Taxing Top Incomes in the World of Entrepreneurs

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Abstract

This paper shows that high top marginal income tax rates generate large losses of aggregate output and productivity. These losses arise because taxes distort the investment decisions of entrepreneurs who constitute a large share of high earners. I identify two novel distortions. The first is the "productivity investment effect". Top income tax rates distort the productivity investment decisions not only of entrepreneurs who are already in the top income bracket but also of those who will become top earners in the future by building up their firms. The second force is the "incorporation timing effect". Successful entrepreneurs grow their firms and then sell their businesses to the corporate sector through incorporation. High top tax rates push these entrepreneurs to sell before the firms reach their full productivity potential. This force is driven by a feature of the tax code that treats the sale of a firm to the corporate sector as capital gains, which are taxed at a lower rate than personal income. Both effects imply that even though it targets only a small fraction of households, increasing the top marginal income tax rate generates large output costs by decreasing productivity. Since lower productivity erodes the tax base, in a calibrated model, the revenue-maximizing top income tax rate that takes both effects into account is 45%.

Keywords: Macroeconomics, Entrepreneurship, Firm dynamics, Income and Wealth distributions, Taxation

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1 Introduction

In the past decades, there has been an increased discussion among academics and policymakers calling for a higher top marginal tax rate (or top tax rate) on incomes. On the one hand, such a tax would reduce the increasing polarization in incomes; on the other hand, there is a concern that raising income taxes on high-income households would have serious adverse consequences for the economy. Therefore, the classic trade-off in the optimal income tax literature is between redistribution and the "size of the pie". One strand of the literature focuses on the labor supply margin. They find a limited "size of the pie" effect because of the low labor supply elasticity and suggest a high optimal top marginal income tax rate of $70 - 80\%$, see for example, Kindermann and Krueger (2022). Motivated by the empirical evidence that entrepreneurs prevail at the top of the income distribution, the recent literature studies the effects of top income taxation in a model of occupational choice between wage work and entrepreneurship. Their finding about the optimal top tax rate (both welfare-maximizing and revenue-maximizing) is around 60%, see for example, Bruggemann (2021).

Entrepreneurs have an active management role in their fully-owned, privately held businesses. While acknowledging the success of previous theories, a more crucial role of entrepreneurs has not been explored: entrepreneur grow their firms by accumulating productivity, then incorporate their businesses. To the extent that top income taxation distorts entrepreneurs' decisions on productivity investment, it can lower the productivity in the entrepreneurial sector populated by pass-through entities.[1] Moreover, entrepreneurs have a strong connection with the corporate sector – they create the whole corporate sector via incorporation.[2] The corporate sector, by all means, is not immutable to top income taxation, even though this tax does not directly target it. Therefore, increasing the top marginal income tax rate may generate large output costs by hitting productivity in both the entrepreneurial and corporate sectors. A decline in productivity erodes the tax base and, thus, constrains revenue-maximizing top tax rates. This paper assesses the dynamic distortions of top income taxation on productivity growth in the entrepreneurial sector and in the aggregate economy as a whole.

To make my argument, I first develop a general equilibrium life-cycle model of entrepreneurs with endogenous productivity growth and incorporation decision. Households choose between wage work and entrepreneurship based on their ability endowments. There

[1] The legal forms which are pass-through entities are: sole proprietorships, general partnerships, limited partnerships, limited liability companies and S corporations. Pass-through entities are owned by particular entrepreneurs, mostly their founders.

[2] The corporate sector is populated by firms owned by an unrestricted number of shareholders. Firms in this sector are C corporations.

are two production sectors – the entrepreneurial sector and the corporate sector. Households pursue entrepreneurship by starting a business in the entrepreneurial sector. They have full ownership of their firms. Namely, business activities are highly related to the founders themselves. The rigid ownership rules make firms in the entrepreneurial sector reliant on internal savings and collateralized borrowing (Dyrda and Pugsley (2019)). Entrepreneurs improve their firm's productivity by accumulating an intangible asset called *organization capital*.[3] In each period, entrepreneurs can choose to incorporate and sell their firms to the corporate sector. Incorporated firms have impersonality and are not owned by any particular entrepreneur. Instead, they belong to an unrestricted number of shareholders. At the same time, they have easier access to capital. The incorporation process is modeled as selling 100% of the firm and getting the market value in return.[4] After incorporating their current business, entrepreneurs leave their firms and make a new occupational choice by either restarting a new firm or becoming a worker. Entrepreneurs can own only one business at a time.

Hence, this paper proposes two new channels interacting with each other through which top income taxation could affect productivity in the economy. First, the endogenous productivity growth channel captures the intensive margin. Changes in top income taxation distort entrepreneurs' incentives to grow their businesses and, thus, alter the future growth path of the firm. Business dynamism has long been recognized as the key driver for aggregate outcomes; see for example, Hopenhayn (1992). Entrepreneurs' response to changes in income taxation will leave large and persistent footprints on the economy through firm dynamics.

The second channel is the incorporation decision, which can be viewed as a business re-organization in this paper. It captures the extensive margin. Considering the incorporation decision is meaningful due to two reasons. First, it links the entrepreneurial sector and the corporate sector. The effects of top-income taxation on productivity in the entrepreneurial sector will be further transmitted to the corporate sector. An entrepreneurial firm with lower productivity becomes a corporation with lower productivity when its business owner incorporates it. Taking this force into account is important quantitatively because the corporate sector produces almost two-thirds of the total output. Second, introducing incorporation decision generates a new feature – the serial entrepreneurs. Serial entrepreneurs have higher skills (e.g., Carbonara et al. (2020)). They are good at growing their firms. In this model,

[3]The literature views organization capital as a firm-specific capital good that helps improve production efficiency, see for example, Ericson and Pakes (1995), Atkeson and Kehoe (2005), Lev and Radhakrishnan (2005).

[4]This is a simplification assumption. In the real world, firm owners choose to sell part of their firm shares when they incorporate. As a result, they become shareholders and get a dividend flow in each period. When modeling that way, I will need an extra state that tracks whether the household has incorporated a firm. For computation convenience, I assume that when entrepreneurs incorporate, they sell 100% of their firm share and get the firm value, which is the present value of the future profit stream.

serial entrepreneurs grow their firms, sell their businesses by incorporating, and then restart a new firm. Once the business has been established, economy efficiency is enhanced by these serial entrepreneurs selling their firms and starting another new business. Entrepreneurs get their firm value when they incorporate. Therefore, when they restart a new business, they have a less binding borrowing constraint, which is relevant to how they grow their new businesses. Changes in top income taxation alter entrepreneurs' incorporation decision, intensifying the effect along intensive margin when serial entrepreneurs start their next firms.

The model is then calibrated to replicate a set of empirical moments characterizing the U.S. economy; in particular, the empirical wealth and income distributions and characteristics of firm dynamics are matched. Finally, given the calibrated model framework, I run policy experiments to quantify the impact of raising the top marginal tax rate, holding all other tax rates and government spending unchanged. Any extra revenue collected in the new steady state is redistributed to every household as a lump-sum transfer.

The peak of the long-run Laffer curve is at a top rate of 45%. At this rate, compared with the benchmark economy, the aggregate output decreases by 5.3%. The output produced by the entrepreneurial sector drops by 5.7%, and the output in the corporate sector drops by 4.8%. More importantly, the total organization capital in the entrepreneurial and corporate sectors decreases by 6.8% and 7.0%, respectively. It reflects a productivity drop in these two production sectors.

There are two effects leading to the productivity drop. The first one is the *productivity investment effect*. Entrepreneurs build up their firms over time by investing in organization capital. Top income tax rates distort the productivity investment decisions of entrepreneurs who are already in the top income bracket. More importantly, those who are still building up their firms in the hope of becoming rich in the future are also affected. An increase in the top tax rate decreases the marginal benefit of productivity investment they receive later in life. These entrepreneurs, thus, have less incentive to grow their firms. Taxing top earners then directly lowers productivity in the entrepreneurial sector.

The second effect is the *incorporation timing effect*. Entrepreneurs with extremely high abilities are good at building up firms. They incorporate the most. Furthermore, after they incorporate, they always choose to restart a new firm. Hence, they are the *serial entrepreneurs*. The productivity threshold for serial entrepreneurs to incorporate becomes lower in the new steady state with the top tax rate of 45%. Namely, taxes distort the incorporation timing and push serial entrepreneurs to sell before their firms reach the full productivity potential. It is a result of the feature of the tax code – the sale of a firm is treated as capital gains, which are taxed at a lower rate than personal income. Serial entrepreneurs fall into the top income bracket soon after they start a firm due to their high abilities. If they keep running the business in the entrepreneurial sector, they pay income tax on their business profits every period. On the other hand, if they incorporate their firms, they get their firm value and only pay the capital gains tax. Therefore, these entrepreneurs use incorporation as a tax shelter to avoid high top income tax rates. The premature businesses incorporated by serial entrepreneurs lower productivity in the corporate sector.

The remainder of the paper is organized as follows. After a brief literature review in Section 2, Section 3 presents the model. Section 4 describes the calibration strategy. Section 5 then discusses the features of the benchmark economy. In Section 6, I explain the setup of the policy experiment and present the results. Section 7 concludes.

2 Related Literature

The key idea of this paper is that top income taxation will affect productivity through two new channels – endogenous productivity growth and incorporation decision. This paper contributes to macroeconomics literature in several different ways.

This paper completes the work on income taxation. There is vast literature on top marginal income rates in quantitative dynamic macro models.[5] Kindermann and Krueger (2022) use a model with ex-ante heterogeneity in labor income risk and find that marginal tax rates of 79 percent are optimal. Their high rates are due to the inelastic labor supply of households with high working productivity. Later research relaxed this restriction, incorporating complementary inputs such as the accumulation of human capital, for example, Badel et al. (2020). Since the top income earners can build their skills, the elasticity of the tax base in Badel et al. (2020) model rises, which generates limits to top tax rates. The idea of investment in organization capital in my paper is similar to Badel et al. (2020) human capital investment, but in a different environment. Bruggemann (2021) and Imrohoroglu et al. (2021) study top income tax rates in a model with entrepreneurship. Their work is based on the household occupational choice model with exogenous productivity.

