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Taxation and Entrepreneurship in the United States

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Keywords: Entrepreneurship, Taxation, Tax Progressivity, Business Risk, Insurance
JEL Classification: E20, E62, H24, J24, J48, L26

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Taxation and Entrepreneurship in the United States*

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1 Introduction

Entrepreneurs, owning and managing their private businesses, are an important part of the U.S. economy and its growth (see, e.g., among others, Lucas (1978), King and Levine (1993) and Evans and Jovanovic (1989)). They own more than 40% of total capital and hire more than half of private sector workers.[1] Across states and time there is, however, substantial heterogeneity in entrepreneurial activity.[2] Is this variation due to differences in public policy, such as the tax and transfer system, or is it explained by other differences between states? As is well known, entrepreneurial careers are associated with higher returns, compared to working in the labor market, but also higher risk. Would a more progressive tax system, which would reduce the risk but also the return to becoming an entrepreneur, lead to more or less entrepreneurs? This question is especially relevant in the 21^{st} century, a time of growing income and wealth inequality (see e.g., Piketty (2014)), when academics and policy makers are debating more redistributive policies.

In this paper, we contribute to the understanding of the relationship between taxation and entrepreneurial choice, both empirically and quantitatively. We first provide new empirical evidence of a strong negative relationship between higher and more progressive taxes and different measures of entrepreneurial activity across U.S. states and time. Next, to understand the mechanisms behind this relationship and to evaluate the effects on employment, output and welfare, we develop a life-cycle, overlapping generations model with incomplete markets, heterogeneous agents and entrepreneurial choice. Our model generates local (untargeted) elasticities of entrepreneurship with respect to taxation that are similar to those we document in the data[3]. This has significant macroeconomic implications, and we use our model to study the effects of major tax reforms, such as the conversion to a flat tax, as well as policies that maximize steady state welfare.

We begin with an empirical analysis of the relationship between the tax system and entrepreneurship in the U.S. We combine tax data from the NBER TAXSIM with household data from the Current Population Survey (CPS) and firm data from the County Business Pattern (CBP) to generate a dataset with different measures of tax level and progressivity as well as measures of entrepreneurship in the U.S. by state and year. We measure the tax level as the average tax rate at different percentiles of the income distribution or as the average tax rate at multiples of average earnings. Tax progressivity is measured either as the increase in the tax rate for earnings above the average or by estimating a parametric tax function as in Benabou (2002) and Heathcote

[1] See e.g. the 2016 Survey of Consumer Finances (SCF) and the 2015 Statistics of the U.S. Businesses. Kitao (2008) and Robinson (2021) refer to numbers of a similar magnitude.

[2] For example, in the summary statistics in Table A1 in the Appendix, the coefficient of variation for the population share of entrepreneurs is as high as 25%. Some states in the U.S. have 18% entrepreneurs and others have just 8%. Even if we control for state level fixed effects, the standard deviation of the population share is about 2 p.p., and the corresponding coefficient of variation is still as large as 16%.

[3] The model elasticities of entrepreneurship with respect to taxation are similar to the elasticities of measures of entrepreneurship derived from the County Business Pattern (CBP), whereas the elasticities of measures derived from the Current Population Survey (CPS) are higher than in the model.

et al. (2017): $y_a = \theta_0 y^{1-\theta_1}$, where y_a denotes after-tax income and θ_0 and θ_1 define the level and progressivity of the tax system, respectively. Our main measures of entrepreneurial activity are the number of households reporting to be entrepreneurs, the number of small establishments and the employment at small establishments.

We study the impact of the tax level and progressivity on entrepreneurship across time and states. Our benchmark method of analysis is a panel regression framework where we regress measures of entrepreneurship on measures of taxation. We control for a rich set of state level characteristics – including state fixed effects, and time-varying, local, economic and demographic conditions. Finally, we follow Bloom et al. (2002) and Akcigit et al. (2022), and use past state-level tax measures as instrumental variables to limit the influence of any other variables that may be correlated with current state-level tax changes. We find that there is a robust, negative relationship between entrepreneurship and tax level and progressivity. For example, we find that a one percentage point increase in the tax rate at median income leads to 4.5% fewer entrepreneurs, 1.3% fewer small firms, and 1.5% fewer employees at small firms. A 1% increase in our estimated index of tax progressivity, θ_1, leads to 1.0% fewer entrepreneurs, 0.4% fewer small firms, and 0.2% fewer employees at small firms.

To explain these empirical findings and to evaluate the impact of taxation on output, employment and welfare, we develop a structural life-cycle, incomplete markets model with entrepreneurial choice, in the spirit of Quadrini (2000) and Cagetti and De Nardi (2006). Our model contains many of the elements that have been emphasized in the literature on entrepreneurial choice such as savings, investment and labor supply decisions; fixed and changing productivity for workers and entrepreneurs; entry and exit costs for entrepreneurs. In addition, we have a progressive tax system, as in Benabou (2002) and Heathcote et al. (2017) that allows us to perform counterfactual experiments.

We calibrate our model to resemble the U.S. economy and find that it matches a variety of data moments well. It also generates (untargeted) elasticities of entrepreneurship with respect to the level and progressivity of the tax schedule that are similar to the elasticities of the number of small firms and the employment at small firms in the CBP data (the measures of entrepreneurship constructed form the CPS are somewhat more elastic).

Theoretically, it is not straightforward that an increase in tax level or progressivity would lead to a drop in entrepreneurship. In Sections 4.1 and A.3 we illustrate this using simple models. In simple models without capital, an increase in tax progressivity has the opposing effects of making entrepreneurship less risky but also less profitable. Quantitatively, it is, however, the latter effect that dominates. Since entrepreneurs on average earn more than workers, there is a direct negative effect of more progressive taxes on the expected returns to entrepreneurship. However, both higher and more progressive taxes make it harder for workers to accumulate the necessary assets to start a business. When taxes become more progressive, more entrepreneurs become borrowing constrained and the average age of entrepreneurs increases. With less savings, the returns to entrepreneurship go down (constrained entrepreneurs cannot invest optimally in productive capital) and the insurance against income risk falls (even if the risk is relatively smaller with more progressivity), making entrepreneurship less attractive. The effect of taxes on savings turns out to be an important driver of entrepreneurial choice in the model.

With the calibrated model in hand, we conduct a macroeconomic analysis of policy reforms. We begin by asking whether differences in tax policy is the main driver of variation in entrepreneurship across U.S. states and time. We treat our calibrated benchmark model with the tax functions that we estimated in each state and year and compare the model outcomes to the data. We find that differences in tax policy cannot explain a large fraction of the raw variation in entrepreneurship. The reason is that there is simply not enough interstate variation in taxation. Other differences between states matter more. However, if we control for state and time fixed effects, we find that taxation can explain about 30% of the remaining variation in entrepreneurship.

We also study the macroeconomic impacts of large tax reforms. We find that converting to a flat tax (keeping the average tax rate constant) would increase the number of entrepreneurs by 25% and output by 4.5%, whereas doubling the progressivity of the tax code would lead to a 40% reduction in the number of entrepreneurs and a 5.6% drop in output. When evaluating the socially optimal tax system there is, however, a trade-off between efficiency on the one hand and distributional concerns and insurance on the other. We study the impact of tax progressivity on the expected welfare of an unborn agent in steady state, and not surprisingly, we find that it is not monotonically decreasing in tax progressivity. Under the benchmark assumption of a small open economy, we find that the current U.S. tax progressivity level is quite close to optimal. The optimal system is 26% less progressive than the current one but the welfare gain from switching is modest. Under an alternative assumption of capital market equilibrium we find it optimal to switch to a 52% less progressive tax system, which would result in a welfare gain of 0.4%. The reason for the difference is the general equilibrium effect on wages. A drop in tax progressivity leads to more entrepreneurs, more demand for workers and higher wages.

The remainder of the paper is organized as follows: Section 2 discusses the related literature. In Section 3, we conduct an empirical analysis of the relationship between entrepreneurial activity and taxation. Section 4.1 uses simple models to develop an intuition for how taxation affects entrepreneurial choice. In Section 5 we develop our quantitative OLG model with entrepreneurial choice. Section 6 is devoted to the model calibration and estimation. In Section 7 we study local model-implied elasticities of entrepreneurship with respect to taxation, entrepreneurship across the household distribution and we disentangle the mechanisms of entrepreneurial choice. Section 8 analyses the macroeconomic impacts of larger tax reforms and studies the policy that maximizes steady state social welfare. We conclude in Section 9.

2 Relation to the Literature

Our paper relates both to the empirical literature on taxation and entrepreneurship and to the quantitative macro literature that studies the effects of taxation in economies with explicit modeling of an entrepreneurial sector. While there is a larger literature focusing on corporate taxation[4], the empirical literature on income taxation and entrepreneurship is quite limited. In an earlier influential work, Gentry and Hubbard (2000) use PSID survey data from 1978 to 1992, and find that progressive marginal tax rates discourage entry into self-employment and into business ownership. This is consistent with our findings in Section 3. Our paper is, however, the first to estimate elasticities of the number of entrepreneurs and employment at entrepreneurial firms with respect to the level and progressivity of the personal income tax code. Comparing to Gentry and Hubbard (2000), we use more micro-level data sets, more entrepreneurial variables and more tax function measures. Our estimates can serve as benchmarks for structural macro models.

The modeling of an entrepreneurial sector in quantitative macro models goes back at least to the classic contributions by Quadrini (2000) and Cagetti and De Nardi (2006), and in our model in Section 5 we borrow extensively from these papers. Early studies of taxation in quantitative macro models with an entrepreneurial sector and occupational choice include Meh (2005) and Kitao (2008). Meh (2005) studies the importance of entrepreneurship when quantifying the aggregate and distributional effects of switching from a progressive to a proportional income tax system. He finds that the reform has a positive effect on output but unlike our empirical and quantitative results there is no effect on the number of entrepreneurs. Kitao (2008) studies the impact of business taxation and capital taxation on entrepreneurial investments, aggregate variables and the wealth distribution. She finds that lower business taxes lead to a significant increase in output.

Among more recent studies, Guvenen et al. (2022b), Guvenen et al. (2022a) and Boar and Midrigan (2022) focus on optimal wealth vs. capital taxation in models with an entrepreneurial sector. In these papers there is, however, no occupational choice. The number of entrepreneurs is fixed. Boar and Knowles (2022) study optimal capital and wealth taxation in a model with a one-time choice of occupation, made at birth, and risky capital investments for entrepreneurs. Brüggemann (2021) studies the optimal top marginal income tax rate on the top 1% of the richest individuals in a Bewley-Huggett-Aiyagari type economy with entrepreneurial choice. She finds that it is optimal to set the tax rate to about 60% on the top 1%. There is, however, no contrast between this finding and our findings on optimal tax progressivity in Section 8.4. With our progressive tax schedule we capture the impact of progressivity on marginal entrepreneurs who make a choice between being a worker and an entrepreneur, whereas Brüggemann (2021) studies the optimal way to redistribute from the very richest entrepreneurs, which are not marginal and will stay where they are.

[4]See, among others, Chetty and Saez (2005), Auerbach and Gorodnichenko (2012) and Mertens and Ravn (2013)).

The focus of our paper is different from the above papers in that it focuses on the elasticity of entrepreneurial choice with respect to the income tax code. To build realistically calibrated macro models suitable for policy analysis, it is important to make sure that the extensive margin of entrepreneurship is in line with the data. We contribute with empirical estimates and a quantitative macro model that can match the data.

3 Empirical Analysis

In this section we use U.S. household, firm and tax data to study the relationship between taxation and different measures of entrepreneurial activity. We find strong evidence of a negative relationship between entrepreneurship and tax level and progressivity.

3.1 Data Sources

We obtain micro data on households from the Current Population Survey (CPS) and data on small businesses from the County Business Pattern (CBP). The NBER TAXSIM provides us with tax data across U.S. states and time.

3.1.1 The Current Population Survey (CPS)

We use the Annual Social and Economic Supplement of the CPS data (obtained from IPUMS) from 1962 to 2019 (CPS march). This survey provides a relatively large sample in the cross-section, representative of each state, and is widely used among economists and policymakers. For our purpose, we mostly use aggregate statistics for each state and year, based on the individual responses to questions about work, employment and income.

We define entrepreneurs as households where either the household head or the spouse are self-employed, with an incorporated or unincorporated firm (using the variable "classwkr"). This is similar to the definition traditionally used in the literature (see e.g. Quadrini (2000), Cagetti and De Nardi (2006), Hurst and Lusardi (2004)). Conceptually, entrepreneurs are households who put both their human and financial capital into operating a business, usually owning 100% of the firm (there are of course exceptions such as partnerships).[5] Across all years, the national population share of entrepreneurs is about 11.7% in CPS.[6] For each state and year, we compute the population share as well as the total (weighted) count of entrepreneurs. The CPS also reports business income

[5] Since the CPS does not ask about assets and business ownership, we could not further restrict our definitions with information on business equity or business ownership. The focus of our empirical analysis is on the so-called "pass-through businesses", which include sole proprietorships, partnerships, or S corporations that are not subject to the corporate income tax; instead, these "pass-through businesses" report their income on the individual income tax returns of the owners and are taxed at individual income tax rates.

[6] Using Survey of Consumer Finances (2016) data, this share would be about 12.8%. This number is also very close to other estimates in the literature.

for each person within the household. We compute the mean and also the total amount of business income for each state and year.[7]

3.1.2 County Business Pattern (CBP)

The CBP data from the U.S. Census Bureau provides annual statistics for all establishments with paid employees within the U.S. We use state-level data from 1986 to 2018. For each state and each year, we have information on Total Mid-March Employees, Total Annual Payroll, Total Number of Establishments, by industry code (using SIC codes before 1997 and NAICS codes after 1997) and by different Employee Size Class. Presumably, small firms are more likely to be associated with entrepreneurs. Therefore, we define small firms vs. large firms, and the former includes Employee Size Class of 1-4, 5-9, 10-19, 20-49 and 50-99, and large firms include classes of 100-249, 250-499, 500-999, and the class for 1,000 or more.[8]

3.1.3 NBER TAXSIM

Our tax data comes from TAXSIM, an online tool that allows the user to compute the federal and state tax liability by income, family type and year.

3.2 Measuring Tax Level and Progressivity

We have two ways of capturing the tax level. We either look at the tax rate at a certain percentile in the national earnings distribution in a given year, or we look at the tax rate at a multiple of the national Average Earnings (AE) in each year, as reported by the social security administration.

Tax progressivity describes how fast the tax rate increases as income increases and there are many ways of capturing it. We follow two approaches. The first is to control for the average tax level using the average tax rate at AE, $\tau(AE)$, and then use the difference between the tax rate at a higher income level and the tax rate at average earnings ($\tau(2AE) - \tau(AE)$, $\tau(5AE) - \tau(AE)$, $\tau(10AE) - \tau(AE)$) to capture progressivity.

Our second method for measuring progressivity is to estimate a simple parametric tax function, which we will also be using in the model in Section 5. We use the tax function proposed by Benabou (2002) and recently employed by Holter et al. (2019) and Heathcote et al. (2017) who argue that it fits the U.S. data well.[9] Let y denote pre-tax income and y_a after tax income. The tax function

[7]To deal with top coding issues related to business income, we mainly follow the approach in Autor et al. (2008) and use an adjustment factor of 1.5 before 1996. After that, we use the detailed information on the coding rules provided by IPUMS. From 1997 to 2011, the CPS only provides the mean value for the group that is being top coded. After 2011, the CPS provides random draws from the empirical distribution of those being top coded to protect anonymity. Since we mainly use the mean or the sum (by state and year) of business income for entrepreneurs (or entrepreneurs with college degrees), the top coding should not be an issue for our estimates.

[8]We also interpolate a few cases of missing data on employment (due to disclosure policies): we assume that employment is the geometric mean of the end points of each Employee Size Class. Since Total Number of Establishments is always not withheld, we can compute the total employment by different classes (and also by state/year/industry). Overall, at the state-year-industry level, only a few cases involving the agricultural sector need to be interpolated.

[9]See Appendix A.2 for more details on the properties of this tax function.

$T(y)$ is implicitly defined by the mapping between pre-tax and after-tax income y_a:

$$y_a = \theta_0 y^{1-\theta_1} \tag{1}$$

so that the tax paid is: $T(y) = y - y_a$. We let $T'(y)$ denote the marginal tax rate and $\tau(y) = 1 - \theta_0 y^{-\theta_1}$ denote the average tax rate a household with income y has to pay. A commonly used measure of tax progressivity in the literature is the *progressivity tax wedge* between two arbitrary income levels y_1 and $y_2 > y_1$:

$$PW(y_1, y_2) = 1 - \frac{1 - T'(y_2)}{1 - T'(y_1)} \tag{2}$$

see e.g. Caucutt et al. (2003), Guvenen et al. (2014), Holter (2015). As long as the tax code is weakly progressive and thus $T'(y_2) \geq T'(y_1)$, this measure takes a value between 0 and 1. It is equal to zero for a proportional tax code for all income levels y_1 and y_2, approaches 1 as the marginal tax rate at the higher income y_2 approaches 1, and in general measures how strongly marginal tax rates increase between incomes y_1 and y_2. A convenient property of our tax function is that tax progressivity, as measured by the wedge $PW(y_1, y_2)$, is uniquely determined by the parameter θ_1, (see Holter et al. (2019)). We can increase the *level* of taxes by decreasing the parameter θ_0 without affecting tax progressivity (as measured by the wedge) at any level of incomes y_1 and y_2. At the same time, an increase in the progressivity parameter θ_1 increases the progressivity of the tax code, independent of the level of tax rates[10].

3.2.1 Constructing Tax Measures from the Data

To construct our measures of tax level and progressivity, we combine the data from the CPS and TAXSIM. To estimate the 2 parameters in our tax function (the progressivity parameter θ_1 and the level parameter θ_0), we proceed as follows. We follow Heathcote et al. (2017) and construct a tax rate measure that combines federal and state income taxes as well as social security taxes paid by the employee and employer. To construct gross (pre-tax) income, we add to income the employer share (50%) of the Federal Insurance Contribution Act (FICA) tax — the sum of Social Security and Medicare taxes, computed directly by TAXSIM. Net (after-tax) income is then gross income minus state and federal income taxes and the FICA tax. We use all the observations in the CPS 2010 sample for the individuals who are 20 years of age and older, and for whom the family income[11] is no less than 50% of the average wage income in 2010[12]. For each observation in this sample, we use the TAXSIM program to compute federal and state personal income tax liabilities implied by the tax code. For this exercise, we do not use the actual information about which state

[10] To be precise, an increase in θ_1 does not change the average tax rate for an individual with average earnings, which is solely determined by θ_0. It may change the economy-wide average tax rate, measured by total revenue as a fraction of earnings, depending on the income distribution.

[11] Individual income for singles, the sum of the income of the two spouses for married.

[12] We exclude households at the very bottom of the income distribution as they are usually not prospective entrepreneurs.

the observation comes from. Instead, we artificially assign the value of the state to each of the 51 possible values (50 U.S. states plus the District of Columbia), and then submit the data on individual income, spouse's income for married households, their marital status and the number of young children in the household to the TAXSIM program, which generates the hypothetical tax liabilities for each observation in the CPS 2010 sample that would occur if an individual (or a family) were residing in each of the U.S. states. We use the individual (or family) income and hypothetical personal income taxes they would have to pay in each state in each year from 1977 to 2019 to obtain the year and state specific estimates of θ_0 and θ_1[13].

Using the data from the CPS 2010 sample allows us to accurately approximate the actual joint distribution over income, family status and the number of children in the U.S. We use the same 2010 CPS sample and compute the implied tax liabilities in each year from 1977 to 2019 for all U.S. states with the TAXSIM program. We scale the distribution in other years by average wage growth, relative to 2010. By using the same fixed sample to approximate the joint distribution of household characteristics, we aim to alleviate possible endogeneity concerns with regards to our estimates of θ_0 and θ_1: one may expect that changes in the tax code can change the observed income distribution, which may affect our estimates of the tax code parameters.

To construct measures of the tax level at different income percentiles, we use different CPS samples from 1977 to 2019. Again, limiting attention to individuals of age 20 and older, with family income above 50% of the average wage income in the corresponding year, we compute the family income that corresponds to the 50th, 90th and 95th percentiles of this truncated national sample in each of these years. We also compute the joint distribution over the marital status and the number of children in the CPS 2010 sample. For each possible combination of these characteristics and the value of the family income that corresponds to different percentiles in each year, computed as explained above, we use TAXSIM to find the corresponding tax liability that would occur in each of the U.S. states (plus D.C.). To compute our estimate of the average tax liabilities at different income percentiles, we average out the family characteristics, using the weights based on the CPS 2010 sample[14].

Finally, to compute the average tax rates at different multiples of the national average wage

[13] Wu (2021) estimates the Benabou tax function in a similar way at the U.S. national level, combining data from the CPS and TAXSIM (one difference is that he has a separate FICA tax). Fleck et al. (2021) estimate the tax function state by state as we do here, combining data from the CPS and TAXSIM. Their focus is, however, more on obtaining a measure of the degree of redistribution and they include low-income households and various types of transfers. This generally results in a more progressive tax schedule and higher estimates of θ_1. We instead focus purely on the income tax schedule and leave out poor households, because they are less likely to be entrepreneurs.

[14] Thus the approach we take here keeps the demographic distribution of households fixed at the 2010 level but not the income distribution. The rationale here is that maybe entrepreneurs keep their ranking in the income distribution but income inequality changed over time. Then by scaling the income distribution from a base year by average income growth, we could miss out on many entrepreneurs. However, we should be able to measure the tax on the entrepreneurs by using a certain percentile in the income distribution each year. If we on the other hand are more concerned about the effect that taxes have on the income distribution, our 2nd way of capturing the tax level, where we use the average tax rate at multiples of average earnings, may be preferable. This approach is invariant to the income distribution.

(AE) income in the corresponding year, we submit the artificial data with individual income assigned to the appropriate multiple of the AE to the TAXSIM program, and condition only on the marital status. For the case of married couples, we assign all the income to the husband. Since couples are taxed jointly in the U.S., the division of the family income between the two spouses is immaterial. We use TAXSIM to obtain the tax liabilities for each such artificial observation, and use the results to compute the corresponding average tax rates.

3.3 Summary Statistics

Figure A1 in the Appendix displays the distribution of average tax rates at the median income level across time and states and Figure A2 at the 90^{th} percentile. Figure A3 illustrates the evolution of the tax rates at the median income level over time for a few selected states in the US (and A4 at the 90^{th} percentile). We observe that although the trends in tax rates are similar over time due to federal taxes, there is significant variation in tax rates across states. Similarly, Figures A5 and A6 plot the overall distribution and the time-series evolution of our estimated measure of tax progressivity, θ_1. Table A1 provides detailed summary statistics for our state-level variables. We make a few more observations: (1) the overall variation of tax rates across time and place is significant. The tax rate at the median income level does for example have a standard deviation of 2.35 percentage points, and the difference between the 5^{th} percentile and the 95^{th} percentile of the distribution is almost 8 percentage points. (2) There is also significant variation in tax rates over time. Since the early 1980s there has been a downward trend in the tax rate at median income. (3) Lastly, the differences between different states are quite persistent. These observations suggest that it is necessary to include state-level fixed effects and time effects in the empirical analysis.

