.3	12.7	3.5
2006	15.9	32.0	44.4	62.5	22.6	12.0	2.9
Year	share of aggregate income:						
1962	8.3	19.6	29.9	46.0	24.0	16.6	13.4
1982	13.6	27.0	37.1	52.2	21.3	14.2	12.3
1985	13.6	26.8	36.9	52.0	21.8	14.4	11.7
1988	16.9	31.5	42.3	57.2	20.0	12.7	10.1
1991	11.7	26.3	37.5	53.6	21.7	13.6	11.2
1994	14.3	28.7	39.3	54.9	20.8	13.5	10.9
1997	16.6	31.0	41.2	56.2	20.5	12.8	10.6
2000	20.0	35.3	45.4	59.6	18.9	11.7	9.9
2003	16.8	31.8	42.6	57.7	19.6	12.3	10.5
2006	21.3	37.0	47.1	60.9	18.2	11.2	9.7

Table A1: Size distribution of wealth, earnings and income in the SCF

Wealth is ranked by the variable NET WORTH, earnings by annual wage income and salaries, and incomes by total income. Earnings and income are intentionally labeled as one year before the release of the actual SCF dataset, as it reports the flow values from the previous year. The 1962/3 data is based on the SFCC/SCFF, the precursor of the SCF.

## C. Numerical Procedure

I first discretize the state space for asset holdings  $a$  using 96 grid points. Since  $m$  is assumed to follow a continuous distribution, I use a Gauss-Legendre quadrature with 10 grid points when computing the expectation over the value function. For the simulation, we need to include two additional points,  $m = 0$  and  $m = \bar{m}$ , for interpolating the policy function. Finally, the AR(1) labor efficiency process  $\{\epsilon_t\}$  is discretized into 5 points according to [Rouwenhorst \(1995\)](#)'s binomial method as described in [Kopecky and Suen \(2009\)](#). Under the stationarity assumption, all aggregate variables and hence prices are constant. For the calibration, I fix  $r = 4\%$  and use the following algorithm to compute an equilibrium:

1. Guess  $\beta$  and  $w$ .
2. Check for existence of a managerial equilibrium, and guess  $\hat{m}$ .
3. For each  $(\beta, w)$  pair and guess for  $\hat{m}$ , generate occupational choices and implied incomes, and iterate on the value function to get policies and the stationary distribution  $\mu$ .
4. Repeat from 2 until manager market clears.
5. Repeat from 1 until capital and labor markets clear.

To compute the stationary distribution, I fix an exogenous process for  $(q, m, \epsilon)$  and simulate the optimal policies of 240,000 individuals for 300 periods. The distribution in the 300th period is taken to be the stationary distribution from which I compute distributional statistics.<sup>41</sup> Both during value function iteration and simulation, points off the grid are computed by (tri-)linear interpolation. For the experiments, I fix  $\beta$  at its calibrated value and iterate on  $r$  instead.

The 5 model parameters and 2 tax parameters  $(\tau_0^{1970}, \tau_3^{1970})$  that minimize the distance between model statistics and empirical targets from 1970 are found by applying an 9-dimensional bounded minimization routine developed in [Powell \(2009\)](#). Once the 1970 steady state is found, I fix the 6 model parameters (which now includes  $\beta$ ) and recalibrate  $(\omega_1, \kappa, \tau_0^{2000}, \tau_3^{2000})$  to the population share of managers, corporate capital share, the average tax rate and top percentile share of total taxes in 2000, iterating on  $r$  instead of  $\beta$ . Global uniqueness of parameters is not guaranteed, so I repeat the exercise starting from multiple initial values found from accelerated random search.

## D. The Transition Path

In addition to the transition used for the welfare experiment that starts from the 2000 steady state, I also compute the transition path starting from the 1970 steady state. In 1971, agents suddenly wake up to find the tax and technology parameters  $(\omega_1, \kappa, \tau_0, \tau_3)$ , at their 2000 values.

**Computing the Transition Path** [Ríos-Rull \(1997\)](#) describes how to compute transitions between steady states. However, his method relies on a single representative firm, and cannot be applied as is to my model. I extend his method to my model as follows:

1. Compute the initial and terminal stationary distributions ( $F_0$  and  $F_\infty$ , respectively) as above.
2. At time 1, agents suddenly gain perfect foresight of all tax variables into the indefinite future. Pick  $T$  large, assuming that  $F_T \simeq F_\infty$ . This implies that  $V_T \simeq V_\infty$ .
3. Guess a path for prices  $\{r_t, w_t, \hat{m}_t\}_{t=1}^T$ . Starting from  $V_T$ , solve out for  $\{V_t\}_{t=1}^{T-1}$  using backward induction.

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<sup>41</sup>Increasing the number of individuals and periods did not change statistics at the equilibrium.

4. Starting from  $F_0$ , simulate the economy for  $T$  periods. Check market clearing for each period, and update the whole sequence of guesses as required.
5. Repeat from 3 until markets clear in all periods.
6. Check whether  $F_T \simeq F_\infty$ . If not, repeat from 2 with larger  $T$ .

In the simulation I set  $T = 300$ . Increasing to  $T = 500$  does not change the results. For each evaluation, I use a weighted bisection method for each period, *independently of other periods*, to update the guesses on prices. While this method is not guaranteed to work in general, the maximum difference between the guessed and implied price sequences converge to zero.

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