My paper is more closely related to Jones (2022). In his paper, top income earners innovate. High marginal tax rates deter their effort and therefore reduce innovation and overall GDP. The key difference between Jones (2022) and my paper is that he studies the "size of the pie" effect with a focus on externalities. In his model economy, entrepreneurs engage in R&D, which is socially desirable because of knowledge spillover. Top rates tax households that generate these positive externalities. By slowing the creation of new ideas

[5] Earlier work uses static model, see for example, Diamond and Saez (2011), Piketty and Saez (2013), among others. Diamond and Saez (2011) suggest that the revenue-maximizing top marginal income tax rate in the U.S. is approximately 73%.

that drive aggregate GDP, top income taxation reduces everyone's income, not just income at the top. As a result, it reduces the size of the pie. In my model, however, there are no externalities. Entrepreneurs capture all the rents they create. Top income taxation generates large output costs because it hits productivity. To the extent that entrepreneurs fail to get all the rents, i.e., externalities come into play, the argument against taxing the top income earners gets stronger. In that sense, Jones (2022) and this paper complement each other.

From the theoretical perspective, this paper is the first work that connects three separate pieces of literature: the household occupational choice literature, the firm dynamics literature, and the choice of the legal form of organization literature. The occupational choice literature, particularly the literature on entrepreneurship in macroeconomics, usually assumes exogenous productivity. Given the productivity endowment, households choose between wage work and entrepreneurship; and productivity evolves exogenously, see for example, Quadrini (2000), Cagetti and De Nardi (2006). Therefore, it focuses on the extensive margin – whether or not to start a firm. This paper extends the standard occupational choice model to include the intensive margin – the entrepreneur's decision on how to grow the firm, and an extra extensive margin – the incorporation decision. Hence, the model in this paper generates new policy implications by bringing new channels through which changes in fiscal policy could affect the economy.

My paper is also closely related to the firm dynamics literature. Business dynamism has been considered a critical driver of aggregate outcomes, see for example, Hopenhayn (1992), Haltiwanger (2012), Haltiwanger et al. (2013). Small changes to the growth potential of firms may leave large footprints on the aggregate economy (Clementi and Palazzo (2016), Sedlacek and Sterk (2020)). Structural macroeconomic models with firm heterogeneity have gained popularity and importance but typically ignore the link between entrepreneurs and firm performance. This paper studies the macroeconomic impact of entrepreneurs and its relation to average firm dynamics. Particularly, this paper provides a new framework for studying the relationship between entrepreneurship and the aggregate economy. It casts new light on how the entrepreneurs' decisions will affect the macroeconomy through the lens of firm dynamics.

Moreover, this paper deepens our understanding of the sources of firm heterogeneity. There is growing evidence showing that ex-ante heterogeneity can have long-lasting effects on firms and, in turn, shape aggregate dynamics, see for example, Sedlacek and Sterk (2017) and Sterk et al. (2021). In my paper, entrepreneurial ability is the key driver determining the firm's growth path. It is consistent with the recent empirical findings (Felix et al. (2022)). Therefore, this paper suggests entrepreneurs as one source of ex-ante heterogeneity. It provides additional insights into the study of firm heterogeneity.

In addition, due to the endogenous choice of the legal form of organization, this paper is able to bridge the gap between the macroeconomics literature studying the aggregate impact of individual firms' decisions and the corporate finance literature studying the consequences of the incorporation choice at the firm level. By recognizing the entrepreneurial origin of firms in the corporate sector, this paper sheds light on how changes in the economic environment (i.e., taxes) might affect the selection of pass-through entities into becoming C corporations, which then might lead to a reallocation of resources and have important macroeconomic implications.

Finally, this paper also contributes to the growing literature that focuses on the importance of entrepreneurship in shaping income and wealth inequality (Gentry and Hubbard (2004), Buera et al. (2015)). Entrepreneurship has been long recognized to play a central role in understanding top economic inequality (Cagetti and De Nardi (2006)). This holds both empirically, since a large share of top earners' income is derived from business owners (Piketty et al. (2018)), and theoretically, since the presence of successful entrepreneurs can help reconcile the highly skewed income and wealth distribution observed in the data with existing models (Gabaix et al. (2016)). It has been shown that a model with entrepreneurs is more successful in replicating the income and wealth distributions in the U.S., especially in the upper tail; recent examples include Quadrini (2000), Cagetti and De Nardi (2006), Tan (2022).The existing studies focus on incumbent entrepreneurs without investigating their occupational history. Whether it is the same group of people who start businesses over and over again (i.e., serial entrepreneurs) or it is the case that entrepreneurship makes many people rich will generate different implications for the question of how vital entrepreneurship is for inequality. This paper provides additional insights into the debate on how entrepreneurship affects economic inequality. It helps explain the high level of wealth inequality observed in the United States and other countries.

3 Model

This section sets out to develop a structural model that will be used as the laboratory to study tax policy changes. The model is a variant of Quadrini (2000) and Cagetti and De Nardi (2006). Households are heterogeneous in entrepreneurial ability, business productivity and working productivity. Given endowments, households make occupational choice between wage work and entrepreneurship. Entrepreneurs accumulate an intangible asset called *organization capital* through production. In each period, entrepreneurs can choose to shut down their businesses and go back to be workers, or to keep running their firms as pass-through entities, or to incorporate and make their firms become C corporations. After they incorporate, entrepreneurs make occupational choice between being a worker or starting a new firm.

3.1 Demographics and Preferences

There is a continuum of households of measure one, each indexed by $i \in [0, 1]$. I adopt a life cycle model with stochastic aging. Households go through two stages of life, young and old. A young household faces a constant probability of aging during each period, Ω_o, and an old household faces a constant probability of dying, Ω_d. For simplicity, I do not allow for entrepreneurship in old age. Once a household becomes old, it retires and receives the retirement benefit from the government. Every old household receives the same retirement benefit regardless of their occupation and income when young. Households are selfish and only leave unintended accidental bequests. When an old household dies, its offspring enters the model, carrying the assets left by this old household. Moreover, there is no intergenerational transmission of abilities. Time is discrete. The model period is one year. There is no aggregate uncertainty in the economy, but households are subject to idiosyncratic shocks.

All households are endowed with an identical utility function and discount future utility at rate β. Utility is from nondurable consumption c, and labor supply l generates disutility. Moreover, I assume workers can choose their working time freely, whereas all the entrepreneurs have to provide a fixed amount of labor, $l = l_e$.

$$\mathbb{E}_0\Big[\sum_{t=0}^{\infty}\beta^t u(c_t, l_t)\Big]$$

Instantaneous utility u satisfies standard conditions, and the expectation operator is with respect to the idiosyncratic shocks.

Assumption discussion: This model does not have any intergenerational link of wealth or ability. This assumption is justified by Guo (2022) and Smith et al. (2019). Guo (2022) finds that inheritance is less important for wealth accumulation for the rich. Smith et al. (2019) document that most of the business owners, who are in the top income groups, earn most of their income from their human capital or from savings out of their previous human capital returns, rather than from inherited financial capital from their parents. Smith et al. (2019) classify these individuals as self-made.

However, there is still a weak intergenerational linkage between parents and children regarding the choice of becoming an entrepreneur. In the model, since successful entrepreneurs are rich, even though there are only unintended accidental bequests, they tend to leave large wealth to their children, leading to a higher likelihood of their children also becoming entrepreneurs.

3.2 Endowments and Shocks

Each household possesses three types of endowments z_i, s_i, and q_i. Households are denoted by i. To economize on notation, the household index i is dropped in what follows.

Upon entering the model economy, households draw their entrepreneurial ability z from a distribution. Then the entrepreneurial ability of this household stays fixed. Households with higher z are more efficiency in accumulating productivity for their firms when they start a business.

At the beginning of each period, households draw their working productivity, s. The initial working productivity s is drawn from its initial distribution. s is an idiosyncratic shock to labor productivity. And the evolution of s depends on the last-period occupational type of the household. If the household was a worker in the last period, then its labor productivity follows a Markov process, $Pr(s|s_{-1})$. If the household was an entrepreneur or an entrepreneur who incorporated (I call such entrepreneur as incorporation entrepreneur hereafter) in the last period, its s in this period is drawn from the initial distribution of s. This assumption indicates that the working history of entrepreneurs will be erased, and in each period, they draw new working productivity.

At the beginning of each period, households also draw business quality, q. Similar to working productivity, the first draw of q is from its initial distribution, and the evolution of q depends on the last-period occupational choice. Non-entrepreneur households get a new q from its initial distribution in each period. Once the household chooses to start a firm, its q evolves according to a Markov Chain, $Pr(q|q_{-1})$.

3.3 Production Technology

The model has four states related to occupation and demographics: young worker, young entrepreneur, young incorporation entrepreneur, and old retiree. A household begins each period as one of these four states. This section focuses on the production technologies available to households and firms.

3.3.1 Workers and Retirees

Young workers provide labor supply to a spot market and receive wage income ws_tl_t, where w is the wage and s is working productivity. An old retiree receives social security payments $\overline{\tau}$ as income. Following Cagetti and De Nardi (2006), I explicitly model old-age social security because it is a very important program affecting life cycle saving decisions.

3.3.2 Entrepreneurial Firms

Households pay a sunk cost, C_e, when they start a new business. Entrepreneurs do two things: first, produce output and, second, improve productivity. All firms are assumed to produce homogeneous outputs. In this model, I consider productivity growth as an intangible asset accumulation. More precisely, it is the organization capital accumulation.[6] Arrow (1962) discusses that organization capital can be knowledge about the best organizational procedure, the marketing, and the development of the product or the technology itself. It is an enabler that helps convert tangible resources into output. Following this idea, in this paper, entrepreneurs improve their firm productivity by accumulating organization capital.

The production function is taken from Atkeson and Kehoe (2005).

$$f(q_t, h_t, k_t, n_t) = q_t h_t^{1-\gamma}(k_t^{\alpha} n_t^{1-\alpha})^{\gamma} \tag{1}$$

where $\gamma \in (0, 1)$ denotes the span-of-control, capturing the fact that firm's production efficiency becomes stretched over larger and larger projects. This production technology combines business quality q_t, organization capital h_t, capital k_t, and labor n_t to produce output y_t.