3.3.1 Correlations Between Taxes and Entrepreneurial Activity

Before diving into our panel regression analysis of the relationship between taxes and entrepreneurship, we take a look at the raw correlations in the data. We make bin-scatter plots with measures of entrepreneurship on the y-axis and measures of taxation on the x-axis. In the plots, each of the points roughly represents about 1% of the total sample. In Figure A7 in the Appendix, we plot the number of entrepreneurs (in a given state and year) and the number of small establishments, both in logs, on the y-axis, and the average tax rates at the 50^{th} or 90^{th} percentiles of the income distribution on the x-axis. We can see a clear negative correlation between average tax rates and entrepreneurial activity. Of course, this is just a raw correlation without controlling for anything. In Figure A8 in the Appendix, we make a plot net of state and year fixed effects, and plot the relationship again. The negative pattern is now even stronger.[15]

We also create bin-scatter plots with the correlation between our estimated tax progressivity parameter, θ_1, and entrepreneurial activity by state and year. These results are in A9. In this figure, we still plot number of entrepreneurs and number of small establishments (both in logs) on

[15]The correlation in the first panel, for example, is -0.0588, with p-value less than 0.001. See other tables for more regression results.

the y-axis, but now we plot the deviation from mean of our measured tax progressivity parameter θ_1 on the x-axis. In the upper panel, we do not control for state and year fixed effects but we do in the bottom two panels.[16] We observe that there is a significant negative correlation between entrepreneurial activity and tax progressivity. So far we have only looked at correlations, without controlling for local economic factors and other characteristics that may affect the results. In the next two sections we will conduct more formal econometric analysis, including a panel regression design as well as an instrumental variable approach, to study the impact of taxation on entrepreneurship.

3.4 Empirical Results

Our benchmark regression is a panel regression framework. In particular, we specify the following regression:

$$y_{s,t+2} = \alpha \text{TAX}_{s,t} + \beta z_{s,t} + \sum_{k \geq t-3}^{t} \gamma_k x_{s,k} + \psi_s D_s + \psi_t D_t + \varepsilon_{s,t}.$$

where s is an index for state, t is an index for time, and y is the dependent variable that we are interested in (different measures of entrepreneurial activity). $\text{TAX}_{s,t}$ refers to the measure of state-level personal income taxes. As described above, we develop a few different measures of tax level and progressivity. We include state fixed effects, D_s, to control for state-level, unobservable, permanent characteristics or factors that may affect the decisions of entrepreneurs. We use time fixed effects, D_t, to control for any aggregate time trends or business cycle effects on y. We also include several variables capturing state-level, possibly time-varying, economic characteristics that may affect entrepreneurship, $z_{s,t}$: the level of real GDP per capita, the employment shares in the agriculture, manufacturing and service sectors. In addition, we control for local business cycles prior to tax changes, using local real GDP per capita growth rates and also local unemployment rates from year $t-3$ to t, $x_{s,k}$. The purpose is to alleviate the concern that local tax changes may respond to changes in local economic conditions. Lastly, in the benchmark specification we focus on the effect of taxation at time $t+2$. This is to capture that households may need some time to recognize changes in the tax code. This approach is common in the literature, see for example Nakamura and Steinsson (2014). In the robustness analysis in Section 3.5 below, we provide more results where we let the timing of the dependent variable vary from $t-3$ to $t+9$. Our results are also consistent when we use standard errors clustered at state levels or we use robust standard errors.

3.4.1 The Impact of Tax Levels

Table 1 displays the results from regressing different measures of entrepreneurial activity on the average tax rates at three income levels: the median, the 90^{th} percentile and the 95^{th} percentile. The first three columns have the log of the total number of entrepreneurs in each state and each

[16] In all panels, we always control for θ_0, which controls the tax level.

year, measured from CPS, as the dependent variable. We find that all the estimated effects are negative. For instance, the estimated value of the coefficient on "Avg. rate at 50^{th}" suggests that an increase in the average tax rate by 1 percentage point for median income level households would decrease the number of entrepreneurs by 4.49%, and this is statistically significant at the 1% level. Alternatively, a 1 standard deviation change in the tax rate would lead to a change in the number of entrepreneurs by about 9.7%[17]. Thus, the impact of changing taxes is significant and economically large. In column (2) and (3) we inspect the impact of tax rates measured at the 90^{th} and 95^{th} income percentiles. We find similar and significant effects, even though the magnitude of these effects tends to become somewhat smaller for taxes at higher income percentiles. This is perhaps as expected because an increase in the tax rate at median income would affect most prospective entrepreneurs, whereas changes at higher percentiles only affect high-earners, although many entrepreneurs fall in this category.

Table 1: Taxes and Entrepreneurial Activities: The Impact of Tax Rates at Different Percentiles

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Num. of Entre.			Num. of College Entre.			Num. of Small Estab.			Small Estab. Emp			Total Emp.		
Avg. rate at 50^{th}	-0.0449***			-0.0608***			-0.0130***			-0.0145***			-0.00937***		
	(0.0165)			(0.0217)			(0.00222)			(0.00261)			(0.00270)		
Avg. rate at 90^{th}		-0.0329**			-0.0433**			-0.00822***			-0.00589***			-0.00259	
		(0.0155)			(0.0201)			(0.00177)			(0.00200)			(0.00206)	
Avg. rate at 95^{th}			-0.0342**			-0.0371*			-0.00813***			-0.00504***			-0.00193
			(0.0155)			(0.0201)			(0.00163)			(0.00185)			(0.00195)
Observations	1,887	1,887	1,887	1,887	1,887	1,887	1,683	1,683	1,683	1,683	1,683	1,683	1,850	1,850	1,850
R-squared	0.890	0.890	0.890	0.879	0.879	0.879	1.000	1.000	1.000	0.999	0.999	0.999	0.999	0.999	0.999
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Business cycles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

NOTE: This table reports the regression results using different average tax rates as described in the main text. "Num. of Entre." is the log of total number of entrepreneurs in each state and each year (from CPS and weighted by CPS sampling weights); "Num. of College Entre." is the log of total number of entrepreneurs with at least college degrees. "Num. of Small Estab." is the log of total number of small-sized establishments, and "Small Estab. Emp" is for the log of employment at small-sized establishments. Column "Total Emp." is for the log of total employment from all establishments in each state and each year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The other columns in Table 1 have alternative measures of entrepreneurial activity as the dependent variable.[18] In columns 4-6 the dependent variable is the log of the total number of entrepreneurs with a college education. We find results similar to before. The magnitudes of the coefficients are even larger for entrepreneurs with college education.

We also use measures of entrepreneurship based on firm side information: Columns 7-9 has the log of the total number of small-sized establishments (with number of employees less than 100) as the dependent variable, Columns 10-12 has the log of the total number of employment at small-sized establishments as the dependent variable, and lastly Columns 13-15 has the log of total employment from all establishments.[19] Across all these different measures, the estimates are all

[17]Recall that in the overall sample, one standard deviation for average tax rate at the median income is about 2.35 percentage points.

[18]In the data, there is no single variable that captures all aspects of entrepreneurship. We, therefore, study the impact of taxes on several different variables related to entrepreneurship, from two different data sets.

[19]We also experimented with establishment entry rates and exit rates as dependent variables; the results are not

negative and mostly significant at the 1% level. Since most small firms are owned and managed by entrepreneurs, it is not surprising that our estimated coefficients for the number of small-sized establishments and the employment at small firms, are quite similar to those estimated when using the number of persons being entrepreneurs as the dependent variable.

We note that the elasticity of the number of entrepreneurs, which we derive from the CPS, with respect to taxes is generally larger than the elasticity of the number of small firms and the employment at small firms, which comes from the CBP. A one percentage point increase in the average tax rate at median income does for example lead to a 1.3% decrease in the number of small firms and a 1.45% decrease in employment at small firms compared to a 4.49% decline in the number of entrepreneurs.

3.4.2 The Impact of Tax Progressivity

Above we have shown that there is a negative statistical relationship between average tax rates and entrepreneurial activity. In this section, we investigate the relationship between tax progressivity and entrepreneurship (holding the level of taxes constant). One can imagine that people become entrepreneurs to increase their net income and thus with more progressive taxes the incentive to become an entrepreneur decreases. However, being an entrepreneur is also riskier than being a worker (income is more volatile). From a theoretical point of view it is also possible that the added insurance from higher tax progressivity makes it more attractive to become an entrepreneur. Below we do, however, find a strong negative relationship between tax progressivity and entrepreneurship.

We investigate the impact of tax progressivity in two different ways. First we measure the average tax rates at different multiples of Average Earnings (AE) in the US each year (1,2,5,10 times AE). These measures are different from the previous ones focusing on different percentiles of the income distribution; using different multiples of AE gives us a straightforward comparison of the earnings levels across years that is independent of how the distribution of earnings has evolved[20]. As before, we look at the impacts of taxes on entrepreneurial activity after 2 years. Now, however, we include two tax measures in the regression at the same time[21]. To control for the tax level, we always include the average tax rate at AE. To study the impact of tax progressivity, we include the average tax rate at 2AE, 5AE and 10AE relative to the average tax rate at AE. The results are displayed in Table 2. We find consistent negative impacts of these measures of tax progressivity on our measures of entrepreneurial activity. Almost all coefficients are significant at the 1% level and economically large. For example the coefficient on "$\tau(2AE) - \tau(AE)$" in column (1) can be interpreted as if a 1 percentage point increase in the average tax rate at 2AE (keeping the tax rate at AE constant) leading to 14.5% fewer entrepreneurs two years later. Similarly a 1

reported here for the sake of brevity but they are available upon requests.

[20]This is a common approach for making comparisons of taxation across time and place. OECD tax statistics are for example constructed using multiples of AE in different countries and years.

[21]For readers who are interested in the effect of each single measurement alone, please see Table A5 in the appendix.

percentage point increase in the average tax rate at 2AE would lead to a 2.5% drop in the number of small firms and 3.0% drop in employment at small firms after two years.

Our second measure of tax progressivity comes from the estimation of the tax function described in Equation 1. As described above, the parameter θ_1 here controls the progressivity of the tax function whereas θ_0 controls the level. We use our estimates of θ_0 and θ_1 across the U.S. states and over time in our regression analysis.

Table 2: The Impact of Tax Progressivity Measured by Average Tax Rates at High Multiples of Average Earnings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Num. of Entre.			Num. of College Entre.			Num. of Small Estab.			Small Estab. Emp			Total Emp.		
$\tau(2AE) - \tau(AE)$	-0.145***			-0.114***			-0.0250**			-0.0297***			-0.0251**		
	(0.0283)			(0.0373)			(0.0126)			(0.0110)			(0.0108)		
$\tau(5AE) - \tau(AE)$		-0.0878***			-0.0521**			-0.0508***			-0.0488***			-0.0367***	
		(0.0192)			(0.0238)			(0.00821)			(0.00755)			(0.00716)	
$\tau(10AE) - \tau(AE)$			-0.0481***			-0.0311*			-0.0379***			-0.0344***			-0.0255***
			(0.0141)			(0.0175)			(0.00615)			(0.00566)			(0.00547)
Avg. rate at 1 AE	-0.0954***	-0.120***	-0.103***	-0.0798***	-0.0911***	-0.0823***	-0.00317	-0.0254***	-0.0213***	-2.17e-05	-0.0205***	-0.0154**	0.00352	-0.0116*	-0.00740
	(0.0181)	(0.0199)	(0.0192)	(0.0219)	(0.0233)	(0.0225)	(0.00717)	(0.00780)	(0.00750)	(0.00692)	(0.00747)	(0.00721)	(0.00616)	(0.00663)	(0.00631)
Observations	1,739	1,739	1,739	1,739	1,739	1,551	1,551	1,551	1,551	1,551	1,551	1,739	1,739	1,739	1,739
R-squared	0.838	0.837	0.845	0.844	0.844	0.996	0.996	0.996	0.997	0.997	0.997	0.996	0.996	0.996	0.838
Controlling for tax levels	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Business cycles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

NOTE: This table reports the regression results using average tax rates at different multiples of average earnings (2,5,10 times average earnings in each year) relative to the rate at 1AE as a measure of tax progressivity, and at the same time we control for tax levels using average tax rate at 1AE. "Num. of Entre." is the log of total number of entrepreneurs in each state and each year (from CPS and weighted by CPS sampling weights); "Num. of College Entre." is the log of total number of entrepreneurs with at least some-college degrees. "Num. of Small Estab." is the log of total number of small-sized establishments, and "Small Estab. Emp" is for the log of employment at small-sized establishments. Column "Total Emp." is for the log of total employment in all establishments in each state and each year.

Table 3: Taxes and Entrepreneurial Activities: The Impact of Tax Progressivity Measured by θ_1

	(1)	(2)	(3)	(4)	(5)
	Num. of Entre.	Emp	Small Estab. Emp	Num. of Small Estab.	Num. of College Entre.
Progressivity θ_1	-7.396*	-1.726***	-1.685**	-3.087***	-7.997
	(4.220)	(0.660)	(0.782)	(0.573)	(6.165)
Tax level θ_0	0.259**	0.0811***	0.0795***	0.105***	0.331*
	(0.122)	(0.0206)	(0.0307)	(0.0199)	(0.181)
Observations	1,887	1,850	1,683	1,683	1,887
R-squared	0.889	0.999	0.999	1.000	0.879
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
State Controls	Yes	Yes	Yes	Yes	Yes
Local Business cycles	Yes	Yes	Yes	Yes	Yes
Local time trends	Yes	Yes	Yes	Yes	Yes

NOTE: This table reports the regression results using the benchmark equations specified in the main text. In Column "Num. of Entre.", the dependent variable is the log of total number of entrepreneurs in each state and each year (from CPS and weighted by CPS sampling weights); Column "Num. of College Entre." refers to the log of total number of entrepreneurs with at least college degrees. Column "Emp" is for the log of total employment in each state and each year, and Column "Small Estab. Emp" is for employment at small-sized establishments. Column "Num. of Small Estab." is for the total number of small-sized establishments (also taking logs).

In Table 3, we focus on the impact of θ_1 on measures of entrepreneurship and control for θ_0 (note that the tax level goes down when θ_0 goes up). We find that when the tax system is more progressive, there is a negative impact on entrepreneurial activities across a variety of measures. For instance, when θ_1 increases by 0.01[22], the total number of entrepreneurs would decrease by 7.4%[23], the number of small-sized establishments by 3.1% and employment at small firms by 1.7%[24]. Equivalently a 1% increase in our measure of tax progressivity leads to a 1.0% drop in the number of entrepreneurs, a 0.4% drop in the number of small-sized establishments and a 0.2% drop in employment at small firms. For the college educated entrepreneurs, the effects are insignificant at 10% confidence level but still negative. This is slightly different compared to our previous results in Table 2, where we obtained significantly negative effects of progressivity on the number of college-educated entrepreneurs.

3.5 Robustness Tests

In this section we provide a number of robustness tests for our main results on the impact of taxes on entrepreneurial activity, including additional control variables and instrumental variable analysis.

3.5.1 Including Local Non-linear Trends and More Local Business Cycle Variables

Some readers may be concerned that not all states in the US are growing at the same rate and perhaps faster growing states have different economic conditions, which could be correlated with entrepreneurship. To address this concern we allow for different quadratic trends for each state. We also include more local business cycle variables, such as unemployment rates and real GDP growth rates starting from 4 years ago. These results are presented in Table A2. We observe that for all the measures of entrepreneurship, our main results are still robust.

3.5.2 Instrumental Variables

Still, one may be worried that there are other omitted variables that are correlated both with taxes and entrepreneurial activity. To address this, we also apply an instrumental variable strategy to further corroborate our analysis. We use lagged local tax rates to create an instrument for current tax rates. This approach has been commonly used in the literature (see e.g. Bloom et al. (2002), Akcigit et al. (2022), and others). In particular, we use the local average tax rate, lagged by 2 years, at three different income percentiles to create instruments for the current average tax rates. For example, when studying the impact of Avg. rate at the 50^{th} percentile of income in year t, we define an instrumental variable, which is a sum of the lagged local tax rate and the current federal tax rate:

$$\tau_t(y_{50^{th}}) = [\text{State Avg. Tax Rate at } 50^{th}]_{t-2} + [\text{Federal Marginal Tax Rate at } 50^{th}]_t$$

[22]about 60% of the standard deviation across states and time.

[23]The number is -8.0% for college-educated entrepreneurs, but this is not significant.

[24]Note that because the units for θ_1 are different, the magnitudes of the estimates are also different from the previous results.

This follows closely the approach in Akcigit et al. (2022). For other percentiles of income, we can also define instrumental variables in a similar way. This approach is based on the assumption that conditional on state-level fixed effects and economic controls, for sufficiently lagged state-level tax rates, they would not be correlated with current economic *shocks* at the state level.

In Table A3, we report the results from our IV approach, next to our OLS estimates for comparison. As before, we always control for state fixed effects, year fixed effects, state time-varying control variables, local business cycles and local trends. In general, we find that both methods give negative and significant estimates of the impact of taxation on measures of entrepreneurship. When using the average tax rate at the median income level as an explanatory variable, the magnitude of the IV estimates is about one to two times of OLS estimates for most of the measures of entrepreneurial activity. We also test the first stage results in our IV-approach and find that the F statistics are all very large, suggesting the instrument is not weak. Finally we also tried using different lags of the local tax rates, such as 3 years, and found that the results are similar.

Table A3 also reports the results using average tax rates at different income percentiles (Avg. rate at 90^{th} and Avg. rate at 95^{th}) as explanatory variables. Overall, the results confirm the negative impact of taxes. However, when looking at the 95th percentile, the IV results are no longer significant.

Finally, when using measured tax progressivity as an explanatory variable, we also confirm our previous results, using instrument variables in Panel B of Table A3. Here, we use the lagged values of θ_1 and θ_0 as instruments for the current ones. These results are also highly consistent with the previous IV results: in general, the IV estimates are about 2 to 3 times larger than the OLS estimates in magnitude, and the results for different measures are mostly significant at the 1% level.

We also provide some further robustness checks. In Table A4 in the appendix, we add controls for lagged entrepreneurial activities (log of number of entrepreneurs and log of number of establishments, lagged by 2 years), in addition to the control variables as laid out previously. By doing this, we hope to rule out the possibility that different states could have different paths in entrepreneurial activities. We find that the results are essentially the same as before.

3.5.3 The Possible Impact of Migration

One possible concern is that entrepreneurs may respond not only to their own state's policy changes but also to the policies in other states. In our empirical analysis, we are mostly focusing on relatively small variations in taxes within states, the federal tax changes can be somewhat larger (see Table A1 in the Appendix for the standard deviations of average tax rates and θ_1 in the pooled sample and the within-states sample), and we therefore think that migration in response to tax changes may be less important. Larger tax changes are presumably more relevant for migration decisions as there are relatively large moving costs involved. However, we conduct some robustness tests aimed at confirming that our main results are not due to migration: (1) In Table A6 in the Appendix, we compute each state's population share, the fraction of the population in the whole country that live in the state, for each year. We then control for current, lagged ($t-2$) and future ($t+2$) population shares in our benchmark and IV regressions. The rationale is that if there is significant migration across states due to tax changes and large changes in population shares, the additional control variables should help to absorb these effects. Since entrepreneurs employ half of the private sector labor force, a movement of entrepreneurs would also be correlated with a movement of people. However, we find that our results for the impact of taxes on entrepreneurship are not affected when introducing population shares as control variables. (2) In Table A7 in the Appendix, we address this concern from another point: we include local time trends at the US regional level (4 in total) and US census economic division level (9 in total) in the benchmark regressions. Intuitively, if households and entrepreneurs migrate from states where taxes are currently high to state where the current tax conditions are favorable, we could hope to pick up some of this by using trends at the regional level. While we cannot fully capture all migration patterns, these additional controls can help us control for some of the moves within larger areas. Table A7, however, shows that our results are robust to adding these additional control variables.

3.5.4 Effects at Different Time-horizons

In our benchmark regressions, we look at the effects of tax changes on entrepreneurship 2 years later. Here we provide more results, considering different time horizons for the dependent variable, ranging from $t-3$ to $t+9$. In Figures A10 and A11 we plot the coefficients from regressing our measures of entrepreneurship at different times on the average tax rate at the 50th percentile and on tax progressivity, θ_1, at time t. The approach is similar to the projection methods used in Jordà (2005) and Teulings and Zubanov (2014). Across different time horizons, we generally find that the impact of changes in the average tax rate at the 50th percentile on entrepreneurship is more pronounced in the short run, and that the effect is decreasing or even disappears in the long-run. For example, in panel (d) of Figure A10, we plot the evolution of the regression coefficient from the regression of employment at small establishments on the average tax rate at the 50th percentile. On impact, employment at small establishments drops by about 1.5%, but over time, the effect is almost monotonically decreasing and after 9 years, the effect is not statistically different from 0. This diminishing effect is perhaps not that surprising, since the taxes could be changed in later years. The results from regressing our measures of entrepreneurship on tax progressivity, θ_1, while controlling for θ_0, in Figure A11 are also similar. In short, when looking at the dynamics of tax impacts, we find negative and quite persistent effects, that tend to diminish after 9 years.

In addition to considering the regression coefficients using future values of the dependent variables, Figures A10 and A11 also plot the dynamics of measures of entrepreneurship before the tax changes occur. We look at $t-3$, $t-2$ and $t-1$. We find that conditional on our benchmark control variables, the effects of taxes on the dependent variables in years prior to the year of the tax change, are generally not significant. For example, consider panel (a) of Figure A10, where clearly there is no effect at $t-3$ and a weak but statistically insignificant effect at $t-2$ and $t-1$. Thus, these results imply that conditional on our state level controls, different U.S. states have more or less similar levels of entrepreneurship before tax changes take place in a state. However, it would also not be completely surprising to find an effect of taxes at time t on entrepreneurship at time $t-1$ or $t-2$. The reason is that tax changes can sometimes be expected or announced ahead of the actual implementation time.

3.5.5 Reshuffling Tax Changes

We also conduct another experiment, "permutation tests", where we randomly shuffle the tax measures (θ_0 and θ_1) across states within each given year. We run the random experiments many times and test if the regression coefficients are significantly different from zero. We find that none of the regression results are significant. In other words, if we randomly assigned the tax measures across states, we would not observe significant regression results, like we do in the benchmark regressions in Table 3.