Rosen (1972) and Lev and Radhakrishnan (2005) view organization capital as *"a firm-specific capital good jointly produced with output and embodied in the organization itself"*. In line with this idea, I assume entrepreneurs start their business with the same initial amount of organization capital, h_0, then accumulate it as they produce. In particular, the organization capital accumulation equation is taken from Rosen (1972), who proposes the joint production of output and organization capital.

$$h_{t+1} = h_t + e^z[f(q_t, h_t, k_t, n_t)]^{\psi} \tag{2}$$

where $\psi \in (0, 1)$. The accumulation of organization capital depends on entrepreneurial ability z and the output, y. Hence, it has a "learning-by-doing" feature, indicating that the entrepreneur accumulates more organization capital as she operates a larger scale of business.

Assumption discussion: In this model, there are two endowments related to business profit: entrepreneurial ability z and business quality q. z is fixed once drawn, whereas q changes stochastically in each period. Both of these two endowments are necessary in the model. z governs productivity growth. Entrepreneurs with high z are more efficient in improving their firm productivity. q induces firm exit. More importantly, these two

[6] The previous work on organization capital includes Arrow (1962), Rosen (1972), Tomer (1987), Ericson and Pakes (1995), among others. Sweat equity is also a type of intangible asset, see for example, Bhandari and McGrattan (2020).

endowments together generate key features of firm dynamics in this model. Young firms are more likely to die because they do not have time to accumulate h to compensate for a low q. Therefore, they are vulnerable to business quality shocks, leading to a high exit rate of young firms (Tian (2018)). Moreover, for those with a high z, their accumulation of h is very fast, generating a high dispersion in productivity growth rate among young firms (Tian (2015)). This model, thus, has the "up or out" dynamics of young businesses documented by Fort et al. (2013), Haltiwanger (2012), and Haltiwanger et al. (2013). As firms age, they have accumulated large organization capital. As a result, old firms are more able to compensate for a bad business quality shock and survive. They exhibit a lower exit rate (Tian (2018)).

3.3.3 Incorporated Firms

Firms in the corporate sector have similar production technology as entrepreneurial firms. The only difference is that incorporated firms do not have organization capital accumulation. Due to the assumption that the accumulation of organization capital depends on entrepreneur's ability z, and that entrepreneurs incorporate by selling 100% of their businesses and then they leave their firms, the organization capital of a C corporation is fixed at the level when the firm is incorporated and does not grow. Therefore, the production function is

$$f^c(q_t, k_t, n_t) = q_t \overline{h}^{1-\gamma} (k_t^{\alpha} n_t^{1-\alpha})^{\gamma} \tag{3}$$

Moreover, in each period, C corporations face a death shock, D.

3.4 Incorporation

The choice of incorporating is modeled as entrepreneurs selling 100% of their firms, getting the market value, paying a fixed incorporation cost C, and leaving the firm. Entrepreneurial firms have a collateral constraint, whereas C corporations do not have any borrowing constraints.

3.4.1 Trade-offs

There are various motives for incorporating, such as to diversify the entrepreneur's holdings, to raise capital for investment, to exploit favorable market conditions, and to make the firm more visible. The trade-off used by this paper is diversification vs. private control. As an owner of a pass-through entity, the entrepreneur's entire wealth is tied up in the firm. Namely, the entrepreneur suffers from under-diversification, but enjoys the benefits of private control. The entrepreneur forfeits these benefits by incorporating the firm but achieves better diversification. The diversification benefits of incorporation are twofold: The first benefit is getting rid of the borrowing constraint. Pass-throughs are subject to a collateral constraint, whereas C corporations have easier access to capital. The second benefit is consumption smoothing. When the pass-through's expected profitability rises, the entrepreneurs expect higher consumption in the future. The entrepreneur wants to smooth the consumption, but cannot borrow against expected future profitability. If expected profitability rises high enough, the consumption path under private ownership becomes so unattractively steep that the entrepreneur prefers to cash out through incorporation and smooth consumption.

3.4.2 Collateral constraint

Entrepreneurs face a collateral constraint, whereas firms in the corporate sector do not. This assumption is the standard setup in the literature (Dyrda and Pugsley (2019)). Empirical findings from the finance literature suggest that most unincorporated firms finance investment by issuing debt or reinvesting internal funds. Very few unincorporated firms issue equity, and for those that do, equity is generally financed by the firm's owner since it is hard to raise external equity financing due to informational frictions.

3.5 Financial Market

There is a risk-neutral mutual fund which accept deposits from households and use the funds to purchase equities of publicly held firms in the corporate sector, and physical capital that they lend to all firms. Firms rent physical capital from the mutual fund to produce at interest rate r. The mutual fund pays interest on deposits at the risk-free rate r. This economy does not feature any aggregate uncertainty. Households are not allowed to borrow.

Firms rent tangible capital from the mutual fund to produce. I focus on the within-period rental market for production purposes. Thus, the capital must be returned immediately after production takes place. The entrepreneur invests her own wealth in the business and borrows from the financial market to fill the investment gap. And I also assume that entrepreneurs can only rent capital up to a level such that $k \leq \eta a$, which is the so-called collateral constraint (Kitao (2008); Buera and Shin (2013)). k is the amount of capital the entrepreneur invests in the business, and a is her personal asset. Firms in the corporate sector do not have the borrowing constraint.

3.6 Government

The government in the model economy collects taxes to finance wasteful government consumption, G, and a retirement benefit to each retiree. There are three taxes: income tax, capital gains tax, and corporate income tax. Workers' labor and capital income, as well as entrepreneurs' net profit and capital income, are subject to a progressive income tax, $T_y(y)$. Retirees also have to pay income taxes on their retirement benefits and their capital income. When entrepreneurs incorporate, they get the market value of their firms and pay a linear capital gains tax at the rate τ_k. The profit of C corporations is subject to a flat corporate income tax at the rate τ_c.

3.7 Households Problem

Young households are allowed to make occupational choice based on their state variables. Once a young household becomes old, it retires. The state variables are: private asset a, entrepreneurial ability z, working productivity s, business quality q, and organization capital h. Entrepreneurial ability z is a state, but it does not change across periods. Upon entering the economy, households are endowed with their z. At the beginning of each period, after they observe their labor productivity s and business quality q, young households make occupational choice. Households need to pay a sunk cost C_e in order to enter entrepreneurship. Workers choose between wage work and entrepreneurship. Entrepreneurs have three choices: they can keep running their firms, or shut down their firms and work for someone else, or sell their firms by incorporating. Incorporation entrepreneurs lose their full ownership and leave the firms that they founded. Hence, they have two occupational choices: either working for someone else as a worker or restarting a new business as an entrepreneur. The organization capital they have accumulated is embedded in the firm they have sold. Therefore, when incorporation entrepreneurs choose to start a new business, they need to accumulate organization capital once again.[7]

3.7.1 Old Retirees

All old households are retired, independent of their occupation when young. The state of old households is fully described by asset, a. The only uncertainty comes from the constant probability of dying in each period. Households are selfish, and they do not care about their descendant. Therefore, they do not have incentive to leave intended bequest.

$$\begin{aligned} &W^r(a) = \max_{c,a'} \; u(c,0) + \beta(1-\Omega_d)W^r(a') \\ &c + a' = y + a - T_y(y) \\ &y = \overline{\tau} + ra, \qquad a' \geq 0 \end{aligned} \tag{4}$$

[7]In my model, transition from C corporations to pass-through entities is not allowed. Hence there are only businesses that switch from pass-throughs to C corporations.

3.7.2 Young worker

Young workers choose labor supply l, consumption c, and saving a' to maximize their period utility and continuation value. When it comes to the next period, they make occupational choice between wage work and entrepreneurship.

$$
\begin{aligned}
&V^w(a, s, z) = \max_{c,a'} \; u(c, l) + \beta(1 - \Omega_o)\mathbb{E}\Big[\max\{V^w(a', s', z),\; V^e(a', h_0, q', z)\} \mid s\Big] + \beta\Omega_o W^r(a') \\
&s.t. \\
&c + a' = y + a - T_y(y) \\
&y = wsl + ra \\
&a' \geq 0 \qquad (5)
\end{aligned}
$$

3.7.3 Young entrepreneur

Based on their asset a, entrepreneurial ability z, business quality q, and organization capital h, entrepreneurs decide their capital and labor input to produce. If this is the first period that the household starts a business, indicated by $h = h_0$, the household needs to pay a sunk cost C_e. Entrepreneurs supply a fixed amount of labor l_e. Note that l_e does not enter production function. It indicates that entrepreneurs do not actually work in their businesses. However, they spend time and effort on thinking about how to run their firms.

$$
\begin{aligned}
&V^e(a, h, q, z) = \max_{c,a'} \; u(c, l_e) \\
&\qquad + \beta(1 - \Omega_o)\mathbb{E}\Big[\max\{V^w(a', s', z),\; V^e(a', h', q', z),\; V^i(a', h', q', z)\} \mid q\Big] + \beta\Omega_o W^r(a') \\
&s.t. \\
&c + a' = y + a - T_y(y) - C_e \times 1_{\{h=h_0\}} \\
&y = qh^{1-\gamma}(k^\alpha n^{1-\alpha})^\gamma - wn - \delta k - r(k - a) \\
&h' = h + e^z[qh^{1-\gamma}(k^\alpha n^{1-\alpha})^\gamma]^\psi \\
&k \leq \eta a, \\
&a' \geq 0 \qquad (6)
\end{aligned}
$$

3.7.4 Young incorporation entrepreneur

Given state variables, entrepreneurs make incorporation decision at the beginning of the period. The incorporation process takes one period. The firm becomes corporation and start producing in the corporate sector in that period. Incorporation entrepreneur sells the firm at its market value, which is the present value of the future profit stream defined as follows.

$$\Pi(\overline{h}, q) = \max_{k,n}(1-\tau_c)(q\overline{h}^{1-\gamma}(k^\alpha n^{1-\alpha})^\gamma - wn - (\delta + r)k) + \frac{1}{1+r}(1-D)\mathbb{E}[\Pi(\overline{h}, q')|q] \quad (7)$$

By incorporating, the entrepreneur pays a fixed incorporation cost, C, gets the present value of the stream of profit flows, pays capital gains tax, and chooses consumption and saving to maximize her period utility and continuation value. When it comes to the next period, the incorporation entrepreneurs choose between wage work and entrepreneurship. If they choose to start a new business, they need to accumulate organization capital for their new firms from the scratch. Incorporation entrepreneurs also supply a fixed amount of labor, l_e. It indicates that entrepreneurs need to spend time and effort to incorporate their firms. For example, they need to file the paperwork, prepare documents, etc.

$$\begin{aligned}
&V^i(a,h,q,z) = \max_{c,a'} \ u(c,l_e) + \beta(1-\Omega_o)\mathbb{E}\Big[\max\{V^w(a',s',z),\ V^e(a',h_0,q',z)\}\Big] + \beta\Omega_o W^r(a') \\
&s.t. \\
&c + a' = y + a + (1-\tau_k)\Pi(h,q) - C - T_y(y) \\
&y = ra \\
&a' \geq 0 \qquad (8)
\end{aligned}$$

3.8 Corporate Sector

The C corporation's objective is to maximize lifetime dividend flows for its shareholders described by equation (7). It decides how much capital to rent and how much labor to hire given the prevailing factor prices. C corporations in this model do not have borrowing constraint. And its profit is the dividend distributed to its shareholders in each period.