4 Building Intuition: The Impact of Taxation on Entrepreneurial Choice

In this section and in Appendix A.3 we develop simple one- and two-period models to theoretically illustrate how higher and more progressive taxes may affect entrepreneurial choice. The impact of tax progressivity is ultimately a quantitative question, and we show that theoretically increased tax progressivity has opposing effects on entrepreneurial choice through the "risk-" and "return-effect" in a static model without wealth. It lowers the return but also the risk of entrepreneurship.[25] In the appendix we also study the impact of risk aversion, a fixed entry cost of entrepreneurship, initial wealth and their interactions with taxation.

4.1 A Static (one-period) Model With Mean-Variance Utility

There is a continuum of individuals who differ in their type a, which determines their productivity if they choose to become workers. They draw their type from some distribution with cdf F_a, and their type is known when they decide whether they want to be a worker or an entrepreneur. Let I denote their gross (pre-tax) income. It is subject to a progressive tax, so that their net (after-tax) income is $\theta_0(I/AE)^{1-\theta_1}$, where AE is the average earnings in this economy. Consumption is equal to net income, $c = m$. If they decide to be workers, they earn a gross income $I_w = a$, while their net income is $m_w = \theta_0(a/AE)^{1-\theta_1}$. On the other hand, if they choose to become entrepreneurs, they earn some profit π, which is random and unknown at the time of the career decision. π has cdf F_π, with mean $\bar{\pi}$ and variance σ_π^2. For entrepreneurs, $m_\pi = \theta_0 \left(\frac{\pi}{AE}\right)^{1-\theta_1}$.

[25] In models with assets things are more complicated because of the negative effect tax progressivity typically has on savings, which makes entrepreneurship less profitable for constrained individuals and also riskier.

Assume mean-variance utility, $U(m) = E(m) - \frac{1}{2}\text{var}(m)$. An individual of type a decides to become an entrepreneur if $U(m_\pi) \geq U(m_w) = \theta_0(a/AE)^{1-\theta_1}$. We observe that $\partial U(m_w)/\partial\theta_1$ is positive if $a < AE$ and negative if $a > AE$. In other words, when tax progressivity increases, the net earnings of individuals making less than the average increase and the net earnings of individuals making more than the average decrease. Let $\bar{a}$ be a cut-off in terms of the worker's productivity such that the individual of type $\bar{a}$ is indifferent between becoming an entrepreneur and a worker, so that $U(m_\pi) = \theta_0(\bar{a}/AE)^{1-\theta_1}$. Notice that since worker's productivity is non-random, we have $\bar{a} < E\pi = \bar{\pi}$.

Using linear approximation around $E\pi = \bar{\pi}$, we have:

$$m_\pi = \theta_0 \left(\frac{\bar{\pi}}{AE}\right)^{1-\theta_1} + \frac{\theta_0(1-\theta_1)}{AE}\left(\frac{\bar{\pi}}{AE}\right)^{-\theta_1} d\pi.$$

Let $d\pi$ be such that $E(d\pi) = 0$ and $E((d\pi)^2) = \sigma_\pi^2$, which implies the mean and variance for m are as follows:

$$E(m_\pi) = \theta_0 \left(\frac{\bar{\pi}}{AE}\right)^{1-\theta_1},$$

and

$$\text{var}(m_\pi) = \left(\frac{\theta_0(1-\theta_1)}{AE}\right)^2 \left(\frac{\bar{\pi}}{AE}\right)^{-2\theta_1} \sigma_\pi^2.$$

We then have the following result for the impact of tax progressivity on expected after-tax income:

$$\frac{\partial E(m_\pi)}{\partial\theta_1} = -\theta_0 \left(\frac{\bar{\pi}}{AE}\right)^{1-\theta_1} \log(\bar{\pi}/AE) < 0.$$

Notice that we assume that on average, entrepreneurs are high earners: they earn more than the average earnings in the economy, so that $\bar{\pi} >$ AE and thus $\log(\bar{\pi}/AE) > 0$. The result above shows that with our tax function, increasing tax progressivity reduces the average payoff to being an entrepreneur. Since $\bar{a} < \bar{\pi}$, higher progressivity reduces the average payoff to being an entrepreneur more than it reduces the payoff to being a worker for the marginal individual (recall that if $\bar{a} < AE$, higher tax progressivity actually *increases* the payoff to being a worker for the marginal individual).

At the same time, we also have:

$$\begin{aligned}\frac{\partial\text{var}(m_\pi)}{\partial\theta_1} &= \left(-2(1-\theta_1)\left(\frac{\bar{\pi}}{AE}\right)^{-2\theta_1} - 2(1-\theta_1)^2\left(\frac{\bar{\pi}}{AE}\right)^{-2\theta_1}\log(\bar{\pi}/AE)\right)\left(\frac{\theta_0}{AE}\right)^2 \sigma_\pi^2 \\ &= -2(1-\theta_1)\left(\frac{\bar{\pi}}{AE}\right)^{-2\theta_1}\left(\frac{\theta_0}{AE}\right)^2 \sigma_\pi^2\left(1 + (1-\theta_1)\log\left(\bar{\pi}/AE\right)\right) < 0.\end{aligned}$$

Thus, increasing tax progressivity also reduces the variance of after-tax income for entrepreneurs. The overall effect of changes in tax progressivity on entrepreneurs' utility is unclear in this example. The lower expected mean return makes it less attractive to become an entrepreneur but the lower variance makes it more attractive to become an entrepreneur.

In Appendix A.3, we study several other simple cases: (1) Log-normal distribution of profits and CRRA utility. We show that entrepreneurial choice is independent of the income tax level. With an inter-temporal elasticity of substitution smaller than one, entrepreneurship is, however, more attractive with higher mean profit but also with less variable profit. The return effect, however, dominates and an increase in tax progressivity, θ_1, leads to less entrepreneurs. (2) Deterministic profit, CRRA utility and fixed cost of entry. With a fixed entry cost, like we have in the quantitative model below, we show that the number of entrepreneurs is decreasing in the income tax level. (3) A simple two-period model with saving and borrowing constraint. We show that individuals with less wealth are less likely to become entrepreneurs. If higher and more progressive taxes lead to less savings, then this is a channel through which they also reduce the number of entrepreneurs.

5 The Quantitative Model

Our model is a life-cycle, overlapping generations economy with incomplete markets. As in Quadrini (2000) and Cagetti and De Nardi (2006) there is occupational choice where households can choose whether to be workers or entrepreneurs. Households are heterogeneous along several dimensions, including innate ability, which affects productivity both as a worker and as an entrepreneur, savings, as well as two different idiosyncratic productivity shocks affecting an individual's productivity as a worker and as an entrepreneur respectively. Importantly, both workers and entrepreneurs are subject to the same progressive income tax code.

5.1 Households

The model economy is populated by a continuum of $J = 61$ overlapping generations who have finite life-cycles. New households enter the economy at age 1, corresponding to real age 20, and live for 61 years. They retire in period $J^W = 46$, equivalent to real age 65, and die in period $J = 61$, equivalent to real age 80. Households differ in their individual state with respect to age, j, fixed innate ability, $\alpha_F \sim N(0, \sigma^2_{\alpha_F})$, the stochastic component of labor market productivity, ϵ, the stochastic component of entrepreneurial productivity, z, and their asset holdings, a. We assume preference parameters are constant throughout the agent's life-cycle. Retired households receive a social security payment, $\omega_R e^{\alpha_F}$, where ω_R is a constant, making pensions proportional to the permanent component of labor productivity. In every time period during working age, individuals choose whether to be workers or entrepreneurs, $O \in \{W, E\}$, how much to consume, c, and next period's asset holdings, a'. In addition, workers decide how many hours, h, to supply in the labor market and entrepreneurs decide how much capital, k, and labor, n, to employ at their firm.

The overall labor market efficiency of an individual is denoted by Φ. We have: $\log \Phi = \chi_j + \alpha_F + \epsilon$, where χ_j is a function of age, α_F is the individual fixed effect of human capital (ability), and ϵ is the stochastic component. We assume that ϵ follows an AR(1) process: $\epsilon' = \rho_\epsilon \epsilon + u$, $u \sim N(0, \sigma^2_u)$. For a given wage rate per efficiency unit of labor, w, the individual's wage rate will be $w\Phi$ and the pre-tax labor income will be $w\Phi h$, where h are working hours.

Similarly, an entrepreneur's productivity is assumed to be: $\log \eta = \chi_j + \alpha_F + z$, where z is the stochastic part, and also follows an AR(1) process: $z' = \rho_z z + \nu$, $\nu \sim N(0, \sigma_\nu^2)$. An entrepreneur optimally chooses labor input and capital for production. She faces a classical collateral constraint in the credit market, $k \leq \Theta a, \Theta > 1$. The amount of debt that can be borrowed and invested in the business as a fraction of the entrepreneur's wealth is $\Theta - 1$.[26] The entrepreneur's production function is assumed to be $\eta_j(k^{1-\alpha_L} n^{\alpha_L})^\nu$, with decreasing returns to scale, $\nu < 1$. α_L and $1 - \alpha_L$ here denote the labor and capital shares, respectively. In each time period, there is a fixed operating cost, Γ_f. The operating profit of the entrepreneur is thus given by:

$$\pi = \; A\eta_j(k^{1-\alpha_L} n^{\alpha_L})^\nu - (r+\delta)k - wn - \Gamma_f, \tag{3}$$

where A is the level of the economy-wide productivity, common to all firms (both in the entrepreneurial and the corporate sectors, the latter is described below). If individual productivity, z, is sufficiently low and the entrepreneur still chooses to operate in the current period, operating profits can be negative. This is in line with data on business income as a significant fraction of entrepreneurs do not have positive income. We also assume that switching in and out of entrepreneurship is costly. A worker has to pay a one-time entry cost, c_e, to become an entrepreneur and an entrepreneur has to pay an exit cost, Γ_s, to become a worker again. The magnitude of this entry cost will be determined quantitatively in Section 6.

5.2 Preferences

The momentary utility function depends on consumption, c, and hours worked, h.:

$$u(c,h) = \frac{c^{1-\gamma}}{1-\gamma} - \frac{h^{1+\eta}}{1+\eta} \tag{4}$$

Future time periods are discounted by β. In the last period, J, of the life-cycle, we assume that households gain utility from their asset holdings given by: $\frac{(\kappa_b a)^{1-\gamma}}{1-\gamma}$, where κ_b captures the bequest motive (there is no labor income and no uncertainty in the last period). The economy-wide bequests are redistributed uniformly to everyone else still alive in the current period, including those who just entered the economy.[27] The bequest transfer is denoted as Γ_b.

5.3 Aggregate Corporate Sector Technology

We follow Quadrini (2000) and Cagetti and De Nardi (2006) and assume the corporate sector is made up of a representative firm, with neoclassical production function, $Y = AK^{1-\alpha_L} N^{\alpha_L}$. The representative firm does not face any financial frictions and the production technology yields constant returns to scale.

[26] This is a parsimonious way to model credit market frictions and collateral constraints, see e.g. Moll (2014), Midrigan and Xu (2014), Buera and Moll (2015).

[27] Note that we assume that in their last period, J, households do not consume or produce.

5.4 Government

The government collects income taxes from households and spends the revenue on a public good, G, pensions, ωe^{α_F}, and lump-sum transfers, Γ_g. As in Section 3, the income tax is approximated by a simple parametric tax function that allows for separation between tax progressivity and level, see Benabou (2002) and more recently Heathcote et al. (2017) and Holter et al. (2019). To estimate the tax function we normalize income by the Average Earnings in the economy, AE, and since we only have one tax in the model and not a separate social security system, the tax rate is the sum of federal, state and payroll taxes (see Section 3.2.1 for more details). For personal income, y, the after-tax income is denoted as ya, normalized by AE, and it is given by: $ya/AE = \theta_0(y/AE)^{1-\theta_1}$, with $\theta_0 < 1$, $\theta_1 < 1$. We adjust AE when computing equilibrium so that the tax rate for a person with average income in the model continues to equal the tax rate of a person with average income in the data. The household income, y, is the sum of labor income and interest income for workers and the sum of business income and interest for entrepreneurs.

5.5 Recursive Formulation of the Household Problem

Let $s = (j, \alpha_F, \epsilon, z, a)$ denote the individual state and $V^W(j, \alpha_F, \epsilon, z, a)$ denote the value function of a worker at the beginning of age j, after the productivity shocks, ϵ and z, are realized. Similarly, let $V^E(j, \alpha_F, \epsilon, z, a)$ denote the value function of an entrepreneurs at the beginning of age j. In a given time period, t, a worker chooses consumption, savings, and labor supply (unless retired). In addition, before the innovations to next period's productivity as a worker, u, and as an entrepreneur, ν, are realized, an individual chooses next period's occupation, $O \in \{W, E\}$. An individual who is a worker in this period solves the below optimization problem:

$$\begin{aligned} V^W(s) &= \max_{\{c,h,a',O'\}} u(c,h) + \beta \max\left\{E_{u,\nu}[V'^W(s')], E_{u,\nu}[V'^E(s')]\right\} \\ s.t.\;\; c + a' &\leq w\Phi h + a(1+r) - T(w\Phi h + ar) + \Gamma_b + \Gamma_g - c_e \cdot \mathbb{1}_{\{O'=E\}} \\ a' &\geq 0, \quad s = (j, \alpha_F, \epsilon, z, a), \quad \epsilon' = \rho_\epsilon \epsilon + u, \quad z' = \rho_z z + \nu \end{aligned} \tag{5}$$

Similarly, the optimization problem for an entrepreneur is given by:

$$\begin{aligned} V^E(s) &= \max_{\{c,n,k,a',O'\}} u(c) + \beta \max\left\{E_{u,\nu}[V'^W(s')], E_{u,\nu}[V'^E(s')]\right\} \\ s.t.\;\; c + a' &\leq a(1+r) + \pi - T(\pi + ar) + \Gamma_b + \Gamma_g - \Gamma_s \cdot \mathbb{1}_{\{O'=W\}} \\ k &\leq \Theta a, \quad a' \geq 0, \quad s = (j, \alpha_F, \epsilon, z, a), \quad \epsilon' = \rho_\epsilon \epsilon + u, \quad z' = \rho_z z + \nu \\ \pi &= A\eta_j (k^{1-\alpha_L} n^{\alpha_L})^\nu - (r+\delta)k - wn - \Gamma_f \end{aligned} \tag{6}$$

An entrepreneur with individual state of $(j, \alpha_F, \epsilon, z, a)$ optimally chooses labor input, n, and capital, k, for production in addition to consumption, c, next period's assets holdings, a' and next period's occupation, O. As described above she faces a classical collateral constraint in the credit market. Note that $T(\pi + ar)$ denotes the tax payments for the case that entrepreneurs have positive firm profits, π, and if $\pi < 0$, then we assume there is only a tax on capital income, ar. This is consistent with real world tax policies for entrepreneurs' (pass-through) firm profits. Γ_s can be interpreted as an exiting or switching cost.

Finally, for a worker after retirement age there is no choice of labor supply and the social security benefit is given by $\omega_R e^{\alpha_F}$ (hence there is no uncertainty about future labor income for a worker). The problem of a retired household is a special case of a typical worker's problem but simpler, and the household chooses consumption, savings, and occupation (we allow for entrepreneurs to continue after the retirement age, which is consistent with data and the previous literature such as Cagetti and De Nardi (2006)[28]):

$$\begin{aligned} V^R(s) &= \max_{\{c,a',O'\}} u(c) + \beta \max\left\{V'^R(s'), E_\nu[V'^E(s')]\right\} \\ s.t.\ \ c + a' &\leq \omega_R e^{\alpha_F} + a(1+r) - T(\omega_R e^{\alpha_F} + ar) + \Gamma_b + \Gamma_g - c_e \cdot \mathbb{1}_{\{O'=E\}} \\ a' &\geq 0, \quad s = (j, \alpha_F, z, a), \quad z' = \rho_z z + \nu \end{aligned} \tag{7}$$

5.6 Recursive Competitive Equilibrium

We consider a recursive competitive equilibrium. In equilibrium, agents optimize given prices, markets clear, the government budget is balanced, and the cross-sectional distribution across household types is stationary. For sake of brevity, the formal equilibrium definition is stated in Appendix A.4. In the benchmark economy and for most of our quantitative exercises we will consider a small open economy with fixed prices (this most closely resembles U.S. states which was the focus of the empirical section). However, when we study welfare and optimal taxation in Section 8.4 we also consider the alternative assumption of a closed economy, where the wage rate and interest rate are allowed to change.

5.7 Model Solution

Appendix A.5 describes the numerical solution of the model.

6 Calibration and Estimation

We calibrate our model to resemble the U.S. economy. Some parameters have direct empirical counterparts and can be set exogenously outside of the model, whereas seven parameters are estimated using a simulated method of moments approach. Table A8 in the Appendix summarizes the exogenously calibrated parameters and Table 4 below contains the estimated parameters.

6.1 Technology and Financial Market

We set the capital depreciation rate, δ_k, to 0.1 and the labor share, α_L, to 0.64, both standard values in the literature. We set the returns to scale parameter in the production function for

[28] It turns out that in our calibrated model typically nobody starts a business after reaching retirement age but some individuals continue to operate their business for a few years.

the entrepreneurs, ν, to 0.85 (largely consistent with the estimates in Basu and Fernald (1997), Burstein and Hellwig (2008) and Atkeson and Kehoe (2005)), and the parameter Θ, which is governing the collateral to asset ratio is set to 1.35 (see Midrigan and Xu (2014) and Zetlin-Jones and Shourideh (2017) among others). In addition, since our benchmark economy is a small open economy, we assume a risk-free interest rate, r, of 2%. The aggregate productivity parameter, A, the entrepreneurs' flow operating cost, Γ_f, the entrepreneurs' entry cost, c_e, and the entrepreneurs' switching cost (exit cost), Γ_s, are among the estimated parameters.

6.2 Wages and Entrepreneurial Ability

For the stochastic component of labor market efficiency, ϵ, which follows an AR(1)-process, we follow Chang and Kim (2007) and set the persistence, ρ_ϵ, to 0.929 and the standard deviation of the innovations, σ_u, to 0.227. We model the exogenous life-cycle profile of productivity, $\chi_j = \gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3$, as a third order polynomial in age and obtain the parameters from Brinca et al. (2016) who regress wages on age in the Luxembourg Income and Wealth Study (LIS). To calibrate the individual fixed effect (ability), $\alpha_F \sim N(0, \sigma^2_{\alpha_F})$, we normalize the mean value to 0 and set the standard deviation to 0.13, to match a variance of log wage rates of 0.6, as in the (LIS). The persistence of entrepreneurial productivity, ρ_z, and the standard deviation of the innovations to z, σ^2_ν, are among the estimated parameters.

6.3 Preferences

Recall that the flow utility function for workers is: $u(c,h) = \frac{c^{1-\gamma}}{1-\gamma} - \frac{h^{1+\eta}}{1+\eta}$. We assume η, the inverse labor supply elasticity, to be 1.0, and set the risk aversion parameter, γ, to be 2.0, both standard values in the macro literature. To save on the number of estimated parameters, the parameter governing the bequest motive, κ_b, is set to 0.02. This is roughly consistent with the range of estimates in Lockwood (2012), and also delivers a reasonable wealth level for older households[29]. Note that the exact level of bequests is an equilibrium object that we iterate on. The bequests, Γ_b, are distributed lump sum to all households who are alive in the current period. The subjective discount factor, β, is among the estimated parameters. It is affecting the average wealth of households, among other data moments.

6.4 Government

The social security payment parameter, ω_R, is set to 0.40, meaning that an individual with average earnings will get around 40% of his earnings as social security payments (in the benchmark economy the average labor earnings is about 1.0). This is consistent with U.S. data, see, e.g. De Nardi (2004). Using the estimates from the empirical section, we set the parameter governing the level of the personal income tax, θ_0, to 0.82 and the parameter governing the progressivity of the tax

[29]In our benchmark model, the ratio of total bequest assets to GDP is about 1.98%, which is quite close to other authors, see e.g. De Nardi (2004) and Coeurdacier et al. (2015). Furthermore, the median net worth of households in the 10 years after retirement relative to the median net worth of households in the 10 years prior to retirement is similar to the value in 2016 SCF data.

Table 4: Endogenously Estimated Parameters

Parameter	Description	Value	Relevant Moments
β	Discount factor	0.913894	Aggregate wealth to output ratio
ρ_z	Persistence for Ent. productivity z	0.802206	Entre. population share/Inequality moments
σ_ν	S.D. for Ent. productivity z	0.26593	Entre. population share/Inequality moments
Γ_f	Operating cost	0.164701	Share Ent. w. neg.profit/Inequality moments
c_e	Ent. entry cost	1.089882	Entre. population share/Inequality moments
Γ_s	Ent. switching cost	2.799498	Ent. population share/Share with neg. profit
A	Aggregate productivity	0.941326	Average earning for workers

code, θ_1, to 0.13. We set Γ_g to 0.1 so that the government transfer is about 10% of average labor earnings in the benchmark model.

6.5 Estimation

The parameters for which we do not have direct empirical counterparts are estimated using a simulated method of moments approach. Appendix A.6 provides a more detailed explanation of the approach. We choose 24 data moments to estimate 7 parameters. They are listed in Table 4 alongside the key data moments that helps to identify each of them. Table 5 displays the 24 moments in the data and model.

Below we provide some economic intuition behind our choice of data moments: β will have an impact on workers' saving incentives and hence on the aggregate savings to output ratio. It also affects the age profile of entrepreneurs and thus the mean and median age of entrepreneurs in the economy. This is because when assets are too low, the incentive to become an entrepreneur is reduced. The aggregate productivity parameter, A, affects average wages as well as the incentive of workers to supply labor, holding all else constant. Thus, average earnings and workers' income shares provide important information for its value; we will normalize the average earnings in the equilibrium to 1.0 when adjusting A. The operating cost Γ_f is closely related to the fraction of entrepreneurs who have negative or zero profits. Intuitively, when an entrepreneur has very low productivity (due to the stochastic component of z), she will reduce the capital and labor inputs; however, without the operating cost, Γ_f, she would always have positive profits even if the firm becomes smaller. The switching cost, Γ_s, is related to the exit rate and hence the population share of entrepreneurs. The persistence, ρ_z, and volatility, σ_z, of entrepreneurial ability will affect different wealth and income moments, such as the wealth and income shares held by entrepreneurs.

Let ω denote the parameter vector, $g(\omega)$ denote the 24×1 vector of simulated model moments and m denote the corresponding data moments. We search over the space for ω and minimize the distance, $[g(\omega) - m]^\top W [g(\omega) - m]$, where W is a 24×24 diagonal weighting matrix. It is an identity matrix, except that we put a higher weight on the wealth to output ratio and the population share of entrepreneurs to better match the data that are crucial to our analysis of entrepreneurial choice.

Table 5: Data Moments vs. Model Moments

Moments	Data	Model
Aggregate Wealth/Output	2.650	2.726
Entre. Pop. share	0.121	0.117
Entre. Employment share	0.560	0.575
Entre. share: Negative profits	0.110	0.083
Entre. Avg. age	49.2	44.6
Entre. Median age	49.0	44.0
Entre. age std	13.2	7.9
Entre. Pop. share $\mid$ Wealth $> 90^{th}$	0.410	0.511
Entre. Pop. share $\mid$ Wealth $> 80^{th}$	0.314	0.381
Entre. Pop. share $\mid$ Wealth $> 50^{th}$	0.230	0.229
Income share for Entre. $\mid$ Income $> 90^{th}$	0.234	0.295
Income share for Entre. $\mid$ Income $> 80^{th}$	0.249	0.307
Income share for Entre. $\mid$ Income $> 50^{th}$	0.274	0.313
Income share for All Entre.	0.279	0.313
Wealth share for Entre. $\mid$ Wealth $> 90^{th}$	0.399	0.320
Wealth share for Entre. $\mid$ Wealth $> 80^{th}$	0.421	0.370
Wealth share for Entre. $\mid$ Wealth $> 50^{th}$	0.438	0.408
Wealth share for All Entre.	0.439	0.409
Wealth share for All HH: Top 10^{th}	0.858	0.517
Wealth share for All HH: Top 20^{th}	0.917	0.715
Wealth share for All HH: Top 50^{th}	0.990	0.958
Relative Avg. HH income: Entre./worker	2.068	1.879
Relative Std. of HH income: Entre./worker	1.919	1.596
Avg. earnings for workers	1.000	1.000

We find that most data moments are matched reasonably well, including the population share of entrepreneurs, income and wealth shares of entrepreneurs, as well as the average household income and the relative standard deviations of earnings for workers and entrepreneurs. From the estimated parameters in Table 4, we observe that the stochastic component of entrepreneurial productivity is persistent ($\rho_z = 0.8022$), and also that the entry and exit costs of entrepreneurs are non-trivial (about 1.1 and 2.8 times average earnings). The operating cost, Γ_f, is in turn about 16% of average earnings and ensures that a significant share of entrepreneurs have zero or negative profits, consistent with the data. Figure A12 in the Appendix displays the distribution of firms' profits by different entrepreneurial characteristics (wealth, productivity, and fixed ability).

To make sure that all the parameters in our estimation are well disciplined by our data moments, we conduct a "sensitivity analysis" where we change one parameter value at the time, while keeping the others at their estimated values, and compute the model implied equilibrium moments. We report some of the results in the Appendix (Figures A13, A14, A15, A16, A17, A18). For almost all of the parameters, most of the model moments move monotonically with the parameter. There are a few exceptions; for example, the top wealth shares do not change that much when firms' operating costs change. This is, however, quite intuitive since relative to the wealth of rich entrepreneurs the operating cost is just tiny. Similarly, the top income and wealth shares move little as the entrepreneurs' switching costs change. However, other moments, such as the overall population share of entrepreneurs, and also the income and wealth shares for medium entrepreneurs (e.g. wealth $> 50^{th}$), change monotonically with the parameter of interest and the pattern is quite robust.

7 Taxation and Entrepreneurial Choice: Inspecting the Mechanisms

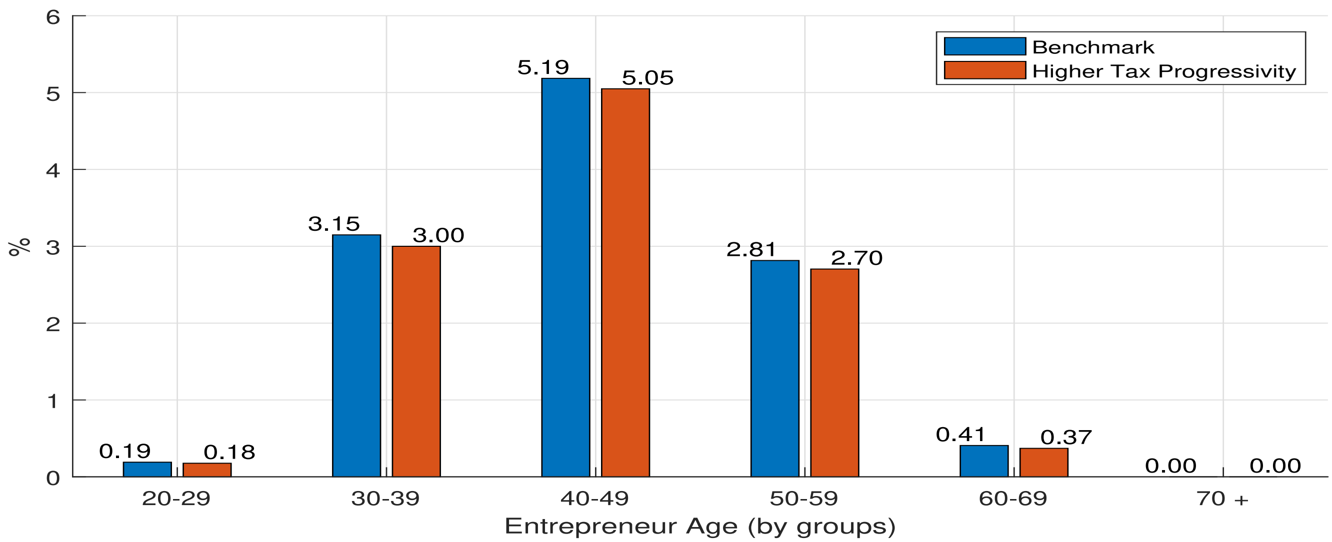
In this section we use our model to examine who becomes an entrepreneur and we analyze the determinants of entrepreneurial choice. In particular we focus on the impact of tax level and progressivity, but we also conduct a number of counterfactual experiments to study the impact of other factors such as income risk and access to loans.

7.1 Entrepreneurship and Taxation Across the Household Distribution

Our first experiment is to study how entrepreneurial choice changes along the household distribution when we increase tax progressivity, θ_1. During the experiment we adjust θ_0 to keep the average tax level constant, and in equilibrium we also adjust AE so that the tax function in different economies is always relative to average income.

In Figure 1 we increase, θ_1, from 0.13 to 0.15 (equivalent to an increase in progressivity of about 15%, or 1.17 standard deviations of θ_1 across time and U.S. states in Section 3). We plot the share of entrepreneurs across different age groups relative to the total population in the benchmark

Figure 1: Share of Entrepreneurs by Age



economy and in the economy with higher tax progressivity (the blue benchmark bars sum up to 11.7% entrepreneurs in the population). We observe that the age-distribution of entrepreneurs is hump shaped across age groups. For example, the fraction of households who choose to become entrepreneurs in the youngest age group (20-29) is only equivalent to about 0.2 p.p. of the total population, however, this number increases to about 3.2 p.p. for those aged 30-39 and to almost 5.2 p.p. for those aged 40-49.

In Figure A19 in the Appendix, we examine the distribution of entrepreneurs across more individual states: idiosyncratic firm productivity z, fixed ability α, stochastic labor market efficiency ϵ, and also different wealth quintile. We find that entrepreneurs are mostly concentrated among individuals with higher values of innate abilities, α, or the stochastic persistent idiosyncratic entrepreneurial productivity, z, with a monotonically increasing pattern. It is also clear that the fraction of entrepreneurs is increasing in wealth. However, for the idiosyncratic labor market efficiency, ϵ, we instead find that there is a more or less monotonically decreasing pattern: As ϵ increases, there are less entrepreneurs on average. This is natural as a high ϵ increases the value of being a worker.

When tax progressivity increases, the share of entrepreneurs falls in all age groups. Tables 6 and 7 provide detailed statistics on the following variables: the population share of entrepreneurs, the fraction of entrepreneurs being borrowing constrained, the average wealth level of entrepreneurs and also its dispersion, mean and dispersion for firm productivity and the z component. We make a few key observations:

(1) Higher tax progressivity leads to lower accumulation of wealth. Entrepreneurs of all ages become poorer and more entrepreneurs are borrowing constrained. One reason for this is that more progressive taxes depress the labor supply of workers, who will work and save less (see Holter et al. (2019)). In addition to the direct effect of reduced after-tax profit with higher

Table 6: Statistics for Entrepreneurs Across Different Age Groups

Age groups	20-29	30-39	40-49	50-59	60-69
Pop. share of Entre.					
Benchmark	0.19%	3.15%	5.19%	2.81%	0.41%
Higher Progressivity	0.18%	3.00%	5.05%	2.70%	0.37%
Share of Entre. being constrained					
Benchmark	90%	72%	39%	6%	0%
Higher Progressivity	91%	74%	41%	7%	0%
Entre. Wealth					
Mean: Benchmark	5.20	12.64	25.27	36.69	36.40
Mean: Higher Progressivity	4.94	11.87	23.31	33.86	33.71

progressivity, the effect on wealth accumulation is a major contributor to the fall in the population share of entrepreneurs. With higher progressivity ,ore potential entrepreneurs become financially constrained and are not able to invest and operate at an optimal level.

(2) Holding firm productivity and capital input constant, the after-tax return of entrepreneurs would decrease. However, there is an equilibrium selection effect pushing marginal entrepreneurs out: the average productivity of entrepreneurs after occupational choices is increasing in tax progressivity, and so is the average before-tax firm profit, see Table 7. For example, for entrepreneurs aged 30-39, the mean productivity is 3.46 in the benchmark case and it is 3.52 after progressivity changes (a productivity increase of about 1.7%).

(3) Even net of selection of more productive entrepreneurs, the average after-tax profit have lower mean but also lower variance. For example, for entrepreneurs aged 30-39 the mean after-tax profit is 4.91 in the benchmark case and is 4.72 after the change in tax progressivity (recall that the average earnings across all individuals in our economy is about 1.00 in the benchmark case). The mean profit is reduced by about 4% after the increase in tax progressivity. At the same time, we observe that the standard deviation of after-tax profit is 4.88 in the benchmark case and 4.45 after the progressivity change, a fall in volatility of about 9%. Higher tax progressivity indeed reduces both the mean and volatility of the return to entrepreneurship and thus the two theoretical channels, the "risk-" and "return-effect" of progressive taxation that we illustrated in Section 4.1 are present. Quantitatively, there is, however, no doubt that the "return-effect" dominates as increased tax progressivity leads to a fall in the share of entrepreneurs in all age groups.

7.1.1 Tax Changes Only for Entrepreneurs

In Table 8, we experiment with increasing the tax progressivity parameter, θ_1, by 0.02 only for entrepreneurs, while keeping the tax system for workers unchanged. We compare the results to the benchmark model and to the case when taxes change for both occupations. In all the experiments we keep constant the economy's average tax rate. Table 8 reports the equilibrium mean and standard deviation of entrepreneurs' after-tax profit, the population share of entrepreneurs and

Table 7: Profit and Productivity Before and After Tax Changes

Age groups	20-29	30-39	40-49	50-59	60-69
Firm profit (before tax)					
Mean: Benchmark	6.75	8.55	6.59	1.69	0.00
Mean: Higher Progressivity	6.91	8.65	6.61	1.73	0.00
Std: Benchmark	5.26	10.07	9.60	3.42	0.26
Std: Higher Progressivity	5.30	9.90	9.43	3.43	0.27
Firm profit (after tax)					
Mean: Benchmark	4.14	4.91	3.71	0.92	-0.13
Mean: Higher Progressivity	4.05	4.72	3.54	0.92	-0.11
Std: Benchmark	2.81	4.88	4.65	1.87	0.23
Std: Higher Progressivity	2.65	4.45	4.25	1.78	0.23
Firm productivity					
Mean: Benchmark	3.72	3.46	2.84	1.72	0.88
Mean: Higher Progressivity	3.81	3.52	2.86	1.74	0.88
Std: Benchmark	1.19	1.33	1.21	0.82	0.34
Std: Higher Progressivity	1.22	1.35	1.22	0.83	0.34
Firm stochastic productivity z					
Mean: Benchmark	1.90	1.46	1.32	1.34	1.47
Mean: Higher Progressivity	1.93	1.47	1.33	1.34	1.47
Std: Benchmark	0.64	0.58	0.54	0.54	0.56
Std: Higher Progressivity	0.65	0.58	0.55	0.54	0.56

also the composition across age groups. We observe that increasing tax progressivity only for entrepreneurs has a large impact on the population share of entrepreneurs. It drops from 11.74% to 11.25%. Increasing progressivity for workers as well leads to slightly more entrepreneurs (the population share increases from 11.25% to 11.32%). When we only tax entrepreneurs the mean after-tax profit also decreases, from 3.24 to 3.14. The effect of increasing progressivity only for entrepreneurs is relatively large, mainly because the return to entrepreneurship compared to being a worker is directly reduced. When we also increase progressivity for workers, this should lower the payoff to being a worker, especially for highly paid workers (marginal entrepreneurs), and one could possibly expect to see a significant increase in the share of entrepreneurs. However, there is almost no change due to the negative effect on worker's wealth working in the other direction. Most entrepreneurs need to slowly accumulate wealth as workers before they can start a business. Higher tax progressivity depresses workers' labor supply and wealth accumulation, and this makes it less tempting to start a business.

Table 8: Tax Changes Only for Entrepreneurs

	Profit: mean	Profit: std	Pop. Share	21-30	31-40	41-50	51-60	60+
Benchmark Model	3.24	4.41	11.74%	0.19%	3.15%	5.18%	2.81%	0.40%
θ_1 increase only for Entre.	3.14	4.10	11.25%	0.18%	2.99%	5.02%	2.68%	0.38%
θ_1 increase for All	3.17	4.15	11.32%	0.18%	3.01%	5.05%	2.70%	0.38%

7.1.2 Local Changes in the Tax Level

In Table 9, we experiment with small changes in the tax level: we increase or decrease θ_0 by 0.02. In contrast to the previous exercises where we changed progressivity, here the equilibrium average tax rate is changing. The progressivity of the tax system governed by θ_1 is, however, constant. Table 9 reports the equilibrium mean and standard deviation of entrepreneurs' after-tax profit, the population share of entrepreneurs and also the composition across age groups. When θ_0 increases, the average tax rate in the economy changes from about 31.9% to 30.3%. As illustrated in the simplest theoretical model in Section 4.1, without entry costs or asset accumulation, the effect of a tax increase on entrepreneurial choice may be ambiguous since both occupations' incomes are affected in a similar way. With fixed startup costs, the relative return to entrepreneurship is, however, reduced when the tax rate increases, and with asset accumulation it also becomes harder to accumulate a sufficient level of assets for starting a business. Quantitatively, we find that entrepreneurship is decreasing in the average tax level. For example, when θ_0 increases by 0.02, the population share of entrepreneurs increases from 11.74% to 12.07%. Table 9 also shows that changing θ_0 seems to have quite symmetric effects on profits and the distribution of profits.

Table 9: Local Changes in Tax Level

	Profit: mean	Profit: std	Pop. Share	21-30	31-40	41-50	51-60	60+
Benchmark Model	3.24	4.41	11.74%	0.19%	3.15%	5.18%	2.81%	0.40%
θ_0 increases	3.31	4.53	12.07%	0.21%	3.26%	5.30%	2.88%	0.41%
θ_0 decreases	3.16	4.30	11.33%	0.17%	2.99%	5.05%	2.73%	0.39%

7.2 *The Elasticity of Entrepreneurship to Taxation in the Model vs. the Data*

Based on the previous exercises, we can compute the implied elasticity of the population share of entrepreneurs and employment at entrepreneurial firms with respect to taxation in the model and compare them with our empirical estimates from Section 3. The elasticities with respect to the progressivity parameter, θ_1, expressed as percent changes of the outcome variables per 0.01 change in θ_1, are roughly 1.8 for the population share of entrepreneurs and about 2.1 for labor employed by entrepreneurs[30]. The corresponding empirical elasticities were 7.4 for the populations share of entrepreneurs, 3.1 for the number of small firms[31], and 1.7 for employment at small firms (recall that these measures of entrepreneurship come from different data sets[32]). Thus the model generates elasticities with respect to tax progressivity that is similar to what we found for employment at

[30]Our experiment where we adjust θ_0 to keep the economy-wide average tax rate constant is not exactly in line with our regressions in Section 3. There, we keep θ_0, which controls the average tax rate for an individual with average earnings, independently of θ_1, constant. To compare to the empirical analysis we also perform an experiment where we only change θ_1 and adjust AE in the tax function to keep the tax rate of a person with average earnings constant. In this experiment the elasticities with respect to the progressivity parameter, θ_1, are roughly 2.3 for the population share of entrepreneurs and about 2.0 for labor employed by entrepreneurs.

[31]In the model the number of entrepreneurs and the number of small firms are identical.

[32]The population share of entrepreneurs that tend to have a higher elasticity in the empirical exercises is constructed using the CPS, whereas the number of small firms and employment at small firms come from the CBP

entrepreneurial firms in Section 3.

The elasticities with respect to the economy's average tax rates expressed as percent changes of the outcome variables per 1 percentage point change in tax rate, are 1.70 for θ_0 increases and 2.13 for θ_0 decreases (for the population share of entrepreneurs), and 1.69 and 2.11 for employment at entrepreneurial firms, respectively. The corresponding empirical elasticities were 4.5 for the population share of entrepreneurs, 1.3 for the number of small firms, and 1.5 for employment at small firms, if we take a one percent increase in the average tax rate at median income in the data as analogues to a one percent increase in the economy-wide average tax rate in the model. Thus the model-implied elasticities with respect to the average tax rate are also fairly close to the empirical ones, in particular the empirical results with a dependent variable from the CBP (see Table 1). Overall, we conclude that the model elasticities of entrepreneurship with respect to tax level and progressivity are quite close to their empirical counterparts.

7.3 Counterfactual Experiments: The Risk and Return Mechanisms

In this section, we conduct more counterfactual experiments to understand the interaction between tax changes and different model elements. We experiment with alternative model parameter specifications that could change the relative strength of the risk vs. return consideration of becoming an entrepreneur: we consider mean-preserving changes in the volatility of entrepreneurial productivity, changes in the households' starting wealth, changes in entrepreneurs' financing conditions and changes in entrepreneurial firms' entry and operating costs, and we interact all these changes with changes in tax progressivity.

7.3.1 Mean-preserving Changes to the Volatility of Productivity Shocks

We consider an increase or decrease in σ_ν, the standard deviation of the innovations to the stochastic component of entrepreneurial firm productivity, of 10%. We adjust the unconditional mean of the new productivity process so that average productivity is the same as in the benchmark case. We then vary the tax progressivity (by +0.02 or -0.02) and compare to the benchmark. The results are displayed in Tables A9 and A10 in the Appendix. We observe that mean-preserving higher volatility on average will induce more people to become entrepreneurs. This happens because it is the households with the highest entrepreneurial ability that choose to become entrepreneurs and the top entrepreneurial ability is now higher. More often than before, even for lower wealth workers, will the entrepreneurial shock be sufficiently high to justify becoming an entrepreneur. Thus, even if this experiment keeps the mean entrepreneurial ability in the population constant, the mean among entrepreneurs increases, and we do not really isolate the effect of risk on entrepreneurial choice.

Table A10 reports elasticities with respect to the progressivity parameter, θ_1, percent changes of the outcome variables per 0.01 change in θ_1, for the population share of entrepreneurs and also the average employment hired by entrepreneurs (the latter captures both the extensive and intensive margins of entrepreneurial activity). When tax progressivity changes, the changes of the population share of entrepreneurs are larger for the low-risk environment compared to the high-risk environment, -1.88% change vs. -1.26% change in the population share of entrepreneurs for a 0.01 increase in tax progressivity. In the low-risk environment, when the highest states of entrepreneurial productivity are lower, there will be more marginal entrepreneurs that can be pushed out of entrepreneurship by tax changes.

7.3.2 More Experiments on the Mean and Standard Deviation of Entrepreneurial Productivity

We also experiment with the process for z and vary the mean and standard deviation (without preserving the mean). These results are displayed in Table A11. We increase the parameter σ_ν by 1% or 2%, and also increase the mean of z (denoted as m_z) by 1% or 2%. In the upper panel of Table A11 in the Appendix, we first compare several implied aggregate variables to the benchmark model. Each column is in percent deviation from the benchmark values. Note that since entrepreneurs are endogenously selected, all the means and standard deviations are equilibrium objects. We observe that with higher m_z or σ_ν, there is a significant inflow of entrepreneurs. For example if the mean of z increases by 2% we get 9% more entrepreneurs. In the lower panel of Table A11, we again compute the semi-elasticity for different with respect to an increase in tax progressivity. We observe that the elasticities are now significantly higher. When the average entrepreneurial productivity increases more people are induced to become entrepreneurs. However, these people are marginal entrepreneurs that are pushed back by the more progressive tax schedule.

7.3.3 The Distribution and Level of Initial Wealth

In our benchmark model we assume that all households begin with the same initial wealth. Alternatively, we here assume that households are endowed with different initial wealth levels, proportional to their innate ability (e^{α_F} in the model), but the mean initial level is still consistent with the society's bequest transfers. This can help us capture that some households may have larger inheritance or other transfers than others. The results in Tables A12 and A13 in the Appendix are essentially the same as in the benchmark model. This is because the initial wealth is still modest, even for the high ability levels.

If we instead significantly increase the starting wealth of all households (from the benchmark level of about 10% of average earnings to 100% of average earnings), we get a boost to entrepreneurship across all ages and in particular at younger ages when credit constraints are more likely to bind. The elasticity of entrepreneurship with respect to tax progressivity drops. This would be consistent with many of the marginal entrepreneurs being credit constrained. Having more wealth also reduces the risk of becoming constrained in the future and generally reduces the riskiness of entrepreneurship.

7.3.4 Easier Financing Conditions

In Tables A12 and A13 in the Appendix, we also consider changes in the collateral constraint parameter, Θ. We increase it or decrease it by 20%. The population share of entrepreneurs is increasing across all age-groups with easier financing conditions. The relative size of the effect is, however, larger for younger households. This is natural because younger entrepreneurs are more likely to be constrained (recall the steady state characteristics in Table 6). For households aged 31-40, the share of entrepreneurs relative to the total population is for example increasing from 3.15% to 3.34% with a more generous borrowing limit. The elasticity of entrepreneurship with respect to tax changes becomes higher when financing is more scarce. With tougher financing conditions there are more marginal entrepreneurs that can be pushed out by increases in tax progressivity, which makes it harder to accumulate assets.

7.3.5 Easier Business Operation Conditions

We study a 20% increase or decrease in the entry cost, c_e. In Tables A12 and A13 in the Appendix, the resulting population share of entrepreneurs changes in the same direction across all age groups: it increases with lower costs. Total employment at entrepreneurial firms is also decreasing in the entry costs. Across the age distribution, we find that more young households select into entrepreneurship, since they have relatively lower wealth when they become entrepreneurs, and reduced entry costs are more valuable to them. The elasticity of entrepreneurs to increases in progressivity is slightly higher with lower entry costs (easier entry); again, this is because the selection of entrepreneurs now is relatively less restrictive, with more marginal entrepreneurs. The elasticity to a decrease in progressivity is slightly lower with lower entry costs because some of the marginal workers have become entrepreneurs.