3.9 Equilibrium

The state space of the model comprises asset holdings $a \in \mathbb{A}$, organization capital holding $h \in \mathbb{H}$, entrepreneurial ability $z \in \mathbb{Z}$, labor productivity $s \in \mathbb{S}$, business quality $q \in \mathbb{Q}$, and occupation state $o \in \mathbb{O}$. There are four occupation states, $\mathbb{O} = \{YW,\ YE,\ YI,\ OR\}$, standing for young worker, young entrepreneur, young incorporation entrepreneur, and old retirees, respectively. Denote by $\Xi = \mathbb{A} \times \mathbb{Z} \times \mathbb{S} \times \mathbb{Q} \times \mathbb{H} \times \mathbb{O}$ the complete state space, and $\xi \in \Xi$ the state vector representing each household. Denote by $\Xi^C = \mathbb{Q}^C \times \mathbb{H}^C$ the state space, and $\xi^c \in \Xi^C$ the state vector representing each firm in corporate sector. A stationary equilibrium of the model is defined by

1. The interest rate r, wage w
2. Value functions
3. Policy functions: $c(\xi)$, $l(\xi)$, $a'(\xi)$, occupation choices
4. Capital input $k(\xi)$, labor input $n(\xi)$, organization capital $h'(\xi)$ for entrepreneurs
5. Capital input $k(\xi^c)$, labor input $n(\xi^c)$ for C corporations
6. Invariant distribution of households Λ
7. Invariant distribution of firms in corporate sector Λ^C

such that the following conditions hold:

1. Given prices and taxes, the households' decision rules and value functions solve their respective dynamic programming problems.
2. Given prices, C corporations choose optimal capital and labor input.
3. Government budget is balanced period by period.
4. Goods market clears

$$\begin{aligned} &\int f \ d\Lambda + \int f^c \ d\Lambda^C - \int C \cdot \mathbf{1}_{\{o=YI\}} \ d\Lambda - \int C_e \cdot \mathbf{1}_{\{o=YE_{new}\}} \ d\Lambda \\ &= \int c \ d\Lambda + \int (k' - (1-\delta)k) \ d\Lambda + G \end{aligned} \tag{9}$$

5. Factor markets clear
   Market clearing for labor

$$\int sl \cdot \mathbf{1}_{\{o=YW\}} d\Lambda = \int n \ d\Lambda + \int n \ d\Lambda^C \tag{10}$$

   Market clearing for capital

$$\int a \ d\Lambda = \int k \ d\Lambda + \int k \ d\Lambda^C \tag{11}$$

6. Firm value is given by equation (7)

7. Time-invariant distribution

$$(\Lambda, \Lambda^C) = \Gamma(\Lambda, \Lambda^C) \tag{12}$$

4 Calibration

This section explains how I map the model to the data. The model is calibrated through the simulated method of moments (SMM) in two steps. In the first step, a subset of the parameters is externally calibrated with estimates independent of the model or commonly used values in the literature. The first step parameters are listed in Table 1. In the second step, the remaining parameters are endogenously determined in the model to match some features of the US economy. Parameters calibrated to match model-generated moments are listed in Table 2.

Table 1: Parameters Imposed Exogenously on the Model

Parameter		Source	Value
Demographics and preferences			
Probability of retiring	Ω_o	Average working period	0.02
Probability of dying	Ω_d	Average retirement period	0.07
Risk aversion	σ_1	Attanasio et al. (1999)	1.5
Frisch elasticity of labor supply	σ_2	Keane (2011)	0.6
Labor supply by entrepreneurs	l_e		0.4
Endowment and productivity			
Persistence of labor productivity	ρ_s	Cagetti and De Nardi (2006)	0.95
Std. of labor productivity.	σ_s	Cagetti and De Nardi (2006)	0.40
Initial endowment of h	h_0	Normalization	1
Technology			
Organization capital share	$1-\gamma$	Atkeson and Kehoe (2005)	0.15
Elasticity of capital input	α	Labor income share of 0.64	0.25
Capital depreciation rate	δ	Stokey and Rebelo (1995)	0.06
Borrowing constraint	η	Kitao (2008)	1.5
Death rate of C corporations	D	Dyrda and Pugsley (2019)	0.09
Government Policies			
Retirement benefit	$\overline{\tau}$	Kotlikoff et al. (1999)	$0.4\overline{y}$
Income cutoff for the highest tax bracket	y_H	Kindermann and Krueger (2022)	$4\overline{y}$
Top marginal tax rate	τ_H	Piketty and Saez (2007)	0.26
Capital gains tax rate	τ_k	U.S. Department of the Treasury	0.15
Corporate income tax rate	τ_c	NIPA	0.20

4.1 Demographics and Preferences

Households enter the model economy at the age of 20. The probability of a young household moving to the retirement phase, Ω_o, is calibrated to match the expected duration of working life being 45 years. Similarly, the probability of dying, Ω_d, is calibrated to match the average duration of retirement being 15 years.

The utility function is of CRRA type and additively separable in consumption and labor.

$$u(c,l) = \frac{c^{1-\sigma_1}}{1-\sigma_1} - \chi \frac{l^{1+\frac{1}{\sigma_2}}}{1+\frac{1}{\sigma_2}} \tag{13}$$

I set the coefficient of risk aversion σ_1 in the utility function to be 1.5, which is in the middle of the range typically used in the literature, such as Attanasio et al. (1999). In line with existing studies, the value of σ_2 is chosen so that the corresponding Frisch elasticity of labor is 0.6, a medium-range value for the Frisch elasticity that tries to incorporate empirical results for both men and women; see, for example, Keane (2011). Following Dyrda and Pugsley (2019), the weight of the disutility of labor, χ, is calibrated such that average hours worked is 0.4, given one unit of time endowment of each household. The value of discount factor β is pinned down by targeting an interest rate of 4 percent annually following McGrattan and Prescott (2001). Labor supply by entrepreneurs is fixed at the average working time supplied by workers, i.e., $l_e = 0.4$.

4.2 Endowments and Productivity Process

There are three productivity endowments in this model. Households draw their entrepreneurial ability z when they first enter the model economy; then it stays fixed. Working productivity s and business quality q change stochastically in every period.

4.2.1 Entrepreneurial ability

The distribution of entrepreneurial ability z is a type I Pareto distribution characterized by a scale parameter z_{min} and a shape parameter ζ. The probability density function is

$$f_Z(z) = \frac{\zeta z_{min}^{\zeta}}{z^{1+\zeta}}, \qquad z_{min} \leq z \tag{14}$$

I discretize the value of z into grids, such that households have a large probability of drawing the lowest entrepreneurial ability and a very small probability of drawing the highest ability. As a result, most draws will turn out to be of low entrepreneurial ability. Since entrepreneurial ability directly affects a household's entrepreneurship entry decision, I calibrate the threshold parameter z_{min} to match the share of entrepreneurs. In the 2007 Survey of Consumer Finances (SCF), the share of entrepreneurs in working age population is 8%. To mimic features of entrepreneurs in the model, I define entrepreneurs in the SCF data as households who have an active management role in privately held businesses and hire at least one worker.[8] The shape parameter ζ is a tail index that measures the right skewness of the distribution. Since entrepreneurial ability z enters the organization capital accumulation equation, it governs how fast entrepreneurs can grow their businesses. Entrepreneurs with high z will eventually incorporate their firms. High entrepreneurial ability determines the productivity of the corporate sector. Therefore, the tail index, ζ, is identified mainly by the share of employment by C corporations, which is around 0.55 in the Statistics of U.S. Businesses data from Census Bureau.

4.2.2 Working productivity

In every period, a worker is endowed with one unit of time that can be allocated to leisure and work. One unit of work time yields a wage-earning ws, where s is the idiosyncratic labor productivity. I assume labor productivity for workers follows AR(1) process given by

$$log(s_t) = \rho_s log(s_{t-1}) + \sqrt{1-\rho_s^2}\sigma_s \varepsilon_t, \qquad \varepsilon \sim N(0,1) \tag{15}$$

The annual persistence of the autoregressive process for labor income, ρ_s, and the standard deviation of labor productivity, σ_s, are set to 0.95 and 0.40, respectively, following Cagetti and De Nardi (2006). I use Tauchen method to discretize this continuous AR(1) process into grid points, $\{s_1, ..., s_n\}$. Furthermore, in order to generate income and wealth distributions and the share of workers at the top 1% realistically, following Castaneda et al. (2003), I introduce a superstar labor state, s_H. As in Bruggemann (2021), I assume that from a lower state, there is a small probability, p_H, to jump to the highest productivity state. At the same time, with probability p_M, workers in the superstar labor state drop to the median labor productivity state. The transition probability of labor states is as follows.

$$\mathcal{P}_s = \begin{bmatrix} p_{11}(1-p_H), & p_{12}(1-p_H), & ..., & p_{1n}(1-p_H), & p_H \\ & \cdots & & \cdots & \\ p_{n1}(1-p_H), & p_{n2}(1-p_H), & ..., & p_{nn}(1-p_H), & p_H \\ 0, & 0, & ..., \; p_M, \; ... & 0, & 1-p_M \end{bmatrix} \tag{16}$$

[8]In the model presented in Section 3, entrepreneurs supply their labor to run their businesses. Their labor is not used in production. Hence, entrepreneurs in this model have to hire someone else to produce.