7.3.6 Tax Credits for Business Income Losses

Governments often use tax credit policies to encourage risk-taking entrepreneurs; one particularly relevant policy is to offset the business income loss (see e.g. Kaymak and Schott (2019)). For example, when business income is negative, $\pi < 0$, it is typically the case that firms can carry some part of the income loss forward (or backward) when computing tax payments. Effectively, there is some loss-offset from tax policy. In our model environment, we can capture this spirit and conduct a similar exercise: when $\pi < 0$, we assume that some fraction, 20% (mild) or 80% (heavy), of this loss is offset by the government, so that the eventual business income for entrepreneurs is $\pi \times (1 - 0.2)$ or $\pi \times (1 - 0.8)$. We report the results in Tables A12 and A13. We find that the quantitative impact of this tax experiment is quite small, mainly because entrepreneurs endogenously accumulate wealth to help them insure against negative productivity shocks when markets are incomplete. There are, however, some differences across different age groups: perhaps surprisingly, we do not find much of a difference for younger households. However, for relatively old households the impact is slightly larger. This is mainly due to the fact that young households are more exclusively selected based on firm productivity (they have the highest productivity state and are likely to stay there). As time goes on, there are entrepreneurs with worse productivity states that would be more likely to experience negative shocks. With more generous income loss offsetting, these entrepreneurs are less likely to exit. We also observe that the elasticity of entrepreneurs to tax progressivity is more or less the same as the benchmark case.

8 Taxation and Entrepreneurial Choice: Macroeconomic Analysis

In this section we first use our model framework to study whether the differences in taxation that we observe across U.S. states are a major driver of the variation in entrepreneurship. Then we examine the consequences of larger changes in tax progressivity and tax level for entrepreneurship and aggregate variables. We conclude by analyzing the socially optimal tax policy in partial and general equilibrium.

We find that because the variation in taxes across U.S. states and time is relatively small, although more than sufficient for the purpose of identifying elasticities in Section 3, it is not the main driver of the variation of entrepreneurship across states and time. Unsurprisingly other factors matter more (infrastructure, demographics, economic developments, business cycles, and so on). However, controlling for many of these factors and regressing entrepreneurship on state and time fixed effects, we see that the variation in taxation explains about 30% of the remaining variation in entrepreneurship.

In the model, like in the data, the local elasticity of entrepreneurship to increases in tax progressivity and level is fairly large. In the model this continues to hold also for large changes in taxation. Converting to a flat tax code results in 25% more entrepreneurs and about 4.5% higher output. Changing to a twice as progressive tax code[33] lowers the number of entrepreneurs by almost 40% and output by 5.6%.

Socially optimal policy is, however, not just about increasing output. There is a trade-off between efficiency on the one hand and insurance and redistribution on the other. Under our benchmark open economy, partial equilibrium assumption, the optimal steady state tax progressivity is about 26% lower, 0.096 compared to the benchmark value of 0.13. Under the alternative assumption of having a closed economy, optimal progressivity is as low as 0.063, or a 52% flatter tax code than in the benchmark model. The reason for the difference is the negative effect on wages that the drop in entrepreneurship has in general equilibrium, which we discuss with more details below.

[33] Some countries in Northern Europe have nearly twice as progressive tax codes as in the U.S., see Holter et al. (2019).

8.1 *Tax Changes in the Model and Data: Explaining State-level Variation in Entrepreneurship*

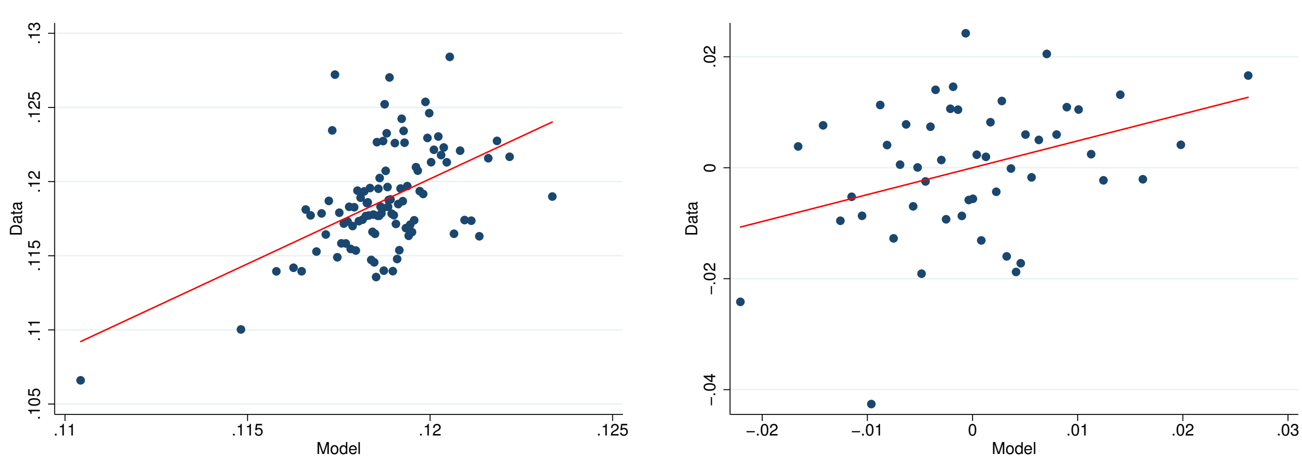
How relevant is taxation for explaining variation in entrepreneurship across time and states? To answer this question we treat our model with the estimated tax codes from Section 3 and compare the model's predictions to the data. We proceed as follows:

(1) from Section 3 we obtain a panel with $(\theta_0, \theta_1, m)_{s,t}$ for each available state s in year t; that is, we have data on tax level, tax progressivity and the population share of entrepreneurs for all s and t. We then insert $(\theta_0, \theta_1)_{s,t}$ in the model for each s, t and obtain the model-generated population share of entrepreneurs, m_{Model}. This gives us $(\theta_0, \theta_1, m_{Model})_{s,t}$ for each s, t. In this exercise, we still assume that the model economy is a small open economy with fixed prices to have it resemble U.S. states.

(2) We then compare our model results to the data counterparts. If we just compare the raw data on entrepreneurship in the data to the model-generated data, the relationship is quite weak. This is perhaps not so surprising because the variation in taxation across states and time is relatively modest and matters less than other factors (different technologies, industry structures, institutions, policies, business cycles etc.). If we control for time- and state-fixed effects we will, however, remove the impact of some of these factors. In the bin-scattered plots in Figure 2 we plot model generated data on the share of entrepreneurs and on workers employed by entrepreneurs on the x-axis against actual data, net of year- and state-fixed effects, on the y-axis. We observe that there is a clear positive relationship between $(m_{Model})_{s,t}$ and $(m)_{s,t}$. For the population share of entrepreneurs, the within group R^2 from the regression of $(m)_{s,t}$ on $(m_{Model})_{s,t}$, controlling for year- and state-fixed effects, is 29.8%. For the share of workers employed by entrepreneurs (the data counterpart used here is the total employment by small establishments) the corresponding within group R^2 is 22.1%. Thus, just using the variation in taxes across years and states, our model can account for roughly 30% of the variation in entrepreneurship (net of year- and state-fixed effects).

Figure 2: Model-generated Data vs. Real Data (Net of Year- and State-fixed Effects)

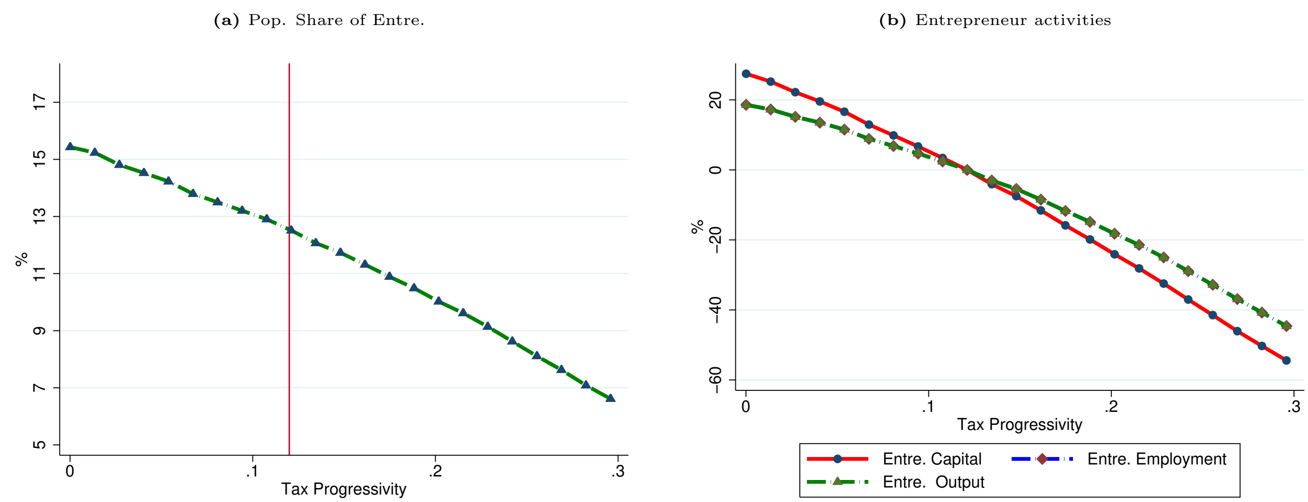
(a) Pop. Share of Entre. **(b)** Employment at Entrepreneurial Firms



8.2 The Impact of Tax Progressivity on Entrepreneurship and Aggregate Variables

To isolate the impact of tax progressivity on entrepreneurship and aggregate variables, we perform the same experiment as in Section 7.1: we change the value of the progressivity parameter θ_1 in our calibrated benchmark model and then adjust the level of θ_0 so that the new equilibrium has exactly the same average tax rate as in the benchmark economy (defined as total tax revenues/total taxable household income). Also recall that in the tax function, the denominator is average earnings, AE. We adjust AE in equilibrium so that the tax function in different economies is always relative to average income. A person with average income in our benchmark economy thus has the same average tax rate as in the data. During the exercise, we keep the level of government transfers constant at the benchmark level and let government spending, G, clear the budget. Since we want our economy to resemble U.S. states we impose the assumption of a small open economy with fixed prices (the wage rate per unit of labor and the interest rate are constant).

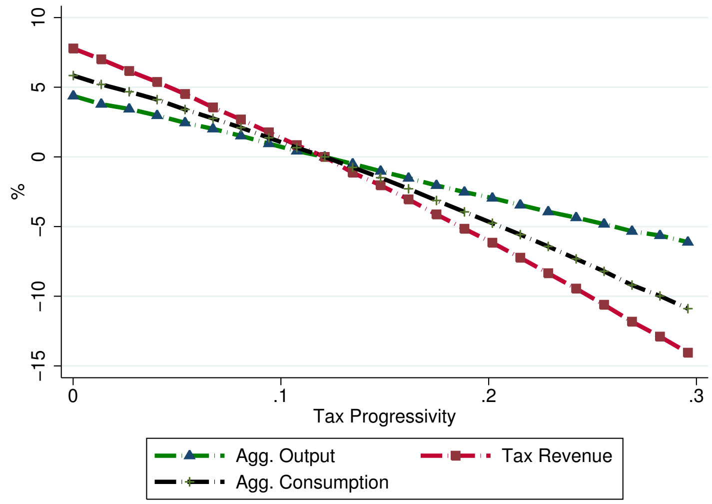
Figure 3: The Impact of Tax Progressivity θ_1 on Entrepreneurs and Aggregate Variables



In the left panel of Figure 3, we plot the population share of entrepreneurs against tax progressivity. Like in the data we observe that the population share of entrepreneurs is falling in tax progressivity. The elasticity of entrepreneurship to progressivity is high and increasing over a wide range of progressivity. Introducing a flat tax and keeping the average tax rate constant, leads to about 25% (3 percentage points) more entrepreneurs in the economy. Doubling the level of progressivity from 0.13 to 0.26 decreases the population share of entrepreneurs by about 4.8 percentage points, or almost 40%. In the right panel of Figure 3, we plot entrepreneurs' average capital, employment and output relative to the benchmark economy (employment is proportional to output due to the Cobb-Douglas production function). These variables are, not surprisingly, decreasing in tax progressivity. Increased tax progressivity leads to fewer entrepreneurs but the intensive margin of entrepreneurship, the average firm size, also decreases.

As discussed and illustrated in Section 4.1 there is an insurance effect and a return effect from making taxes more progressive. Entrepreneurs on average make higher income compared to workers

Figure 4: The Impact of Tax Progressivity (θ_1) on Aggregate Variables



but their income is also more volatile. Making taxes more progressive reduces income volatility but also makes the relative average wage difference between workers and entrepreneurs smaller. This happens mechanically due to the tax, but as we saw in Section 7 higher progressivity also makes it harder for workers to save enough to start a business. With more progressive taxes the average age of entrepreneurs increases and more entrepreneurs are credit constrained (further lowering their return). Quantitatively the return-effect strongly dominates the insurance-effect.

Figure 4 displays the effect of tax progressivity on aggregate variables in the economy. Output, consumption and tax revenue are all decreasing in tax progressivity. Given that we have just seen how more progressive taxes lead to fewer high-earning entrepreneurs this is what we would expect. Quantitatively, when we double the progressivity of the tax schedule from 0.13 to 0.26 aggregate output is reduced by about 5.6%, consumption by about 7%, and also the total tax revenue drops for about 10%, even though we keep the average tax rate constant. Converting to a flat tax increases output by about 4.5% and revenue by 7.7%.

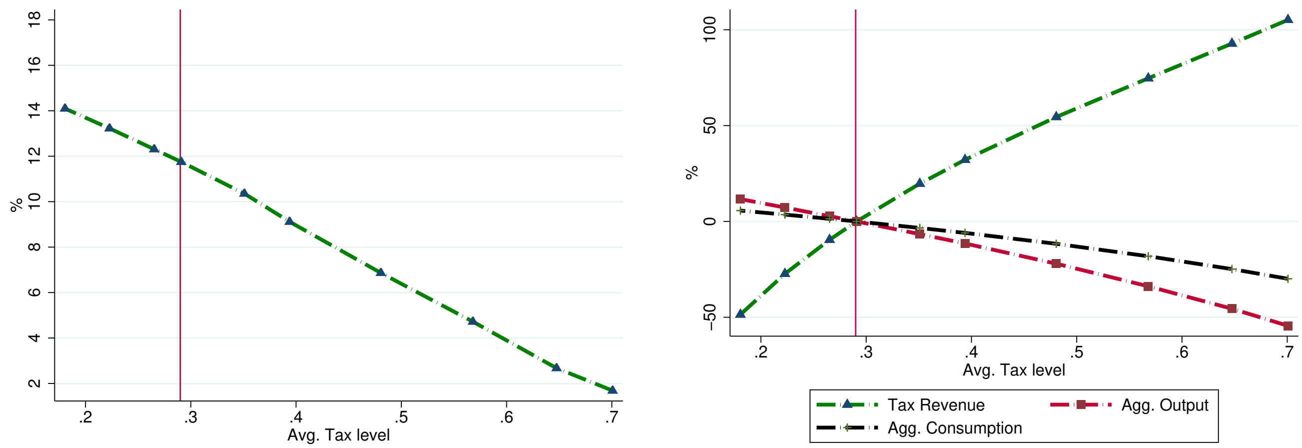
8.3 The Impact of Average Tax Rates on Entrepreneurship and Aggregate Variables

By changing θ_0 and keeping θ_1 constant we can change the average tax rate in the economy while keeping progressivity constant. Like before, we adjust average earnings, AE, in the tax function, and let wasteful government spending clear the budget. In Figure 5, we plot the equilibrium average tax level on the x-axis against the population share of entrepreneurs (for left panel) and against aggregate tax revenue, consumption and output (for right panel). The population share of entrepreneurs, consumption and output are (as expected) are all decreasing when the average tax level goes up. Quantitatively, if we for example double the equilibrium average tax level from about 28% to 56% – a dramatic tax reform – the population share of entrepreneurs falls by almost 60%, and aggregate output and consumption are reduced by almost 33%.

Although a higher average tax rate lowers the returns to both work and entrepreneurship, it

Figure 5: The Impact of Tax levels on Aggregate Variables

(a) Pop. Share of Entre. **(b)** Agg. Output, Consumption, and Tax Revenue



has a strong negative effect on entrepreneurial choice. A higher tax rate makes it harder to save and lowers the average wealth level for the whole economy. As we have seen above, making it harder to save leads to later entry into entrepreneurship and more credit-constrained entrepreneurs. Having less savings as insurance also makes entrepreneurship appear riskier and finally the fixed entry cost into entrepreneurship is relatively larger when taxes are higher.

8.4 Welfare Analysis

Having seen that a more progressive tax schedule leads to less entrepreneurship and lower economic activity, a natural question is whether a flatter tax system would be socially optimal. As usual, there is a trade-off between efficiency on the one hand and insurance and redistribution on the other hand. Since the main focus of this paper is not optimal taxation, we do not study transitions and limit ourselves to the classical experiment of maximizing the expected steady state utility of an unborn agent, as in Conesa and Krueger (2006), Conesa et al. (2009), Peterman (2016), Heathcote et al. (2017), Heathcote et al. (2020), Wu (2021).

We focus on a tax experiment where we keep the level of government spending exogenously fixed and focus on finding the most efficient way to cover the current spending level. This has been a traditional approach in much of the literature on optimal taxation in Aiyagari-type OLG models, and has the advantage that one does not have to make assumptions about the utility from the government-provided goods. For a given level of tax progressivity, θ_1, we adjust the tax level, θ_0, such that the government can raise enough tax revenue to cover the level of government expenditure, G, in the initial steady state. Our utilitarian social welfare function is defined as:

$$W = E_{\alpha_F,\epsilon,z} \max \left[V^W(j=1,\alpha_F,\epsilon,z,a_0), V^E(j=1,\alpha_F,\epsilon,z,a_0) \right] \tag{8}$$

The problem solved by our social planner is:

$$\max_{\{\theta_0,\, \theta_1\}} W, \quad s.t. \quad G = G^* \tag{9}$$

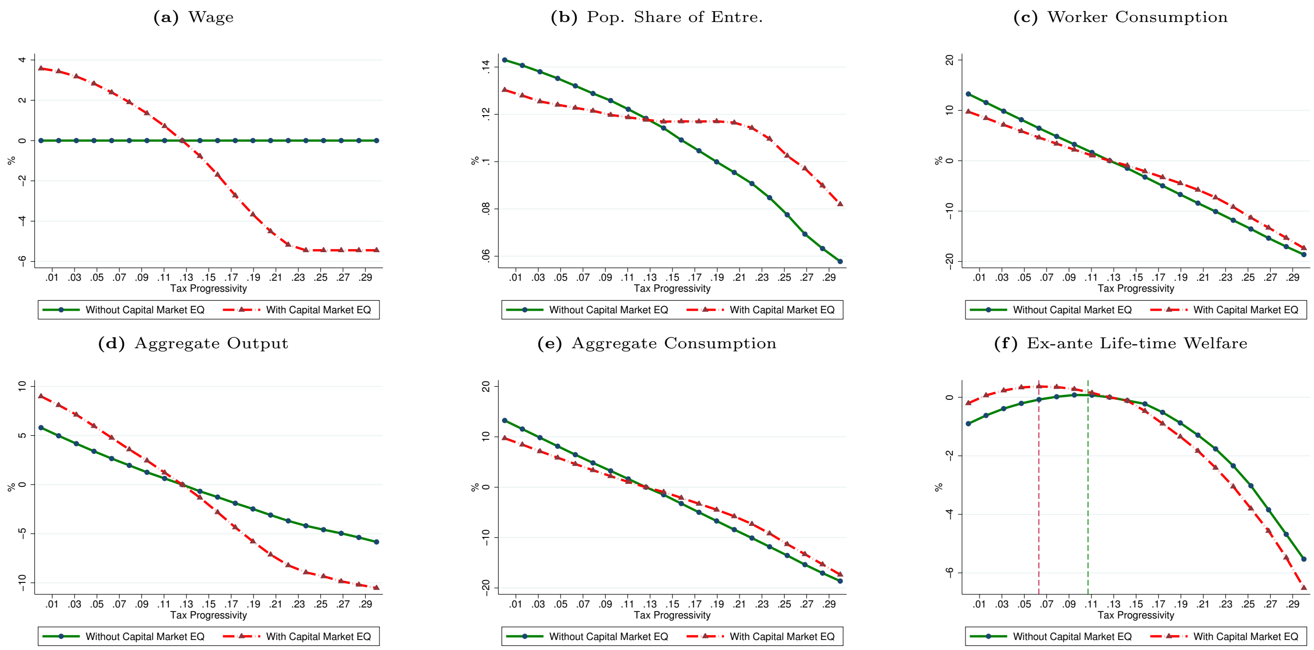
That is, the social planner takes government spending as given and finds the socially optimal progressivity and level of the tax system to raise the required revenue. First, we conduct this experiment in Partial Equilibrium (PE) with fixed prices as before. In addition, we consider a version of capital market General Equilibrium (GE), where we adjust the level of the interest rate so that the whole economy's net foreign asset position is the same as in the benchmark model when we change taxes. Adjusting the interest rate also implies that – through the representative firm's optimality condition – the wage rate per efficiency unit of labor is also adjusted and not constant any more.

Figure 6 displays our results on optimal tax policy in partial and general equilibrium. We plot welfare and aggregate variables against tax progressivity, θ_1 (θ_0 is adjusted to clear the government budget). The optimal policy is at the peak of the welfare curves (in consumption equivalents relative to the benchmark) in panel (f). We observe that optimal tax progressivity is lower than the benchmark both in PE and GE. In PE the optimum is at $\theta_1 = 0.096$ and in GE the optimum is at $\theta_1 = 0.063$. Aggregate consumption is higher at the optimum comparing to the benchmark, 3.2% higher in PE and 4.6% higher in GE. The welfare gain is, however, relatively modest, 0.078% increase relative to the benchmark level in PE and 0.36% increase to the corresponding benchmark level in GE. These results suggest that flatter taxes lead to less insurance and redistribution.

The reason for why the optimal tax schedule is less progressive and the potential welfare gain is larger with GE is the effect of entrepreneurs on wages. Since lower tax progressivity will induce more workers to become entrepreneurs, this leads to more demand for and lower supply of labor and higher wages. In the GE case, we observe that wages increase and interest rates decrease as progressivity decreases. The equilibrium effects on wages dampens the redistributive gains from progressive taxation and shifts optimal progressivity to the left.

We also observe that the equilibrium effects alter the elasticity of entrepreneurship and aggregate variables to tax progressivity. When progressivity is lowered and there are more entrepreneurs, wages go up and this counteracts the inflow of workers to the entrepreneurial sector.

Figure 6: Optimal Tax Progressivity in General and Partial Equilibrium



9 Conclusion

Entrepreneurs are an important part of the American macro-economy. In this paper we have obtained empirical estimates of the elasticity of several measures of entrepreneurial activity with respect to the level and progressivity of the income tax code. Higher and more progressive taxes generally lead to a fall in entrepreneurial activity. Furthermore, we have shown that a relatively simple macroeconomic model with elements that are by now quite standard in the literature is capable of generating elasticities of entrepreneurship with respect to taxation that are in line with the data.

In addition to the direct negative effect of progressive taxation on the returns to entrepreneurship, the impact on savings plays a crucial role in generating the negative relationship between entrepreneurship and taxation. High and progressive taxes make it harder to accumulate sufficient assets for starting a business. When taxes go up, marginal entrepreneurs are pushed out and the remaining entrepreneurs become older and more often credit constrained.

From the perspective of designing optimal public policy it is important to accurately account for the effects these policies have on entrepreneurship, which has a large impact both on efficiency (output) as well as the income distribution. Under the assumption of a small open economy, we find that the current progressivity of the U.S. tax system is not far from optimal. Under the alternative assumption of a capital market equilibrium, on the other hand, there is an additional harmful effect of reducing the number of entrepreneurs. Fewer entrepreneurs leads to lower demand for labor and lower wages, and thus a tax code which is about half as progressive as the current one, becomes optimal.

While our relatively simple macroeconomic model does a good job of capturing the extensive margin of entrepreneurship, we do not go as far as some recent papers in our modeling of the entrepreneurial firm.[34] Our entrepreneurs only make investments in the firm that matter for one period at the time and there are no state variables for the firm. In future research one may wish to relax this assumption, go further in the modeling in the firm and study the implications for tax policy.

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[34] see, e.g. Robinson (2022) for a model where entrepreneurs choose between several risky projects and Sedláček and Sterk (2017) for a model where the firm makes marketing decisions to increase it's consumer base, which is a state variable.

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A Appendix (For Online Publication Only)

A.1 Additional Empirical Results

Figure A1: Average Tax Rates at Median Income in the U.S.

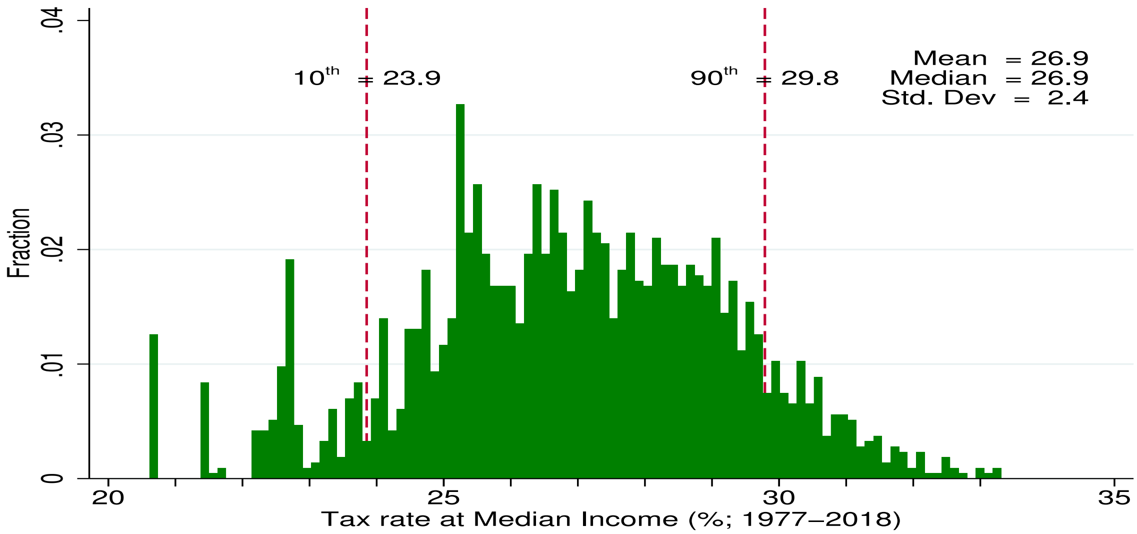
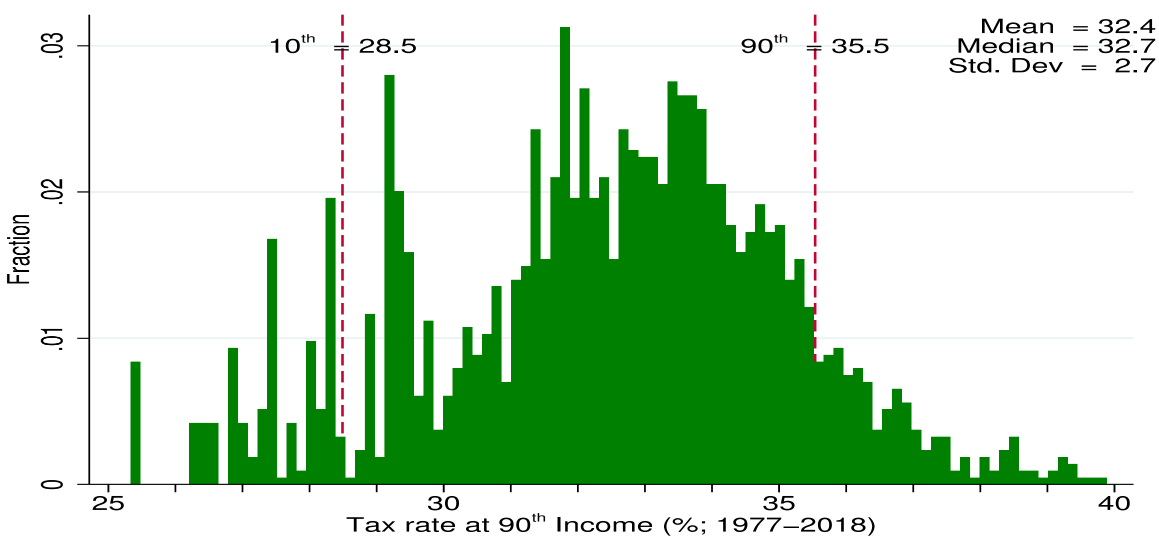


Figure A2: Average Tax Rates at the 90^{th} Percentile of Income in the U.S.



NOTE: The upper panel figure plots the distribution of state-level tax rates at median income in the U.S. from 1977 to 2018. The lower panel plots the state-level tax rates at the 90^{th} percentile of income. Both the median and the 90^{th} percentile income are according to the national distribution of household income. See more details in the main text.

Figure A3: Tax Rates at the Median Income Over Time for Selected States

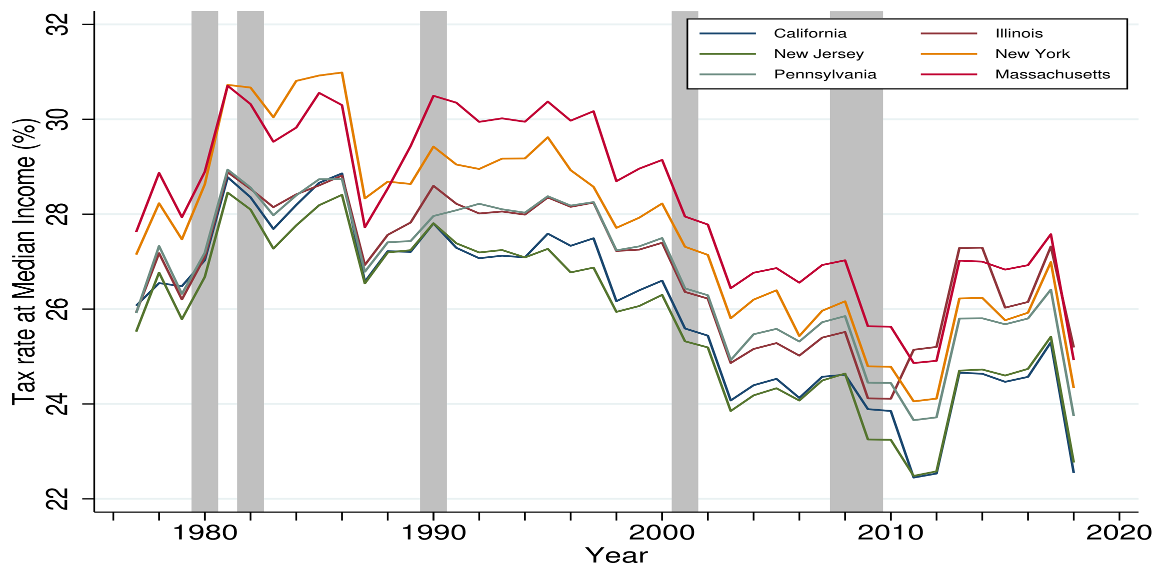
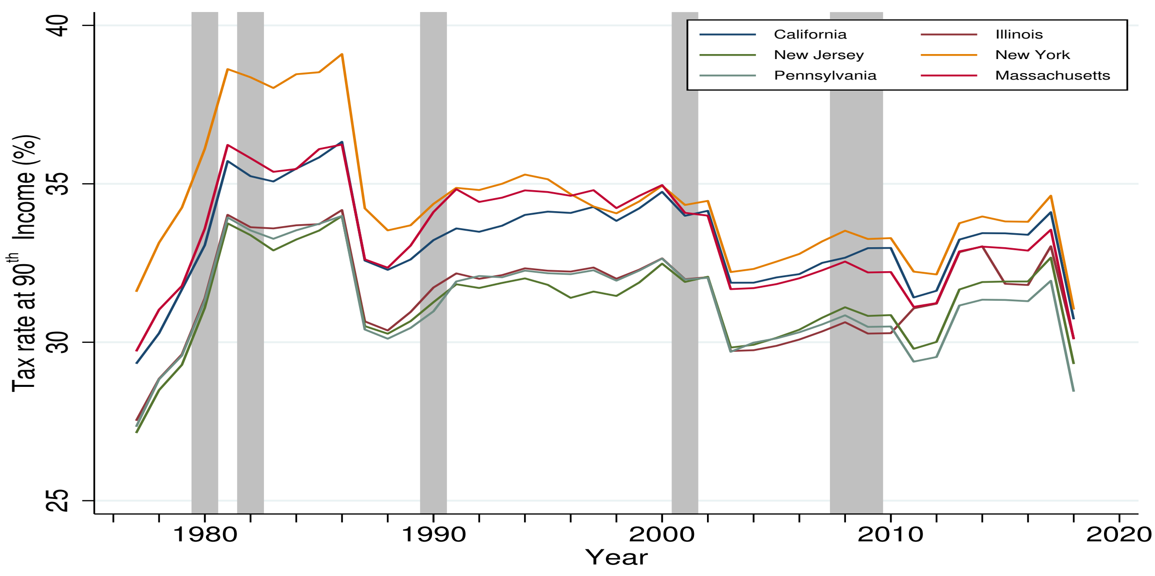


Figure A4: Tax rates at the 90^{th} Percentile of Income Over Time for Selected States



NOTE: The upper panel of the figure plots the state-level tax rates for median income from 1977 to 2018, for a few selected states (California, Illinois, New Jersey, New York, Pennsylvania, Massachusetts), and the lower panel plots the state-level tax rates at the 90^{th} percentile of income over time. The shaded areas refer to U.S. business cycles recessions. See more details in the main text.

Figure A5: Estimated Tax Progressivity(θ_1): Distribution

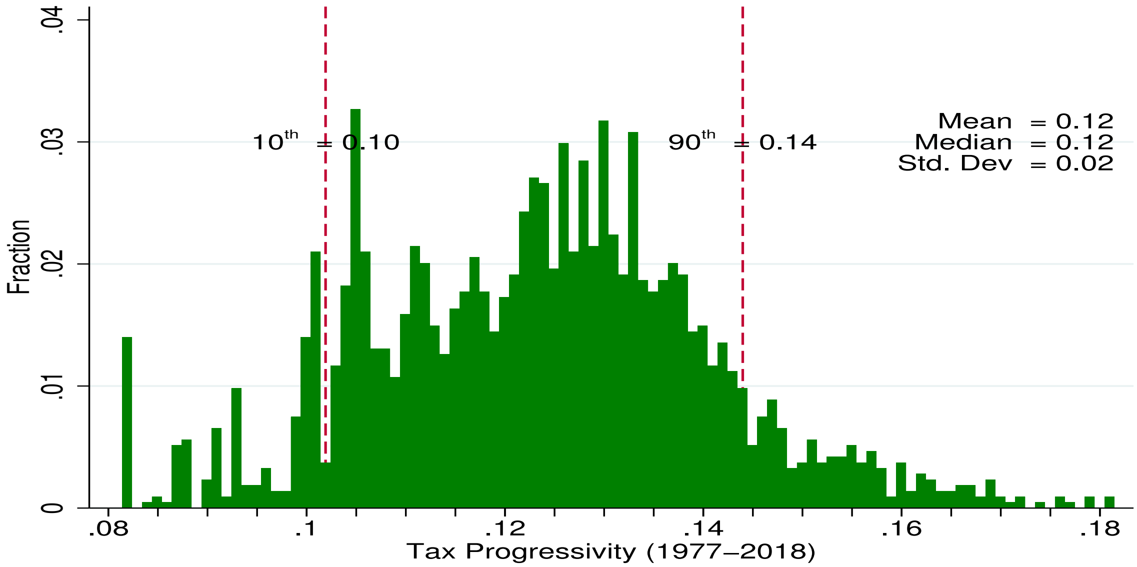
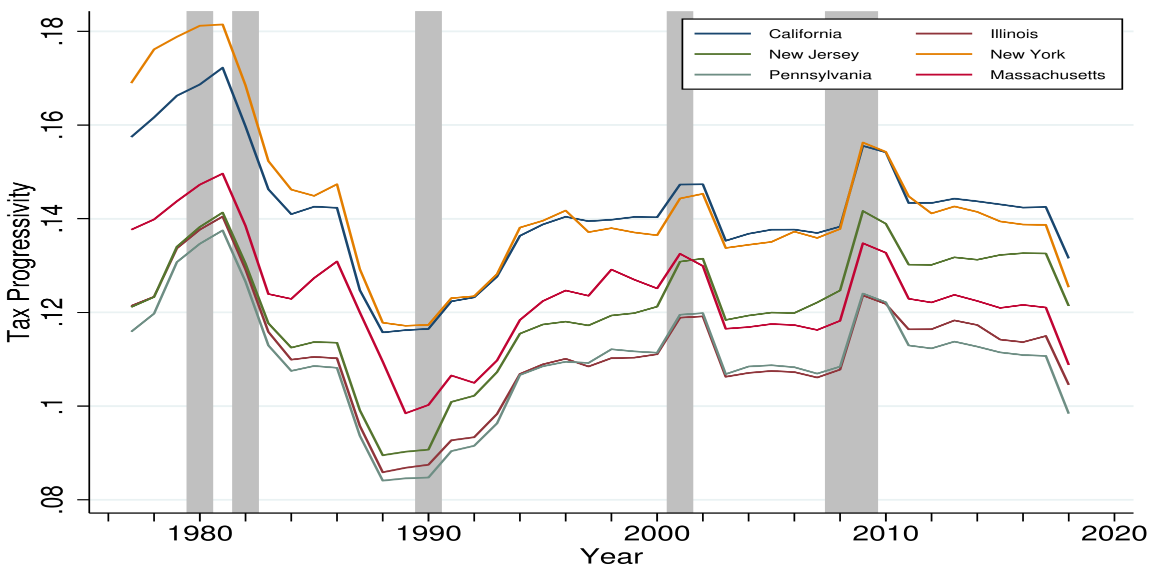


Figure A6: Estimated Tax Progressivity(θ_1): Over Time for Selected States



NOTE: The upper panel of the figure plots the distribution of the estimated state-level tax function progressivity parameter, θ_1, for all states from 1977 to 2018. See the main text for details on how to compute θ_1 and the economic interpretation. The lower panel plots the evolution of θ_1 over time for a few selected states (California, Illinois, New Jersey, New York, Pennsylvania, Massachusetts). The shaded areas refer to U.S. business cycles recessions.

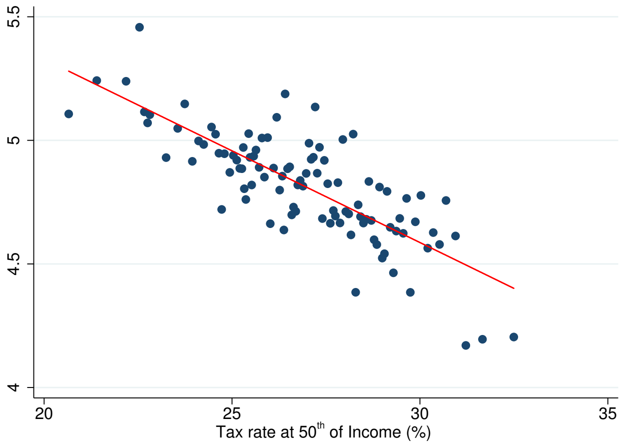
Table A1: Summary Statistics

	Obs.	Mean	S.D.	Percentiles						
				5^{th}	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	95^{th}
Avg. rate at 50^{th}	2142	26.891	2.350	22.697	23.852	25.332	26.927	28.599	29.788	30.594
Avg. rate at 90^{th}	2142	32.395	2.686	27.427	28.491	30.750	32.660	34.195	35.538	36.510
Avg. rate at 95^{th}	2142	33.398	2.765	28.373	29.383	31.899	33.627	35.194	36.652	37.739
Tax function θ_1	2142	0.123	0.017	0.096	0.102	0.111	0.124	0.134	0.144	0.153
Tax function θ_0	2142	2.806	0.474	2.036	2.227	2.442	2.809	3.136	3.427	3.621
Avg. rate at 50^{th}: Within states	2142	0.000	1.686	-3.055	-2.332	-1.294	0.250	1.357	1.951	2.369
Avg. rate at 90^{th}: Within states	2142	0.000	1.687	-2.863	-2.121	-1.104	0.044	0.982	2.230	2.841
Avg. rate at 95^{th}: Within states	2142	0.000	1.710	-2.598	-1.817	-1.091	-0.129	0.752	2.722	3.444
Tax function θ_1: Within states	2142	0.000	0.013	-0.022	-0.017	-0.005	-0.001	0.006	0.018	0.025
Tax function θ_0: Within states	2142	0.000	0.364	-0.673	-0.552	-0.175	0.007	0.248	0.417	0.573
Real GDP (per capita, 10,000s)	2142	3.373	1.352	2.127	2.294	2.627	3.120	3.711	4.450	5.232
Real GDP (per capita,in logs)	2142	10.375	0.297	9.965	10.041	10.176	10.348	10.522	10.703	10.865
Real GDP growth	2091	0.056	0.041	0.000	0.016	0.034	0.052	0.079	0.104	0.122
Employment to population ratio	2142	0.683	0.048	0.603	0.623	0.651	0.687	0.715	0.740	0.754
College population share	2142	0.485	0.119	0.282	0.318	0.391	0.498	0.581	0.638	0.660
Agriculture emp. share	2142	0.019	0.033	0.000	0.000	0.001	0.005	0.024	0.053	0.088
Manufacturing emp. share	2142	0.242	0.092	0.114	0.140	0.175	0.225	0.304	0.381	0.415
Unemployment rate	2142	0.052	0.021	0.024	0.029	0.037	0.048	0.062	0.079	0.091
Entre. population share (%)	2142	0.121	0.033	0.074	0.082	0.098	0.117	0.140	0.167	0.183
Entre. population share (with College, %)	2142	0.139	0.035	0.086	0.096	0.114	0.137	0.161	0.185	0.201
Num. of Entre. (in logs)	2142	4.817	0.576	3.984	4.146	4.456	4.765	5.136	5.527	5.910
Entre. population share (in logs)	2142	-2.148	0.274	-2.605	-2.497	-2.326	-2.150	-1.963	-1.791	-1.700
Num. of non-College Entre. (in logs)	2142	3.950	0.604	3.070	3.291	3.568	3.901	4.280	4.767	5.046
Num. of College Entre. (in logs)	2142	4.189	0.703	3.123	3.361	3.695	4.165	4.668	5.016	5.386
College Entre. population share (in logs)	2142	-2.008	0.266	-2.453	-2.343	-2.173	-1.989	-1.826	-1.686	-1.605
Total employment (in logs)	1683	14.065	1.044	12.346	12.628	13.160	14.163	14.777	15.415	15.777
Total employment in small firms (in logs)	1683	13.497	0.988	11.933	12.122	12.655	13.585	14.139	14.779	15.111
Total establishments (in logs)	1683	11.355	0.956	9.882	9.986	10.532	11.405	11.979	12.576	13.064
Establishment entry rates (%)	2050	11.672	2.525	8.001	8.572	9.862	11.343	13.209	15.060	16.271
Establishment exit rates (%)	2050	9.787	1.485	7.628	8.031	8.776	9.619	10.634	11.755	12.417
Establishment entry rates (in logs)	2050	-3.922	0.137	-4.118	-4.086	-4.025	-3.939	-3.833	-3.732	-3.666
Establishment exit rates (in logs)	2050	-3.918	0.113	-4.085	-4.055	-3.998	-3.927	-3.844	-3.768	-3.724

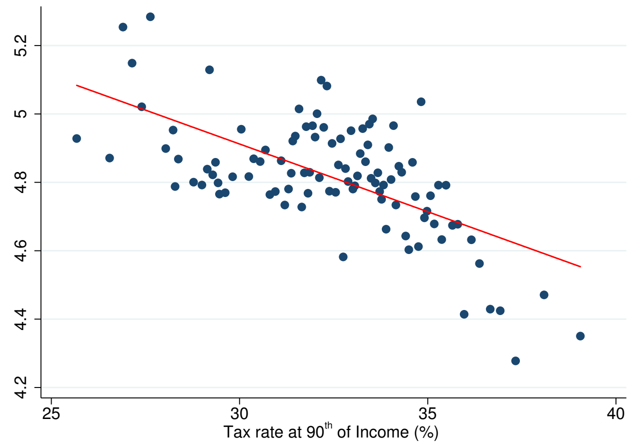
NOTE: All nominal variables are deflated by the CPI and we use 2000 CPI as the benchmark price.