Overall, there are 3 parameters to be calibrated: s_H, p_H, p_M. They are calibrated to match wealth and income distributions as well as the Gini coefficient of labor income of 0.52 in SCF (2007).

Table 2: Parameters Calibrated Within the Model

Parameter		Value
Preferences		
Discount factor	β	0.96
Weight on disutility of labor	χ	1.58
Endowments		
Scale parameter of z distribution	z_{min}	0.16
Shape parameter of z distribution	ζ	2.74
Top labor state	s_H	21.02
Prob. of reaching the top labor state	p_H	0.002
Prob. of leaving the top labor state	p_M	0.15
Persistence of q	ρ_q	0.78
Std. of q	σ_q	0.23
Technology		
Curvature in h accumulation	ψ	0.73
Sunk cost	C_e	0.86
Incorporation cost	C	65.76
Government Policies		
Income tax level parameter	τ_y	0.93
Income tax progressivity parameter	λ	0.07

4.2.3 Business quality

I impose the following AR(1) process for business quality

$$log(q_t) = \rho_q log(q_{t-1}) + \sqrt{1-\rho_q^2}\sigma_q\varepsilon_t, \qquad \varepsilon \sim N(0,1) \tag{17}$$

The persistence of business quality shocks, ρ_q, is calibrated to match firm exit rates. More persistent business quality, i.e., higher ρ_q, implies a lower exit rate. It is especially relevant for the exit rate of young firms. Entrepreneurs start their businesses with the same initial endowment of organization capital, h_0. And I normalize h_0 to be 1. The profitability of young firms highly depends on business quality q because young firms do not have enough time to accumulate large organization capital to buffer against a bad q.

The previous studies usually use the share of entrepreneurs among the top 1% income as the targeted moment to pin down the parameter value of σ_q; see, for example, Bruggemann (2021), Imrohoroglu et al. (2021). In this model, σ_q affects business income in a similar way as in the previous literature. However, more importantly, it is the key parameter that induces firm exit in my model. Thus, the value of σ_q is constrained mainly by firm age profile. A more detailed discussion about how σ_q generates firm exit is at the end of this section.

4.3 Technology

There are two production sectors in this model: the entrepreneurial sector and the corporate sector. The entrepreneurial sector is populated by firms owned by entrepreneurs. Entrepreneurs produce and accumulate organization capital. The corporate sector is populated by firms owned by an unrestricted number of shareholders. There is no productivity growth in the corporate sector.

4.3.1 Entrepreneurial sector

There are two functions related to this sector, the production function

$$f(q_t, h_t, k_t, n_t) = q_t h_t^{1-\gamma}(k_t^{\alpha} n_t^{1-\alpha})^{\gamma}$$

and the organization capital accumulation equation

$$h_{t+1} = h_t + e^z[q_t h_t^{1-\gamma}(k_t^{\alpha} n_t^{1-\alpha})^{\gamma}]^{\psi}$$

Atkeson and Kehoe (2005) estimate the total payments owners of manufacturing firms receive from all intangible capital in the U.S. National Income and Product Accounts (NIPA) to be around $10 \sim 15$ percent of output. Hence, I set γ to be 0.85. The elasticity of the capital input α is disciplined by the labor income share of 0.64. The parameter ψ is between 0 and 1. It, thus, makes the accumulation equation concave. In particular, it slows down the firm growth when h is high. Therefore, the value of ψ is calibrated to match the growth rate of firms by age.

There are three more parameters related to an entrepreneur's production, the sunk cost to start a new business C_e, the depreciation rate δ, and the borrowing constraint η. On average, young households are poorer than the old. They do not have enough assets to pay for the sunk cost of starting a business. Hence, the sunk cost postpones the young households' choice to enter entrepreneurship. Following this logic, the value of C_e is calibrated to match the average age at first entry to entrepreneurship, which is around 32-36 years old (Hincapie (2020)). The depreciation rate, δ, is set to 0.06 as in Stokey and Rebelo (1995). The parameter that governs the entrepreneur's collateral constraint, $k \leq \eta a$, is set to 1.5 as in Kitao (2008), which implies that entrepreneurs cannot borrow more than 1.5 times their current assets.

4.3.2 Corporate sector

Firms in the corporate sector have the same production function as in the entrepreneurial sector. Due to the assumption that entrepreneurs leave their firms after incorporating, the organization capital of each C corporation is fixed at its incorporation level. Hence, C corporations do not have organization capital accumulation. I use an exogenous death shock, D, to induce firm exit in the corporate sector. D is set to 0.09, indicating that in each period, firms in the corporate sector face a constant death probability of 0.09. This value is borrowed from Dyrda and Pugsley (2019), which estimates the exit rate of C corporations to be around 9 percent using the Longitudinal Business Database. The value of incorporation cost, C, is calibrated so that C corporations account for 10 percent of the firms (Census Bureau).

4.4 Government Policies

The expenditure side of the government budget consists of wasteful government spending and total retirement benefits paid out to retirees. On the revenue side, there are three taxes: a progressive income tax, a flat capital gains tax, and a flat corporate income tax.

Government wasteful expenditure, G, is calibrated to balance the government budget. The retirement benefit paid to each retiree, $\overline{\tau}$, amounts to 40 percent of average gross income as in Kotlikoff et al. (1999).

I adopt the income tax system from Benabou (2002) and adjust it to study the top tax rate.

$$T_y(y) = \begin{cases} y - \tau_y y^{1-\lambda} & y \leq y_H \\ y_H - \tau_y y_H^{1-\lambda} + \tau_H(y - y_H) & y > y_H \end{cases} \tag{18}$$

The parameter τ_y determines the net tax revenue. λ governs the progressivity of the tax schedule. y_H is the threshold for incomes that are in the top income tax bracket. For incomes above y_H, there is a linear tax rate τ_H, which is the *top marginal tax rate*. Empirically, this tax schedule fits the income tax system in the U.S. remarkably well (Heathcote et al. (2017)). Later in my policy experiments, I change the value of τ_H and study the effects.

The parameter τ_y controls the average level of income taxes. It is calibrated to match the income tax revenue to GDP ratio, which is around 0.1 as in Guo (2022). The progressivity parameter λ is identified by the top income threshold y_H, because the marginal tax rate at the threshold level should be equal to the top tax rate τ_H, which can be written as

$$1 - \tau_y(1-\lambda)y_H^{-\lambda} = \tau_H. \tag{19}$$

Given τ_H and τ_y, λ is a monotonically decreasing function of y_H. Therefore, given the value of y_H, I can calculate the value for λ. The threshold value, y_H, is fixed at 4 times the average gross taxable income, as in Kindermann and Krueger (2022). Moreover, I set τ_H to 0.26. The top federal income tax rate is 0.35 in 2010. However, the effective tax rate is lower. Piketty and Saez (2007) estimate the average income tax rate of individuals in the 99.99^{th} to 100^{th} percentile of income distribution to be 0.26. Hence, I use this value as the top tax rate in my model. This value is also very close to the effective top marginal tax rate calculated by Bruggemann (2021), which is around 0.24.

Following the method proposed by McGrattan and Prescott (2005), I estimate an average U.S. corporate income tax rate in the period around 2010 of 20%. I, thus, set the linear corporate income tax rate, τ_c, to 0.2. The value of the flat capital gains tax rate is taken from the report by the U.S. Department of the Treasury, which is 0.15.

4.5 Discussion about Key Parameters

Relative to the standard entrepreneurship model in macroeconomics literature, there are five new technology parameters: the persistence of business quality shock ρ_q, the standard deviation of business quality shock σ_q, the shape parameter z_{min} and the tail index ζ associated with entrepreneurial ability, and the curvature parameter in organization capital accumulation equation ψ. They enter the output production function and the organization capital accumulation equation. Although there is not a one-to-one mapping between each parameter and each statistic, there are intuitive forces at work that guide me to choose certain empirical moments to match. More precisely, the Business Dynamics Statistics (BDS) data on firm dynamics are most informative for inference here because these technology parameters are quantitatively important in predicting the life path of a firm.

The standard deviation of business quality shock, σ_q, affects business income, just as in the previous literature. However, in this model, it plays an extra role as the key factor that induces firm exit. In the previous literature, firm exit is induced by assuming a hazard rate or an absorbing state in business quality. Moreover, in models of previous studies, the working productivity of entrepreneurs also changes according to a Markov chain. Hence, entrepreneurs may choose to shut down their businesses because their working productivity evolves to a better state that gives them higher value; see, for example, Imrohoroglu et al. (2021). However, in this paper, entrepreneurs draw new working productivity in each period from its initial distribution, which is concentrated around the mean. Therefore, to generate firm exit, the low states of business quality q have to be low enough such that once the entrepreneurs are hit by these low states, they choose to shut down their businesses.

The low states of q are so low that it is not optimal to run the business. As a result, households do not choose to start a business unless they draw a good q. Namely, firms start with high qs. The persistence parameter ρ_q affects how fast firms drop to lower qs. Given σ_q, a lower ρ_q means the business quality process is less persistent. Households start their businesses with a good q, but it drops to lower states quickly. As a result, entrepreneurs do not have enough time to accumulate h to buffer against the bad q. Fewer firms will survive, leading to a higher share of young firms and a lower share of old firms. Therefore, I use the standard targets on entrepreneur's income as well as the firm dynamics moments on firm age distribution to constrain the model and to pin down the value of σ_q and ρ_q. Firm age distribution provides information on firm exit rate by age.

As for the two parameters associated with entrepreneurial ability, z_{min} and ζ. The scale parameter z_{min} controls the overall entrepreneurial ability level. Since entrepreneurial ability directly affects a household's entrepreneurship entry decision, I calibrate the threshold parameter z_{min} to match the share of entrepreneurs in the SCF (2007) data. The tail parameter ζ affects the right skewness of entrepreneurial ability z. Only entrepreneurs with high zs can accumulate large h such that their firm value overcomes the incorporation cost. That is to say, firms in the corporate sector are those owned by entrepreneurs with high zs. Therefore, the value of high zs determines the hs of firms in the corporate sector. And the productivity of the C corporations has to match the fact that even though they account for only 15 percent of firms, more than half of the workers are employed by this sector. ζ is identified by the employment share of C corporations.