Figure A7: Number of Entrepreneurs and Small Establishments (in logs), vs. Average Tax Rates at 50^{th} or 90^{th} Percentile

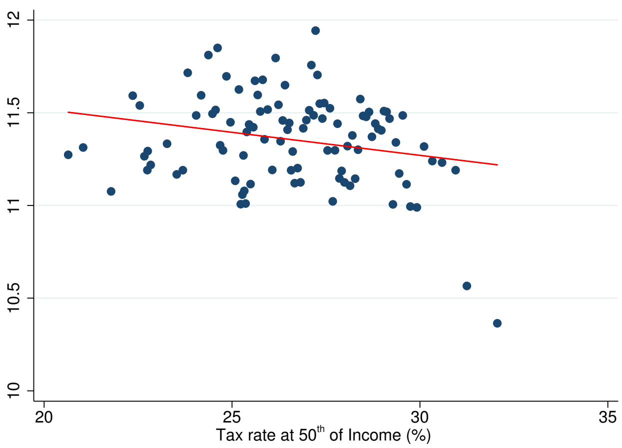
(a) Number of Entrepreneurs



(b) Number of Entrepreneurs



(c) Number of Small Establishments



(d) Number of Small Establishments

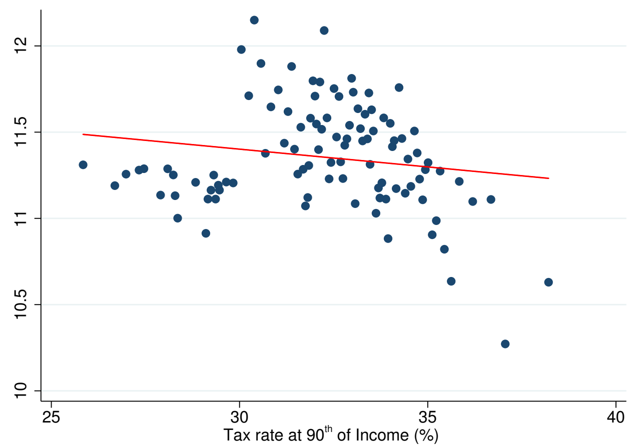


Figure A8: Number of Entrepreneurs and Small Establishments (in logs), vs. Average Tax rates at 50^{th} or 90^{th} Percentile; Net of Fixed Effects

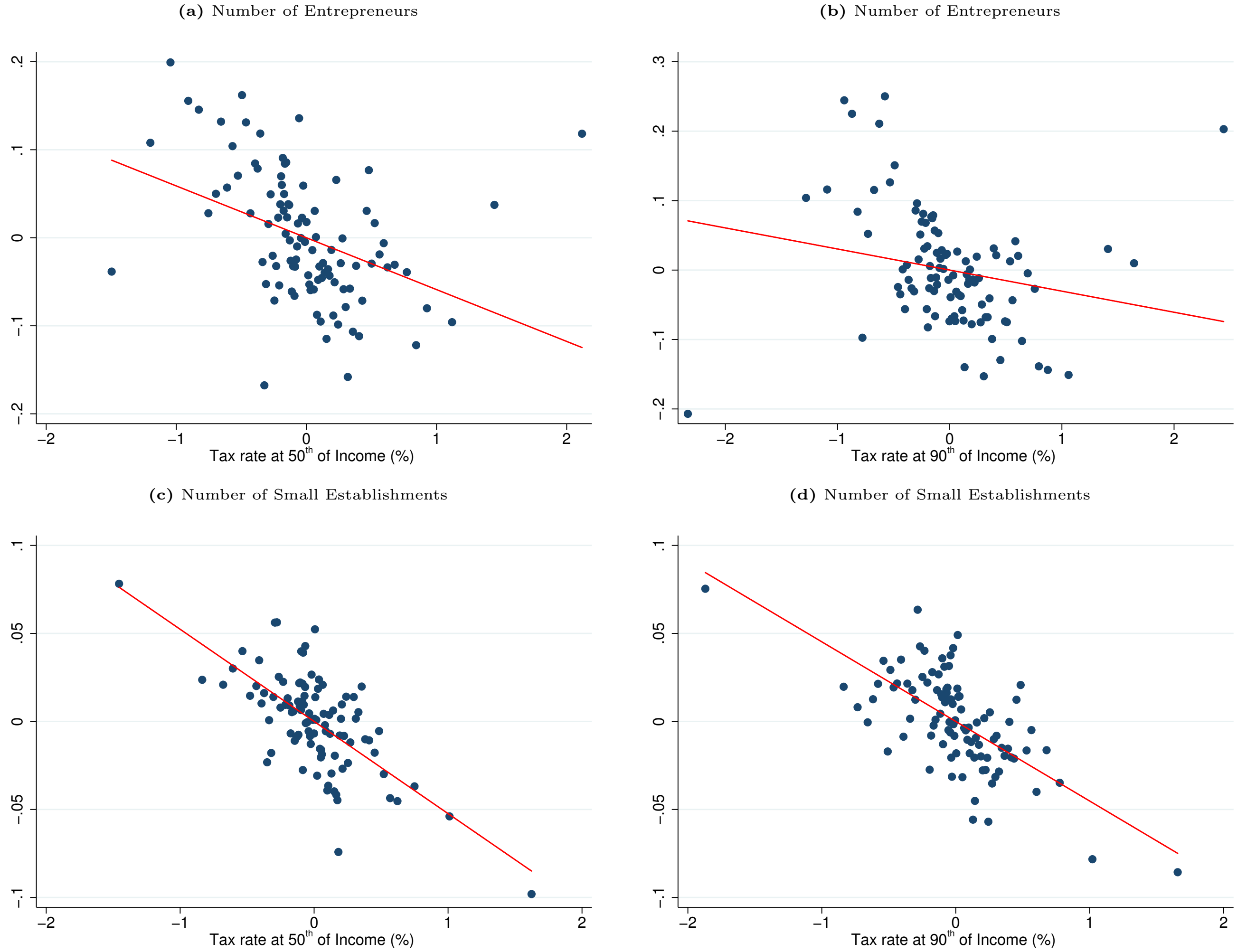
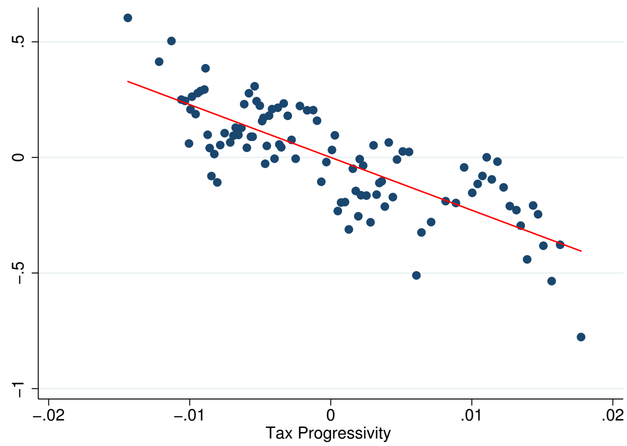
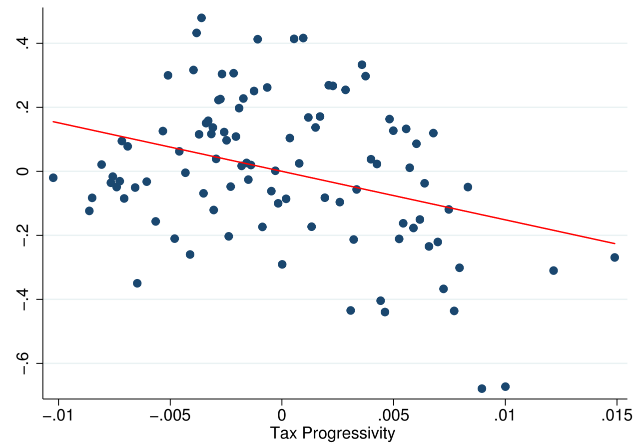


Figure A9: Number of Entrepreneurs and Small Establishments (in logs), vs. Tax Progressivity; With and Without Fixed Effects

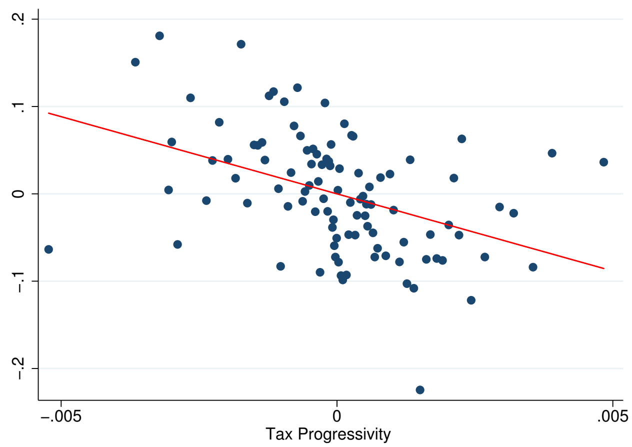
(a) Number of Entrepreneurs



(b) Number of Small Establishments



(c) Number of Entrepreneurs



(d) Number of Small Establishments

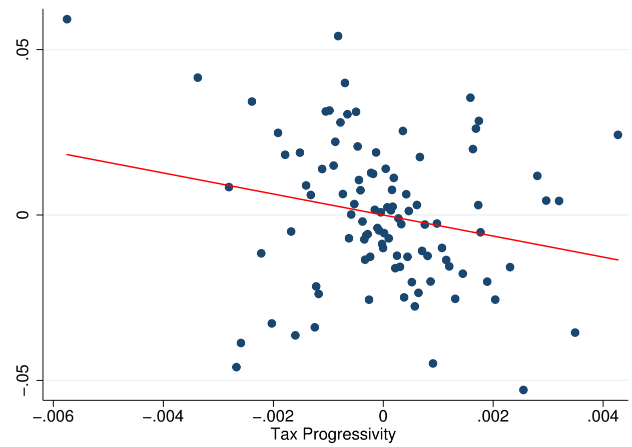


Table A2: Taxes and Entrepreneurial Activities: Robustness Tests With More Lagged Controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Num. of Entre.			Num. of College Entre.			Num. of Small Estab.			Small Estab. Emp			Total Emp.		
Avg. rate at 50^{th}	-0.0409**			-0.0567**			-0.0126***			-0.0142***			-0.00970***		
	(0.0175)			(0.0232)			(0.00218)			(0.00257)			(0.00269)		
Avg. rate at 90^{th}		-0.0307*			-0.0399*			-0.00796***			-0.00561***			-0.00305	
		(0.0164)			(0.0217)			(0.00175)			(0.00200)			(0.00203)	
Avg. rate at 95^{th}			-0.0365**			-0.0395*			-0.00780***			-0.00470**			-0.00269
			(0.0162)			(0.0218)			(0.00163)			(0.00184)			(0.00191)
Observations	1,785	1,785	1,785	1,785	1,785	1,785	1,683	1,683	1,683	1,683	1,683	1,683	1,750	1,750	1,750
R-squared	0.898	0.898	0.898	0.886	0.886	0.886	1.000	1.000	1.000	0.999	0.999	0.999	0.999	0.999	0.999
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Business cycles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

NOTE: This table reports the regression results when we include more lagged economic control variables and local linear and quadratic time trends, relative to the benchmark setting as specified in the main text. "Num. of Entre." uses the log of total number of entrepreneurs in each state and each year (from CPS, and weighted by CPS sampling weights); "Num. of College Entre." uses the log of total number of entrepreneurs with at least some-college degrees. "Num. of Small Estab." uses the log of total number of small-sized establishments, and "Small Estab. Emp" is for the log of employment at small-sized establishments. Column "Total Emp." uses the log of total employment for all establishment in each state and each year.

Table A3: Taxes and Entrepreneurial Activity: Instrumental Variable Analysis

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Num. of Entre.		Num. of Estab.		EMP		Num. of Small Estab.		Small Estab. Emp	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Avg. rate at 50^{th}	-0.0449***	-0.0828***	-0.0133***	-0.0232***	-0.00937***	-0.0143***	-0.0145***	-0.0170***	-0.0130***	-0.0194***
	(0.0165)	(0.0281)	(0.00206)	(0.00389)	(0.00270)	(0.00412)	(0.00261)	(0.00405)	(0.00222)	(0.00372)
Observations	1,887	1,887	1,850	1,850	1,850	1,850	1,683	1,683	1,683	1,683
R-squared	0.890	0.889	1.000	1.000	0.999	0.999	0.999	0.999	1.000	1.000
First stage F stat	162.9	162.9	162.9	162.9	162.9	162.9	162.9	162.9	162.9	162.9
p-value for F stat	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Avg. rate at 90^{th}	-0.0329**	-0.104**	-0.00733***	-0.0191***	-0.00259	-0.0115	-0.00589***	-0.0201**	-0.00822***	-0.0204**
	(0.0155)	(0.0473)	(0.00162)	(0.00718)	(0.00206)	(0.00774)	(0.00200)	(0.00931)	(0.00177)	(0.00810)
Observations	1,887	1,887	1,850	1,850	1,850	1,850	1,683	1,683	1,683	1,683
R-squared	0.890	0.888	1.000	0.999	0.999	0.999	0.999	0.999	1.000	1.000
First stage F stat	30.88	30.88	30.88	30.88	30.88	30.88	30.88	30.88	30.88	30.88
p-value for F stat	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Avg. rate at 95^{th}	-0.0342**	-0.0791	-0.00688***	-0.0172	-0.00193	-0.0250	-0.00504***	-0.0232	-0.00813***	-0.0192
	(0.0155)	(0.0959)	(0.00158)	(0.0144)	(0.00195)	(0.0161)	(0.00185)	(0.0159)	(0.00163)	(0.0136)
Observations	1,887	1,887	1,850	1,850	1,850	1,850	1,683	1,683	1,683	1,683
R-squared	0.890	0.889	1.000	0.999	0.999	0.999	0.999	0.999	1.000	1.000
First stage F stat	8.134	8.134	8.134	8.134	8.134	8.134	8.134	8.134	8.134	8.134
p-value for F stat	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044

Panel B	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Num. of Entre.		Num. of Estab.		EMP		Num. of Small Estab.		Small Estab. Emp	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Progressivity θ_1	-7.396*	-13.04	-3.300***	-8.249***	-1.726***	-6.863***	-1.685**	-7.533*	-3.087***	-12.87***
	(4.220)	(8.318)	(0.564)	(1.302)	(0.660)	(1.181)	(0.782)	(4.103)	(0.573)	(1.901)
θ_0	0.259**	0.417*	0.106***	0.220***	0.0811***	0.221***	0.0795***	0.303*	0.105***	0.460***
	(0.122)	(0.220)	(0.0188)	(0.0318)	(0.0206)	(0.0342)	(0.0307)	(0.155)	(0.0199)	(0.0706)
Obs.	1,887	1,887	1,850	1,850	1,850	1,850	1,683	1,683	1,683	1,683
R-squared	0.889	0.889	1.000	0.999	0.999	0.999	0.999	0.999	1.000	0.999
First stage F stat (for θ_0)	136	136	136	111.8	136	111.8	111.8	136	111.8	111.8
p-value for F stat	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
First stage F stat (for θ_1)	111.8	111.8	111.8	136	111.8	136	136	111.8	136	136
p-value for F stat	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

NOTE: This table reports the regression results using instrument variables. For more details on the construction of instrumental variables please see the main text. "Num. of Entre." uses the log of total number of entrepreneurs in each state and each year (from CPS and weighted by CPS sampling weights); "Num. of Estab." uses the log of total number of establishments and "EMP" is for the log of total employment. "Num. of Small Estab." uses the log of total number of small-sized establishments, and "Small Estab. Emp" is for the log of employment at small-sized establishments in each state and each year. Note that for all regressions we always control for State FE, Year FE, State time-varying Control variables, Local Business cycles and local non-linear trends. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A4: Robustness Test for Instrumental Variable Analysis: Controlling for Lagged Entrepreneurial Activities

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Num. of Entre.		Num. of Estab.		EMP		Num. of Small Estab.		Small Estab. Emp	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Avg. rate at 50^{th}	-0.0464***	-0.0840***	-0.0102***	-0.0144***	-0.00843***	-0.0112***	-0.0154***	-0.0209***	-0.0123***	-0.0163***
	(0.0161)	(0.0271)	(0.00160)	(0.00328)	(0.00244)	(0.00389)	(0.00278)	(0.00456)	(0.00208)	(0.00420)
Observations	1,887	1,887	1,850	1,850	1,850	1,850	1,479	1,479	1,479	1,479
R-squared	0.894	0.893	1.000	1.000	0.999	0.999	1.000	1.000	1.000	1.000
First stage F stat	79.54	79.54	79.54	79.54	79.54	79.54	79.54	79.54	79.54	79.54
p-value for F stat	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Avg. rate at 90^{th}	-0.0338**	-0.0937**	-0.00531***	-0.00909	-0.00156	-0.00987	-0.00577***	0.00455	-0.00674***	0.00333
	(0.0151)	(0.0457)	(0.00135)	(0.00600)	(0.00198)	(0.00748)	(0.00205)	(0.00522)	(0.00164)	(0.00487)
Observations	1,887	1,887	1,850	1,850	1,850	1,850	1,479	1,479	1,479	1,479
R-squared	0.893	0.892	1.000	1.000	0.999	0.999	1.000	1.000	1.000	1.000
First stage F stat	41.61	41.61	41.61	41.61	41.61	41.61	41.61	41.61	41.61	41.61
p-value for F stat	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Avg. rate at 95^{th}	-0.0369**	-0.0567	-0.00420***	0.00175	-0.000656	-0.0178	-0.00376**	0.00176	-0.00540***	-9.53e-05
	(0.0152)	(0.0935)	(0.00133)	(0.0135)	(0.00193)	(0.0154)	(0.00190)	(0.00678)	(0.00158)	(0.00578)
Observations	1,887	1,887	1,850	1,850	1,850	1,850	1,479	1,479	1,479	1,479
R-squared	0.894	0.893	1.000	1.000	0.999	0.999	1.000	1.000	1.000	1.000
First stage F stat	22.30	22.30	22.30	22.30	22.30	22.30	22.30	22.30	22.30	22.30
p-value for F stat	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044

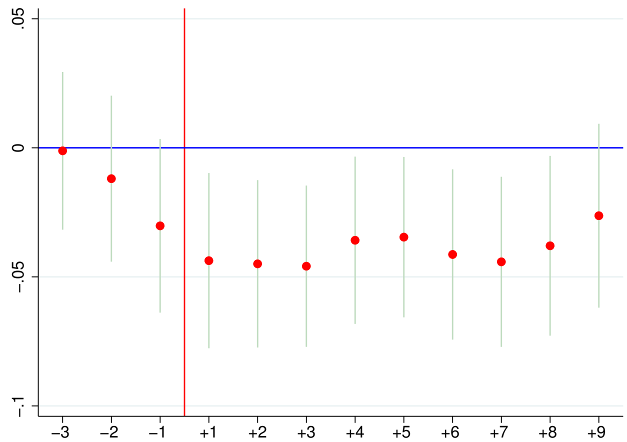
Panel B

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Num. of Entre.		Num. of Estab.		EMP		Num. of Small Estab.		Small Estab. Emp	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Progressivity θ_1	-7.459*	-11.99	-1.946***	-5.318***	-1.299**	-5.740***	-0.628	-13.40***	-1.587***	-11.95***
	(4.090)	(8.044)	(0.495)	(1.256)	(0.659)	(1.239)	(0.679)	(3.836)	(0.578)	(3.046)
θ_0	0.272**	0.358*	0.0706***	0.131***	0.0725***	0.182***	0.0443**	0.502***	0.0593***	0.435***
	(0.118)	(0.209)	(0.0164)	(0.0282)	(0.0204)	(0.0336)	(0.0201)	(0.136)	(0.0172)	(0.107)
Observations	1,887	1,887	1,850	1,850	1,850	1,850	1,479	1,479	1,479	1,479
R-squared	0.893	0.893	1.000	1.000	0.999	0.999	1.000	1.000	1.000	1.000
First stage F stat (for θ_0)	104.1	104.1	55.66	55.66	104.1	104.1	55.66	104.1	104.1	55.66
p-value for F stat	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
First stage F stat (for θ_1)	55.66	55.66	104.1	104.1	55.66	55.66	104.1	55.66	55.66	104.1
p-value for F stat	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

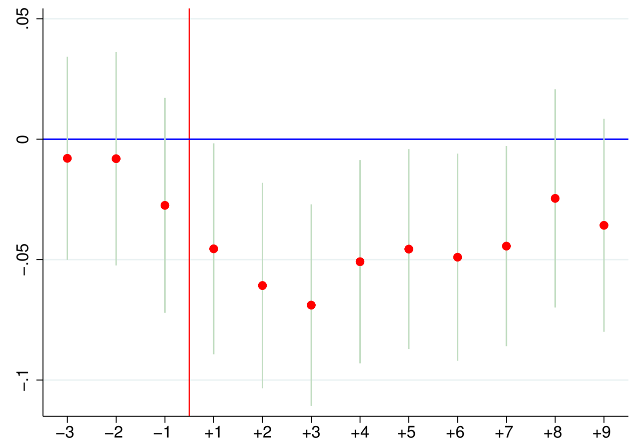
Note: This table reports the regression results using instrument variables and also controlling for lagged Entrepreneurial Activities (by 2 periods) in the regressions. For more details on the construction of instrumental variables please see the main text. "Num. of Entre." uses the log of total number of entrepreneurs in each state and each year (from CPS and weighted by CPS sampling weights) as dependent variable; "Num. of Estab." uses the log of total number of establishments and "EMP" is for the log of total employment. "Num. of Small Estab." uses the log of total number of small-sized establishments, and "Small Estab. Emp" is for the log of employment at small-sized establishments in each state and each year. Note that for all regressions we always control for State FE, Year FE, State time-varying Control variables, Local Business cycles and local non-linear trends. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure A10: Taxes and Entrepreneurship at Different Time Horizons (Using Avg. rate at 50^{th})

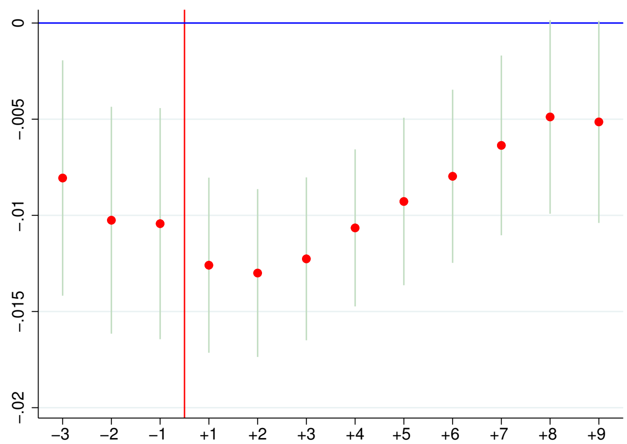
(a) Num. of Entre.



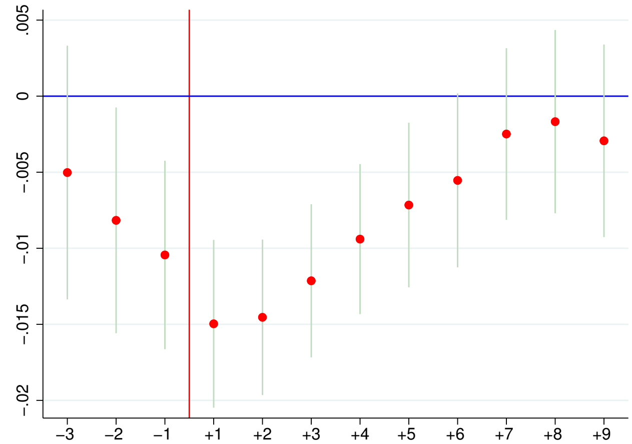
(b) Num. of College Entre.