The organization capital accumulation equation is concave due to the parameter ψ. In particular, it slows down the firm growth when h is high. The value of ψ is pinned down by the growth rate of firms by age. However, due to the data availability, with the BDS data, I cannot keep track of the same group of firms across years and compute the growth rate of those firms at different ages. Thus, I use firm age distribution and the firm employment share by age as an indirect way to obtain information on growth rates.

5 Features of the Benchmark Economy

In this section, I evaluate the performance of the benchmark economy against the empirical targets. To conduct meaningful policy experiments regarding changes in the tax rates, a good fit of the model-generated data with respect to empirical facts is a requirement. I also assess the performance of the model against some data moments that were not explicitly targeted in the calibration, like the share of tax payment by different income groups.

There are 14 parameters to be calibrated within the model. However, I have more than 30 targeted moments to constrain the model. Successfully matching all these targets is a proof of good performance of the model. Table 3 presents the targeted moments on aggregates in the data and compares them to the model generated moments. The model moments match key features of the economy well. Especially the share of entrepreneurs among the top one percent income earners and the share of top one percent income held by entrepreneurs match their empirical counterparts.[9]

Table 3: Targeted Moments: Data and Model

Target	Source	Data	Model
Overall Economy			
Risk-free interest rate	McGrattan and Prescott (2001)	0.04	0.04
Income tax revenue/GDP	Guo (2022)	0.1	0.09
Corporate Sector			
Share of C corporations	Census Bureau	0.1	0.09
Employment share by C corps	Census Bureau	0.55	0.54
Entrepreneurs			
Share of entrepreneurs	Boar and Midrigan (2019)	0.08	0.08
Age first entry to entrepreneurship	Hincapie (2020)	32-36	34.08
Entrepreneurs's income Gini	SCF (2007)	0.64	0.66
Share of ents. in the top 1% income	SCF (2007)	0.45	0.41
Share of top 1% income held by ents.	SCF (2007)	0.50	0.53
Workers			
Average working time	Dyrda and Pugsley (2019)	0.40	0.45
Worker's income Gini	SCF (2007)	0.52	0.52

As described in the calibration section, parameters related to the labor productivity process and the shape parameter of the entrepreneurial ability distribution are calibrated by targeting the income and wealth distributions, especially the right tail. Tables 4 and 5 present the distributions of wealth and income in the model economy and compare them to the empirical distributions based on SCF (2007) data. The income and wealth distributions in the benchmark economy are very close to their empirical counterparts. As this model is developed to study the repercussions of higher taxes on top income earners, the benchmark

[9]I define entrepreneurs in the SCF data as households who have active management role in privately held businesses and hire at least one worker.

model must hit the upper tail of the distributions well. The model successfully replicates the top end of wealth distribution, where it deviates from the data by only 3 percentage points. Moreover, the top 1 percent of income earners, who are at the heart of my policy experiments, are reasonably well represented in the model economy.

Table 4: Wealth Distribution (%)

	Quintile				Top Groups		
	$1^{st}+2^{nd}$	3^{rd}	4^{th}	5^{th}	Top 10%	Top 5%	Top 1%
Data	0.88	4.45	11.24	83.42	71.42	60.34	33.60
Model	0.81	4.50	11.95	82.75	71.51	60.75	30.57

Table 5: Income Distribution (%)

	Quintile				Top Groups (Percentile)		
	$1^{st}+2^{nd}$	3^{rd}	4^{th}	5^{th}	Top 10%	Top 5%	Top 1%
Data	9.65	11.23	18.20	60.91	47.13	37.08	21.30
Model	12.88	9.62	16.71	60.79	46.01	36.11	21.37

One of the contributions of this paper is that it provides a model of entrepreneurship with firm dynamics. The model is able to match both the life-cycle of entrepreneurs and the key features of firm dynamics. For the entrepreneurs part, I use entrepreneurship participation rates by age as targeted moments to constrain the model. Figure 1 compares model generated participation rates with data. In the data, the entrepreneurship participation rate is increasing in age. The model successfully mimics this upward trend in data.

Figure 1: Entrepreneurship Participation Rate by Age

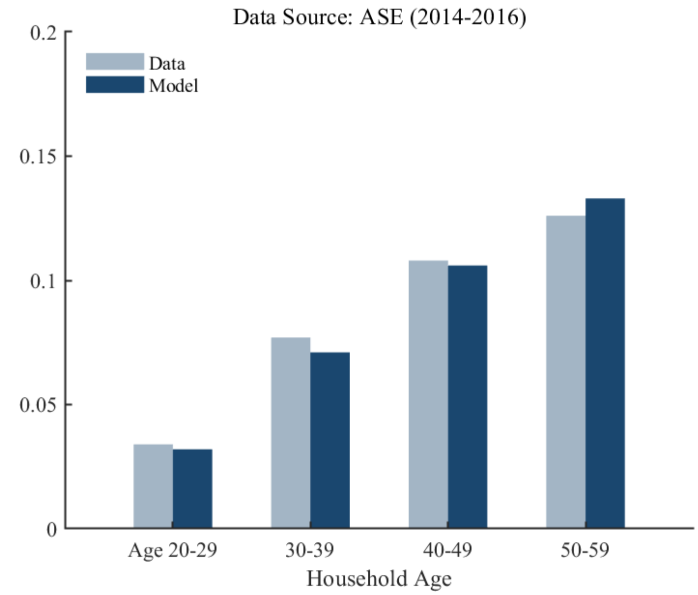
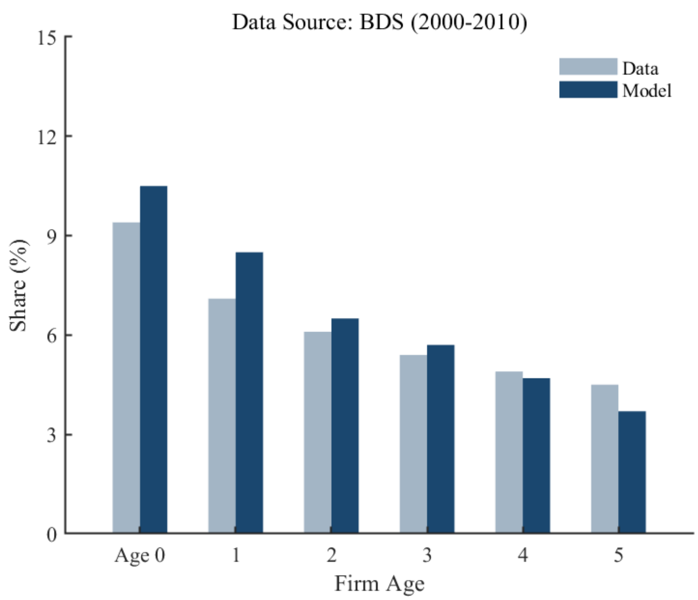
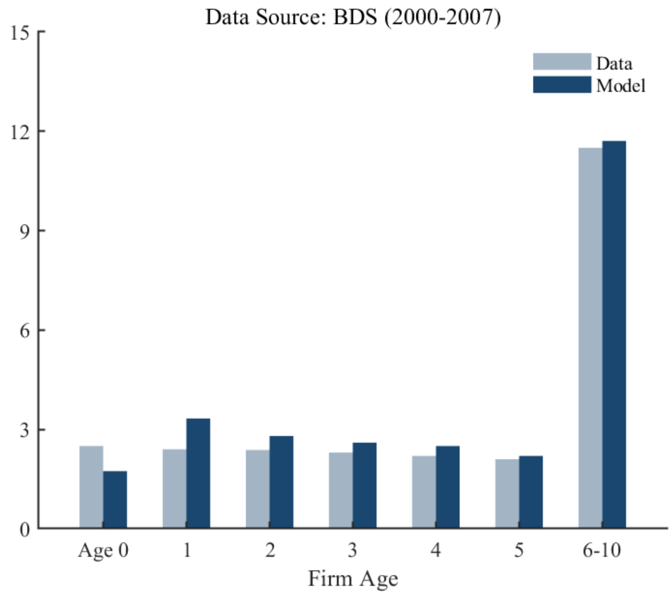


Figure 2: Firm Age Distribution



Since the main innovation of this paper is that it provides a framework where it is possible to study how the changes in entrepreneurs' decisions will affect the aggregate economy through firm growth and exit, it is important to ensure that the benchmark model can deliver realistic firm dynamics. Figure 2 presents the firm age distribution, provides information on firm exit rates by age. Figure 3 shows the firm employment share by age. Figures 2 and 3 together provide information on firm growth.

Figure 3: Firm Employment Share by Age



Untargeted Moments

Table 6 shows the distribution of income taxes paid in the data and the one generated by the model.[10] Due to the progressive income tax schedule, the distribution of tax payments is concentrated at the top income quintiles. In the data, for example, 74.6 percent of tax payments are attributable to the fifth income quintile. The model does a good job at replicating the tax burden that income-rich households face, especially given that the shares of tax payments presented in Table 6 are not targeted moments when calibrating the model.

Table 6: Share of Tax Payments by Each Income Group (%)

	Income Distribution Quintiles				
	1^{st}	2^{nd}	3^{rd}	4^{th}	5^{th}
Data	0.3	2.3	6.9	15.9	74.6
Model	1.06	3.58	5.89	14.21	75.35

[10]The share of tax payments by each group in the income distribution is borrowed from Guner et al. (2016).

6 Policy Experiments

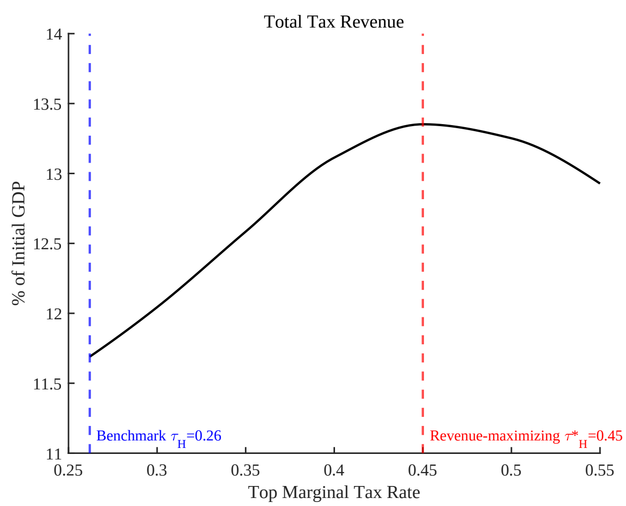
As demonstrated in the last section, this model can replicate the highly skewed income and wealth distribution well and sufficiently capture key features of firm dynamics. In this section, I investigate how entrepreneurs shape the economy's reaction to a change in the top marginal income tax rate.

In the benchmark model, the income tax schedule is

$$T_y(y) = \begin{cases} y - \tau_y y^{1-\lambda} & y \leq y_H \\ y_H - \tau_y y_H^{1-\lambda} + \tau_H(y - y_H) & y > y_H \end{cases}$$

where y_H is the cutoff value of taxable income above which households fall into the highest income tax bracket. I refer to those households as the top income earners. The top marginal tax rate in the benchmark model is 26 percent, i.e., $\tau_H = 0.26$. In the policy experiments, I vary the value of τ_H, while keeping the level of government spending (wasteful government expenditure G and retirement benefits to old retirees), as well as other tax parameters including the threshold value y_H at their benchmark level. Any additional tax revenue is redistributed by paying a lump-sum transfer, T, to all households to re-establish the government budget balance. Policy experiments are conducted in general equilibrium. Moreover, I focus only on the steady-state comparison without studying the transition path.

Figure 4: Laffer Curve



This figure shows the tax revenue as a percentage share of total output in the benchmark economy, when raising the top marginal tax rate from 26 percent to 55 percent while keeping the level of government spending as well as other tax parameters at their benchmark level.

The revenue-maximizing top marginal tax rates are determined through a grid search over potential rates. Starting from the benchmark steady state, I increase the top marginal tax rate. Then I solve the model for the new steady state. The government revenue is maximized when the top marginal tax rate is 45 percent. Figure 4 presents the government tax revenue as a percentage share of the total output in the benchmark economy when raising the top marginal tax rate from 26 percent to 55 percent. The government revenue peaks at tax rate of 45 percent.

Table 7: Macro Effects When $\tau_H = 0.45$

% Change	Overall	Entrepreneurial Sector	Corporate Sector
Interest rate (r)	21.83		
Wage (w)	-2.33		
Output (Y)	-5.25	-5.78	-4.81
Capital (K)	-12.99	-15.17	-11.88
Employment (N)	-1.77	-1.84	-1.71
Organization capital (H)	-6.90	-6.81	-7.00
Number of firms	2.41	2.89	-2.05

6.1 Effects on Aggregates

Table 7 reports the effects on aggregate variables when raising the top marginal tax rate to the revenue-maximizing level. Compared with the benchmark economy, the output in the new steady state decreases by 5.25%. Meanwhile, the aggregate capital and employment decreases by 12.99% and 1.77%, respectively. Capital drops to a larger degree than labor does, reflecting the increase in the interest rate. In the new steady state, the interest rate is 21.83% higher than that in the benchmark economy. Wages behave in the opposite way. It falls by 2.33%. Wages fall despite the drop in aggregate labor because the large decrease in capital leads to an overall decrease in the capital-labor ratio. When taking a closer look at the two production sectors separately, the output produced by the entrepreneurial sector and the corporate sector decreases by 5.78% and 4.81%, respectively. More importantly, there is also a drop in organization capital, which is the endogenous part of TFP. The aggregate organization capital decreases by 6.90% in the economy, with a 6.81% drop in the entrepreneurial sector and a 7.00% drop in the corporate sector. Lower wages and the lump-sum transfer encourage entry into entrepreneurship. As a result, the number of firms in the entrepreneurial sector increases by 2.89%. However, on the other hand, the number of firms in the corporate sector falls by 2.05%. Taken together, these two effects lead to a 2.41% increase in the total number of firms in the economy.

6.2 Heterogeneous Responses of Entrepreneurs

Behind the changes in aggregates are the different responses by entrepreneurs with different abilities to the higher top marginal tax rates. Two interesting effects emerge.

Productivity Investment Effect

Entrepreneurs build up their firms over time by investing in organization capital. Top income tax rates distort the productivity investment decisions of entrepreneurs who are already in the top income bracket. More importantly, those who are still building up their firms in the hope of becoming rich in the future are also affected. More precisely speaking, there is a clear behavioral change of entrepreneurs whose ability is in the $98-99.5^{th}$ percentile of entrepreneurial ability distribution of the whole population. They account for around 10% of all the entrepreneurs. I call them *middle-ability entrepreneurs*, hereafter.

Middle-ability have high abilities. It is usually more optimal for them to run a business in the entrepreneurial sector than working for someone else. However, their ability is not high enough, so that they can build up large firms to incorporate. Therefore, middle-ability entrepreneurs stay in the entrepreneurial sector over their lifetime. Most of them do not incorporate. Moreover, they are very likely to become top income earners later in life if they keep accumulating productivity.

Increasing the top tax rate lowers the marginal benefits of productivity investment that these entrepreneurs receive later. As a result, they have less incentive to build up their firms. The left panel of Figure 5 plots the average organization capital of firms of different ages run by middle-ability entrepreneurs. In the new steady state, the accumulation of organization capital by middle-ability entrepreneurs gets slower than that in the benchmark economy. Therefore, the top tax rates not only distort the actions of those who are currently in the top tax bracket but also discourage productivity accumulation by entrepreneurs who earn less today but could earn more in the future by building up their businesses. This dynamic effect further dampens the productivity drop in the entrepreneurial sector.

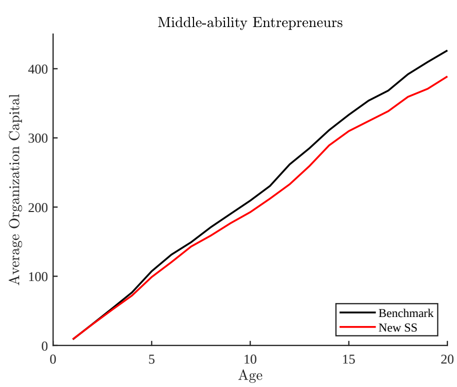
Furthermore, since middle-ability entrepreneurs invest less in their productivity accumulation, it takes them longer to accumulate large enough productivity to incorporate. In the benchmark economy, it takes the middle-ability entrepreneurs 35.53 years to incorporate their firms; whereas in the new steady state, it takes them 39.55 years. As a result, the number of firms in the corporate sector founded by middle-ability entrepreneurs decreases by 9.38% in the new steady state with tax rate of 45%.

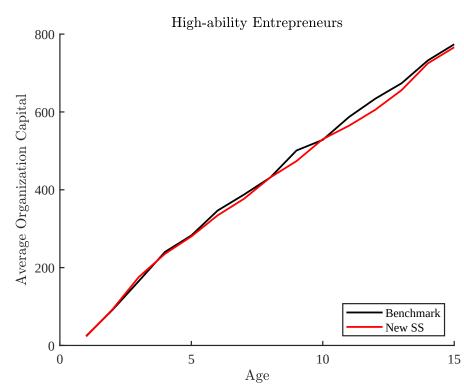
Incorporation Timing Effect

Another interesting finding emerges from Figure 5. The right panel of Figure 5 shows the average organization capital of firms at each age run by entrepreneurs whose ability is the top 0.5% of entrepreneurial ability distribution of the whole population. They account for $5-6\%$ of all the entrepreneurs. I call them *high-ability entrepreneurs*, hereafter.

Entrepreneurs with extremely high abilities are good at building up firms. They incorporate the most. 67% of firms in the corporate sector are founded by high-ability entrepreneurs. Furthermore, after they incorporate, they always choose to restart a new firm. Hence, they are the *serial entrepreneurs*. From the right panel of Figure 5, there is no significant difference between the benchmark economy and the new steady state. Hence, unlike the middle-ability entrepreneurs, high-ability entrepreneurs do not reduce their productivity investment to avoid taxes. For these entrepreneurs, since their ability is extremely high, they fall into the top income bracket soon after they start a business. Therefore, slowing down productivity accumulation is not an optimal way for them to avoid the high tax rate.

Figure 5: Average Organization Capital by Firm Age





This figure plots the average organization capital of firms of different ages in the entrepreneurial sector. The left panel presents firms owned by middle-ability entrepreneurs. The right panel is the firms founded by high-ability entrepreneurs.

Instead, high-ability entrepreneurs use incorporation as a tax shelter to avoid the high income tax. Namely, the productivity threshold for serial entrepreneurs to incorporate becomes lower in the new steady state with the top tax rate of 45%. It is a result of the feature of the tax code – the sale of a firm is treated as capital gains, which are taxed at a lower rate than personal income. Particularly, when entrepreneurs incorporate, they get their firm value, which is the present value of the future profit stream. As entrepreneurs cash out of their businesses through incorporation, they only need to pay capital gains tax, instead of income tax. Therefore, in the new steady state with a higher top tax rate of 45%, high-ability entrepreneurs have incentive to incorporate early. Hence, top tax rates distort the incorporation timing and push serial entrepreneurs to sell before their firms reach the full productivity potential. On average, in the new steady state, high-ability entrepreneurs run their firms for only 10.04 years before they incorporate, whereas in the benchmark economy, it takes 12.07 years to incorporate. Due to the more frequent incorporation by high-ability entrepreneurs, the number of firms in the corporate sector founded by high-ability entrepreneurs increases by 4.03%. It mitigates the drop in the number of firms in the corporate sector coming from the middle-ability entrepreneurs. As a result, the overall number of firms in the corporate sector falls by 2.05%.

As high ability entrepreneurs speed up their incorporation process, they do not have enough time to grow their firm productivity to the optimal level before incorporating. They take the premature firms to the corporate sector. It lowers the productivity in the corporate sector. Hence, the total organization capital in the corporate sector falls by 7.00% compared with the benchmark economy. Namely, higher top income tax rate distorts the incorporation timing of high-ability entrepreneurs, leading to a drop in corporate productivity.

It is noteworthy that middle-ability entrepreneurs do not use incorporation as a tax shelter. It is because once the entrepreneurs incorporate their businesses, they have to leave their firms; and if they choose to restart a business, they will need to accumulate organization capital for their new firms all over again. Only the high-ability entrepreneurs have high enough ability that can support them to grow a firm quickly. The middle-ability entrepreneurs need longer time to build up a new business.

7 Conclusion

This paper studies the effects of taxing top incomes in an environment where most top earners are entrepreneurs. This topic has recently attracted a lot of attention because wealth and income have become more unevenly distributed over the last several decades. The concern of raising the top marginal income tax rate is that high taxes on the rich cause large output losses. The literature considers a variety of of decisions that are distorted by top tax rates. Correspondingly, the optimal top tax rate suggested by the literature varies.

In this paper, I focus on two specific entrepreneurial activities that are distorted by top income taxation. First, entrepreneurs build up their firms over time by investing in organization capital. Taxing top earners then discourages entrepreneurs to grow their firms. It lowers the productivity in the entrepreneurial sector. The second activity that is distorted by top tax rates is the sale of firms. Successful entrepreneurs eventually sell their firms to the corporate sector through incorporation to gain access to capital market. The productivity of the corporate sector depends on the productivity of each firm incorporated by entrepreneurs. Taxing top earners distorts entrepreneurs' incorporation decision, thus, lowers corporate sector productivity. As a result, even though the top marginal tax rates are levied only on a small fraction of households, they have the potential to reduce productivity throughout the economy. A decline in productivity reduces the tax base and, thus, constrains the optimal tax rate. In my model economy, the revenue-maximizing top marginal tax rate is 45 percent.

This paper is the first work that connects the household occupational choice literature, the firm dynamics literature, and the legal form of organization literature. The model framework can be applied to study various of topics. For example, the analysis about income taxation in this paper largely depends on the assumption that the capital gains tax and the corporate income tax are fixed at their benchmark level. Relaxing this assumption allows us to study the optimal tax combination. Moreover, it can also be used to discuss topics on entrepreneurial activities. Structural macroeconomic models with firm heterogeneity have gained on popularity and importance, but they typically ignore the role of entrepreneurs. Studying the macroeconomic impact of entrepreneurship and its relation to average firm dynamics will constitute a further step towards a better understanding of how policies, related to taxation, bankruptcy, and financing, can be used to affect the economy. Lastly, there is no externalities in this model. If firms create positive externalities, taxing entrepreneurs would be even less attractive. There are a number of interesting extensions in this direction. One of the many possibilities would be that firms create "good jobs" that benefit workers.

References

Arrow, K. J. (1962). The economic implications of learning by doing. *The Review of Economic Studies*, 29(3):155–173.

Atkeson, A. and Kehoe, P. (2005). Modeling and measuring organization capital. *Journal of Political Economy*, 113(5):1026–1053.

Attanasio, O. P., Banks, J., Meghir, C., and Weber, G. (1999). Humps and bumps in lifetime consumption. *Journal of Business & Economic Statistics*, 17(1):22–35.

Badel, A., Huggett, M., and Luo, W. (2020). Taxing Top Earners: a Human Capital Perspective. *The Economic Journal*, 130(629):1200–1225.

Benabou, R. (2002). Tax and education policy in a heterogeneous-agent economy: What levels of redistribution maximize growth and efficiency? *Econometrica*, 70(2):481–517.

Bhandari, A. and McGrattan, E. R. (2020). Sweat equity in u.s. private business. *The Quarterly Journal of Economics*, 136(2):727–781.

Boar, C. and Midrigan, V. (2019). Markups and inequality. NBER Working Papers 25952, National Bureau of Economic Research, Inc.

Bruggemann, B. (2021). Higher taxes at the top: The role of entrepreneurs. *American Economic Journal: Macroeconomics*, 13(3):1–36.

Buera, F. J., Kaboski, J. P., and Shin, Y. (2015). Entrepreneurship and financial frictions: A macrodevelopment perspective. *Annual Review of Economics*, 7(1):409–436.

Buera, F. J. and Shin, Y. (2013). Financial frictions and the persistence of history: A quantitative exploration. *Journal of Political Economy*, 121(2):221–272.

Cagetti, M. and De Nardi, M. (2006). Entrepreneurship, frictions, and wealth. *Journal of Political Economy*, 114(5):835–870.

Carbonara, E., Tran, H. T., and Santarelli, E. (2020). Determinants of novice, portfolio, and serial entrepreneurship: an occupational choice approach. *Small Business Economics*, 55(1):123–151.

Castaneda, A., Díaz-Giménez, J., and Ríos-Rull, J.-V. (2003). Accounting for the u.s. earnings and wealth inequality. *Journal of Political Economy*, 111(4):818–857.

Clementi, G. L. and Palazzo, B. (2016). Entry, exit, firm dynamics, and aggregate fluctuations. *American Economic Journal: Macroeconomics*, 8(3):1–41.

Diamond, P. and Saez, E. (2011). The case for a progressive tax: From basic research to policy recommendations. *Journal of Economic Perspectives*, 25(4):165–90.

Dyrda, S. and Pugsley, B. (2019). Taxes, private equity and evolution of income inequality in the u.s. *Working Paper*.

Ericson, R. and Pakes, A. (1995). Markov-perfect industry dynamics: A framework for empirical work. *The Review of Economic Studies*, 62(1):53–82.

Felix, S., Karmakar, S., and Sedlacek, P. (2022). Serial entreprenuers and the macroeconomy. *CEPR Discussion Paper 16449*.

Fort, T. C., Haltiwanger, J., Jarmin, R. S., and Miranda, J. (2013). How firms respond to business cycles: The role of firm age and firm size. *IMF Economic Review*, 61(3):520–559.

Gabaix, X., Lasry, J.-M., Lions, P.-L., Moll, B., and Qu, Z. (2016). The dynamics of inequality. *Econometrica*, 84(6):2071–2111.

Gentry, W. M. and Hubbard, R. G. (2004). Entrepreneurship and household saving. *Advances in Economic Analysis & Policy*, 4(1).

Guner, N., Lopez-Daneri, M., and Ventura, G. (2016). Heterogeneity and government revenues: Higher taxes at the top? *Journal of Monetary Economics*, 80:69–85.

Guo, Y. (2022). Inheritance, wealth distribution, and estate taxation. *Working Paper*.

Haltiwanger, J. (2012). Job creation and firm dynamics in the united states. *Innovation Policy and the Economy*, 12:17–38.

Haltiwanger, J., Jarmin, R. S., and Miranda, J. (2013). Who creates jobs? small versus large versus young. *The Review of Economics and Statistics*, 95(2):347–361.

Heathcote, J., Storesletten, K., and Violante, G. L. (2017). Optimal Tax Progressivity: An Analytical Framework*. *The Quarterly Journal of Economics*, 132(4):1693–1754.

Hincapie, A. (2020). Entrepreneurship over the life cycle: Where are the young entrepreneurs? *International Economic Review*, 61(2):617–681.

Hopenhayn, H. A. (1992). Entry, Exit, and Firm Dynamics in Long Run Equilibrium. *Econometrica*, 60(5):1127–1150.

Imrohoroglu, A., Kumru, C., and Nakornthab, A. (2021). Revisiting taxes on high incomes. *Working Paper*.

Jones, C. I. (2022). Taxing top incomes in a world of ideas. *Journal of Political Economy*, 130(9).

Keane, M. P. (2011). Labor supply and taxes: A survey. *Journal of Economic Literature*, 49(4):961–1075.

Kindermann, F. and Krueger, D. (2022). High marginal tax rates on the top 1 percent? lessons from a life-cycle model with idiosyncratic income risk. *American Economic Journal: Macroeconomics*, 14(2):319–66.

Kitao, S. (2008). Entrepreneurship, taxation and capital investment. *Review of Economic Dynamics*, 11(1):44–69.

Kotlikoff, L. J., Smetters, K., and Walliser, J. (1999). Privatizing social security in the united states—comparing the options. *Review of Economic Dynamics*, 2(3):532–574.

Lev, B. and Radhakrishnan, S. (2005). The valuation of organization capital. In *Measuring Capital in the New Economy*, pages 73–110. National Bureau of Economic Research, Inc.

McGrattan, E. and Prescott, E. (2001). Is the stock market overvalued? NBER Working Papers 8077, National Bureau of Economic Research, Inc.

McGrattan, E. R. and Prescott, E. C. (2005). Taxes, Regulations, and the Value of U.S. and U.K. Corporations. *The Review of Economic Studies*, 72(3):767–796.

Piketty, T. and Saez, E. (2007). How progressive is the u.s. federal tax system? a historical and international perspective. *Journal of Economic Perspectives*, 21(1):3–24.

Piketty, T. and Saez, E. (2013). Chapter 7 - optimal labor income taxation. In Auerbach, A. J., Chetty, R., Feldstein, M., and Saez, E., editors, *handbook of public economics, vol. 5*, volume 5 of *Handbook of Public Economics*, pages 391–474. Elsevier.

Piketty, T., Saez, E., and Zucman, G. (2018). Distributional national accounts: Methods and estimates for the united states. *The Quarterly Journal of Economics*, 133(2):553–609.

Quadrini, V. (2000). Entrepreneurship, saving, and social mobility. *Review of Economic Dynamics*, 3(1):1–40.

Rosen, S. (1972). Learning by experience as joint production. *The Quarterly Journal of Economics*, 86(3):366–382.

Sedlacek, P. and Sterk, V. (2017). The growth potential of startups over the business cycle. *American Economic Review*, 107(10):3182–3210.

Sedlacek, P. and Sterk, V. (2020). Startups and Employment Following the COVID-19 Pandemic: A Calculator. CEPR Discussion Papers 14671, C.E.P.R. Discussion Papers.

Smith, M., Yagan, D., Zidar, O., and Zwick, E. (2019). Capitalists in the twenty-first century. *The Quarterly Journal of Economics*, 134(4):1675–1745.

Sterk, V., Sedláček, P., and Pugsley, B. (2021). The nature of firm growth. *American Economic Review*, 111(2):547–79.

Stokey, N. L. and Rebelo, S. (1995). Growth effects of flat-rate taxes. *Journal of Political Economy*, 103(3):519–550.

Tan, E. (2022). Entrepreneurial investment dynamics and the wealth distribution. *Working Paper*.

Tian, C. (2015). Riskiness, endogenous productivity dispersion and business cycles. *Journal of Economic Dynamics and Control*, 57:227–249.

Tian, C. (2018). Firm-level entry and exit dynamics over the business cycles. *European Economic Review*, 102:298–326.

Tomer, J. F. (1987). Organizational capital: The path to higher productivity and well-being. *Praeger*.