(c) Num. of Small Estab.



(d) Small Estab. Emp



(e) Total Emp.

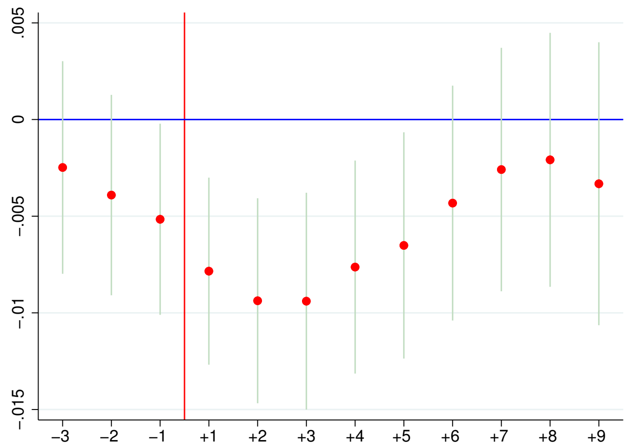
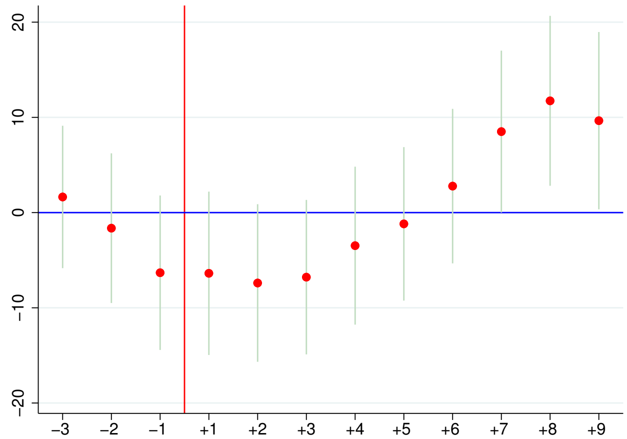
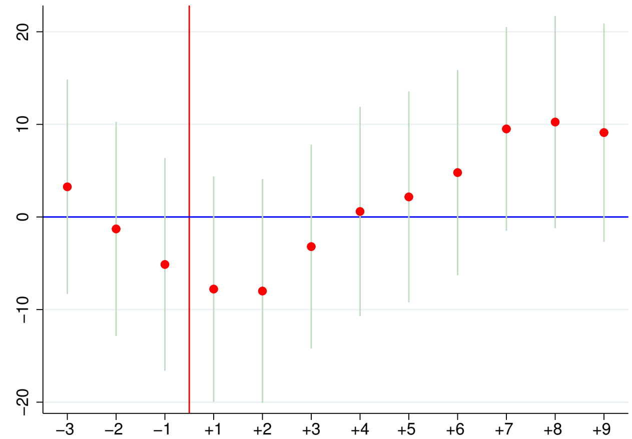


Figure A11: Taxes and Entrepreneurship at Different Time Horizons (Using Measured Tax Progressivity θ_1)

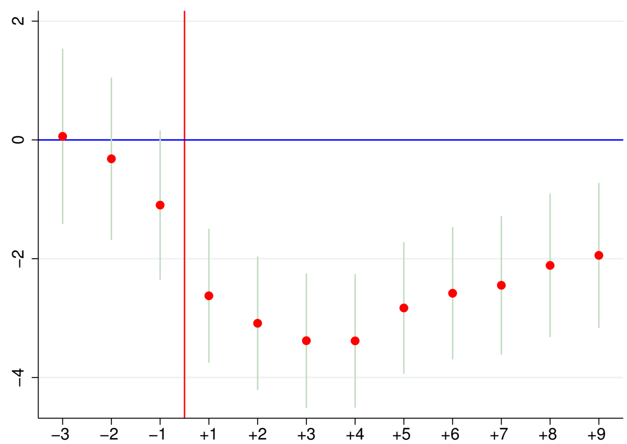
(a) Num. of Entre.



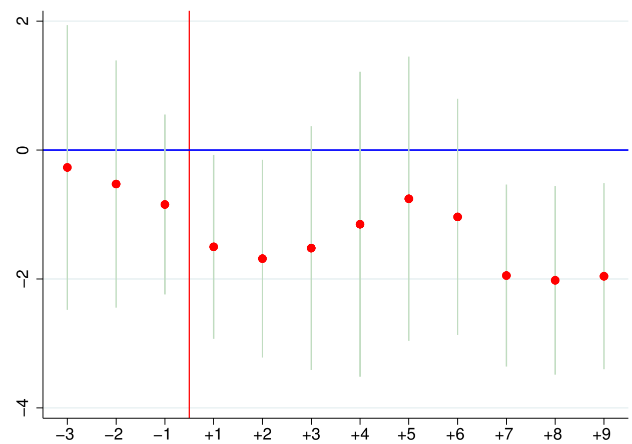
(b) Num. of College Entre.



(c) Num. of Small Estab.



(d) Small Estab. Emp



(e) Total Emp.

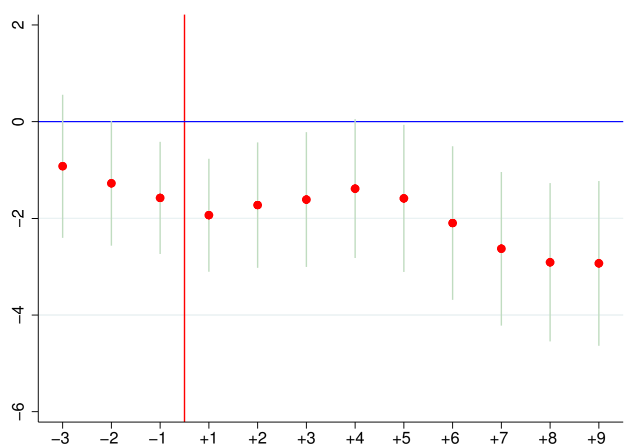


Table A5: Taxes and Entrepreneurial Activities: The Impact of Average Tax Rates at Multiples of Average Earnings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
	Num. of Entre.				Num. of College Entre.				Num. of Small Estab.				Small Estab. Emp.				Total Emp.			
Avg. rate at 1 AE	-0.0767***				-0.0792***				0.000817				0.00472				0.00675			
	(0.0177)				(0.0198)				(0.00687)				(0.00665)				(0.00579)			
Avg. rate at 2 AE		-0.104***				-0.0958***				-0.00749				-0.00591				-0.00141		
		(0.0167)				(0.0183)				(0.00691)				(0.00656)				(0.00602)		
Avg. rate at 5 AE			-0.107***				-0.0853***				-0.0378***				-0.0342***				-0.0223***	
			(0.0168)				(0.0179)				(0.00710)				(0.00668)				(0.00611)	
Avg. rate at 10 AE				-0.0673***				-0.0543***				-0.0331***				-0.0289***				-0.0192***
				(0.0132)				(0.0144)				(0.00568)				(0.00532)				(0.00496)
Observations	1,739	1,739	1,739	1,739	1,739	1,739	1,739	1,739	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,551	1,739	1,739	1,739	1,739
R-squared	0.836	0.838	0.837	0.836	0.857	0.858	0.857	0.856	0.996	0.996	0.996	0.996	0.997	0.997	0.997	0.997	0.996	0.996	0.996	0.996
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Business cycles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

NOTE: This table reports the regression results using average tax rates at different multiples of average earnings (such as 1,2,5,10 times of average earnings of US in each year). For more details please see the main text. "Num. of Entre." uses the log of total number of entrepreneurs in each state and each year (from CPS and weighted by CPS sampling weights); "Num. of College Entre." uses the log of total number of entrepreneurs with at least some-college degrees. "Num. of Small Estab." uses the log of total number of small-sized establishments, and "Small Estab. Emp" is for the log of employment at small-sized establishments. Column "Total Emp." uses the log of total employment in all establishments in each state and each year.

Table A6: Robustness Tests: Controlling for Lagged and Current Population Shares

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Num. of Entre.		Num. of Estab.		EMP		Num. of Small Estab.		Small Estab. Emp	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Progressivity θ_1	-8.115*	-14.64	-3.951***	-9.373***	-2.275***	-7.122***	-2.102**	-8.586*	-3.626***	-14.59***
	(4.398)	(8.950)	(0.578)	(1.379)	(0.689)	(1.229)	(0.837)	(4.460)	(0.605)	(2.150)
θ_0	0.228*	0.420*	0.127***	0.252***	0.0994***	0.233***	0.0957***	0.339**	0.122***	0.514***
	(0.129)	(0.235)	(0.0192)	(0.0344)	(0.0214)	(0.0355)	(0.0319)	(0.166)	(0.0212)	(0.0797)
Observations	1,720	1,720	1,694	1,694	1,694	1,694	1,533	1,533	1,533	1,533
R-squared	0.895	0.894	1.000	0.999	0.999	0.999	0.999	0.999	1.000	0.999
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Business cycles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table A7: Robustness Tests: Controlling for Region/Divisions Time trends

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Num. of Entre.		Num. of Estab.		EMP		Num. of Small Estab.		Small Estab. Emp	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Progressivity θ_1	-9.367**	-19.36**	-3.506***	-8.888***	-1.695***	-6.571***	-1.262	-5.479	-2.439***	-11.23***
	(4.132)	(8.356)	(0.521)	(1.265)	(0.613)	(1.148)	(0.776)	(3.938)	(0.573)	(1.816)
θ_0	0.330***	0.649***	0.105***	0.219***	0.0676***	0.187***	0.0578**	0.196	0.0786***	0.376***
	(0.119)	(0.214)	(0.0167)	(0.0295)	(0.0186)	(0.0318)	(0.0294)	(0.149)	(0.0194)	(0.0673)
Observations	1,887	1,887	1,850	1,850	1,850	1,850	1,683	1,683	1,683	1,683
R-squared	0.897	0.897	1.000	1.000	0.999	0.999	0.999	0.999	1.000	1.000
Region FE × Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Census Divisions FE × Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Business cycles	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

NOTE: These tables report the regression results using instrument variables (and the corresponding OLS results), with some further controls for a robustness check. For more details please see the main text. "Num. of Entre." uses the log of total number of entrepreneurs in each state and each year (from CPS and weighted by CPS sampling weights) as the dependent variable; "Num. of Estab." uses the log of total number of establishments and "EMP" is for the log of total employment. "Num. of Small Estab." uses the log of total number of small-sized establishments, and "Small Estab. Emp" is for the log of employment at small-sized establishments in each state and each year. Note that for all regressions we always control for State FE, Year FE, State time-varying Control variables, Local Business cycles and local non-linear trends.

A.2 *Tax Function*

Given the tax function

$$ya = \theta_0 y^{1-\theta_1}$$

that we employ, the after tax income is defined as

$$ya = (1 - \tau(y))y.$$

And thus we have,

$$\theta_0 y^{1-\theta_1} = (1 - \tau(y))y.$$

and further,

$$\begin{aligned} 1-\tau(y) &= \theta_0 y^{-\theta_1}, \\ \tau(y) &= 1-\theta_0 y^{-\theta_1}, \\ T(y) &= \tau(y)y = y - \theta_0 y^{1-\theta_1}, \\ T'(y) &= 1-(1-\theta_1)\theta_0 y^{-\theta_1}. \end{aligned}$$

Thus the tax wedge for any two incomes (y_1, y_2) is given by

$$1 - \frac{1-T'(y_2)}{1-T'(y_1)} = 1 - \left(\frac{y_2}{y_1}\right)^{-\theta_1} = 1 - \frac{1-\tau(y_2)}{1-\tau(y_1)}. \tag{10}$$

Therefore, the tax wedge is independent of the scaling parameter θ_0. [35] Thus by construction, one can raise average taxes by lowering θ_0 and not change the progressivity of the tax code, since (as long as tax progressivity is defined by the tax wedges) the progressivity of the tax code[36] is uniquely determined by the parameter θ_1. Heathcote et al. (2017) estimate the parameter $\theta_1 = 0.18$ for all households. In above analysis we let θ_1 vary by family type.

A.3 *Gaining Intuition: Taxation and Entrepreneurial Choice in Simple Models*

Below we continue our theoretical explorations of entrepreneurial choice from Section 4.1 in the main text.

A.3.1 Log-normal Distribution of Profits

Assume that $\log(\pi) \sim \mathbf{N}(\bar{\pi}, \sigma_\pi^2)$. If we have $u(c) = \log(c)$, an individual of type a will choose to be an entrepreneur if and only if:

$$E \log\left(\theta_0 \left(\frac{\pi}{AE}\right)^{1-\theta_1}\right) \geq \log\left(\theta_0 \left(\frac{a}{AE}\right)^{1-\theta_1}\right) \quad \Leftrightarrow \quad \bar{\pi} \geq \log(a),$$

and the cutoff does not depend on the taxes at all in this special example.

What if we have $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$, with $\gamma > 1$? Then the expected payoff from becoming an entrepreneur is:

$$E \frac{\left(\theta_0 \left(\frac{\pi}{AE}\right)^{1-\theta_1}\right)^{1-\gamma}}{1-\gamma} = \left(\frac{\theta_0}{AE^{1-\theta_1}}\right)^{1-\gamma} \left(e^{(1-\theta_1)(1-\gamma)\bar{\pi} + \frac{1}{2}(1-\theta_1)^2(1-\gamma)^2\sigma_\pi^2}\right) \frac{1}{1-\gamma}$$

[35] It should be noted that the last inequality only holds in the absence of additional lump-sum transfers.

[36] Note that

$$1 - \tau(y) = \frac{1-T'(y)}{1-\theta_1} > 1 - T'(y)$$

and thus as long as $\theta_1 \in (0,1)$ we have that

$$T'(y) > \tau(y),$$

so marginal tax rates are higher than average tax rates for all income levels.

This is very much like mean-variance utility: it increases in π and decreases in σ_π^2. The individual of type a chooses to become an entrepreneur if and only if:

$$E\frac{\left(\theta_0\left(\frac{\pi}{AE}\right)^{1-\theta_1}\right)^{1-\gamma}}{1-\gamma} \geq \frac{\left(\theta_0\left(\frac{a}{AE}\right)^{1-\theta_1}\right)^{1-\gamma}}{1-\gamma} \Leftrightarrow \quad \bar{\pi}+\frac{1}{2}(1-\theta_1)(1-\gamma)\sigma_\pi^2 \geq \log(a)$$

Thus, the left hand side of the last inequality is just like the mean-variance utility (note that $1-\gamma<0$, so it is decreasing in σ_π^2). Let $\bar{a}$ be the cutoff such that:

$$\bar{\pi}+\frac{1}{2}(1-\theta_1)(1-\gamma)\sigma_\pi^2 = \log\left(\bar{a}\right).$$

This implies that entrepreneurial choice is independent of, θ_0, governing the tax level. The change in the cutoff responding to the change in tax progressivity is:

$$\frac{\partial \log\left(\bar{a}\right)}{\partial \theta_1} = \frac{(\gamma-1)\sigma_\pi^2}{2} > 0.$$

With more progressive taxes, less people will choose to become entrepreneurs. The negative effect on the mean return dominates the positive effect on the variance.

A.3.2 The Impact of the Average Tax Level with Fixed Entry Costs

Here, we drop the assumption that entrepreneurs' profit is risky. Assume that entrepreneurs earn a deterministic profit π which is higher than the earnings of the worker with ability a, but they need to pay a fixed monetary "entry cost". The cutoff in terms of the worker's ability so that the individual is indifferent between becoming an entrepreneur or a worker is determined by:

$$\frac{\left(\theta_0\left(\frac{\pi}{AE}\right)^{1-\theta_1}-F\right)^{1-\gamma}}{1-\gamma} = \frac{\left(\theta_0\left(\frac{\bar{a}}{AE}\right)^{1-\theta_1}\right)^{1-\gamma}}{1-\gamma} \tag{11}$$

The derivative of the left-hand side of the above equation with respect to θ_0 is:

$$\frac{\partial}{\partial\theta_0}\left[\frac{\left(\theta_0\left(\frac{\pi}{AE}\right)^{1-\theta_1}-F\right)^{1-\gamma}}{1-\gamma}\right] = \left(\left(\theta_0\left(\frac{\pi}{AE}\right)^{1-\theta_1}-F\right)^{1-\gamma}\right)^{-\gamma}\left(\frac{\pi}{AE}\right)^{1-\theta_1}$$

The derivative of the right-hand side of the above equation with respect to θ_0 is:

$$\frac{\partial}{\partial\theta_0}\left[\frac{\left(\theta_0\left(\frac{\bar{a}}{AE}\right)^{1-\theta_1}\right)^{1-\gamma}}{1-\gamma}\right] = \left(\theta_0\left(\frac{\bar{a}}{AE}\right)^{1-\theta_1}\right)^{-\gamma}\left(\frac{\bar{a}}{AE}\right)^{1-\theta_1}$$

From (11), we have $\left(\left(\theta_0\left(\frac{\pi}{AE}\right)^{1-\theta_1}-F\right)^{1-\gamma}\right)^{-\gamma} = \left(\theta_0\left(\frac{\bar{a}}{AE}\right)^{1-\theta_1}\right)^{-\gamma}$, and $F>0$ implies $\frac{\pi}{AE}>\frac{\bar{a}}{AE}$. Therefore:

$$\frac{\partial}{\partial\theta_0}\left[\frac{\left(\theta_0\left(\frac{\pi}{AE}\right)^{1-\theta_1}-F\right)^{1-\gamma}}{1-\gamma}\right] > \frac{\partial}{\partial\theta_0}\left[\frac{\left(\theta_0\left(\frac{\bar{a}}{AE}\right)^{1-\theta_1}\right)^{1-\gamma}}{1-\gamma}\right],$$

which means that a decrease in the tax level (or an increase in θ_0) leads to an increase in $\bar{a}$, and thus to an increase in the share of entrepreneurs.

A.3.3 A Simple Two-period Model with Saving and Borrowing Constraint

We can illustrate the impacts of tax changes on endogenous saving and entrepreneurial choices with a simple two period model. Consider an individual who lives for 2 periods: at age $j = 1$, he can only be a worker with productivity ε_1, which is a random variable with some distribution. At age $j = 2$, he can be either a worker with some fixed productivity ε_2, or an entrepreneur. In period 1, the individual can invest in an asset, a, which yields a risk free return, r, for workers and entrepreneurs in period 2. Entrepreneurs, however, also use a to finance capital in their production function in period 2. They produce output with the technology: $z\left(n\right)^{\alpha\nu}\left(k^*\right)^{\nu}$. A worker of age $j = 2$ consumes $c = \theta_0(w\varepsilon_2 + ra)^{1-\theta_1} + a$.

An entrepreneur consumes $c = \theta_0(\pi(a) + ra)^{1-\theta_1} + a$. Profit, $\pi(a)$, potentially depends on savings a because of a borrowing constraint. An entrepreneur that is not constrained chooses the unconstrained optimal $Ak^* = n^* = \frac{R\alpha k^*}{w(1-\alpha)}$, where $A = \frac{R\alpha}{w(1-\alpha)}$. A constrained entrepreneur instead chooses $k = \Theta a$ and $n = Ak = A\Theta a$. Therefore:

$$\pi = \begin{cases} z\left(A\right)^{\alpha\nu}\left(k^*\right)^{\nu} - \frac{R}{1-\alpha}k^* & \text{if } k^* \leq \Theta a, \\ z\left(A\right)^{\alpha\nu}\left(\Theta a\right)^{\nu} - \frac{R}{1-\alpha}\Theta a & \text{other cases} \end{cases}$$

Suppose that savings are high enough for unconstrained production in period 2, $k^* \leq \Theta a$, and that $z\left(A\right)^{\alpha\nu}\left(k^*\right)^{\nu} - \frac{R}{1-\alpha}k^* > w\varepsilon_2$, so the individual chooses to be an entrepreneur. With savings below the level that allows for unconstrained production, profit will be increasing in a. There will be some cutoff level of savings $\bar{a}$ at which the individual is indifferent between being a worker and an entrepreneur:

$$z\left(A\right)^{\alpha\nu}\left(\Theta\bar{a}\right)^{\nu} - \frac{R}{1-\alpha}\Theta\bar{a} = w\varepsilon_2.$$

Intuitively, savings will be increasing in ε_1. Consider an individual with savings such that in period 2, he becomes an entrepreneur, $a > \bar{a}$, but his choice of capital and labor inputs are constrained by the borrowing limit, $\Theta a < k^*$. Suppose per period utility is $u(c) = \log(c)$. His choice of saving a will satisfy the following Euler equation:

$$\frac{1}{\theta_0(w\varepsilon_1 + ra)^{1-\theta_1} - a} = \frac{1 + \theta_0(1-\theta_1)(\pi + ra)^{-\theta_1}\left(\frac{\partial\pi}{\partial a} + 1\right)}{\theta_0(\pi + ra)^{1-\theta_1} + a}$$

where $\frac{\partial\pi}{\partial a} = z\left(A\right)^{\alpha\nu}\nu\Theta^{\nu}a^{\nu-1} - \frac{R}{1-\alpha}\Theta$ denotes the marginal increase in profit from saving. This is the term that differentiate the constrained entrepreneurs from the unconstrained ones. An increase in tax progressivity, θ_1, has several effects on the above Euler equation:

1. Individuals who decide to become entrepreneurs in period 2 are more likely to be high earners in period 1, so more progressive taxes will lower income and consumption, $c_1 = \theta_0(w\varepsilon_1 + ra)^{1-\theta_1} - a$ for them (the denominator on the LHS), this ceteris paribus will also reduce their savings and make it less likely they will become entrepreneurs in period 2.

2. If we assume that entrepreneurs are high earners, more progressive taxes will reduce the level of income in the second period even if holding savings constant, $c_2 = \theta_0(\pi + ra)^{1-\theta_1} + a$ (the denominator on the RHS), and thus increasing the incentive for them to save more.

3. More progressive taxes reduce the marginal returns of saving (the numerator on the RHS), thus reducing incentives to save. Individuals who are constrained entrepreneurs in period 2 get an "extra savings kick" from the $\frac{\partial\pi}{\partial a}$ term but this effect is also reduced by higher progressivity.

In this model it is hard to say theoretically whether (1) + (3) or (2) will dominate. However, we know from the quantitative macro literature that higher and more progressive taxes usually have a strong negative impact on the labor supply and savings of workers, see e.g Holter et al. (2019).

A.4 Definition of Recursive Competitive Equilibrium

Let $\mu^W(j, \alpha_F, \epsilon, z, a)$ denote the measure of workers at the beginning of age j, $\mu^E(j, \alpha_F, \epsilon, z, a)$ denote the measure of entrepreneurs and similarly $\mu^R(j, \alpha_F, z, a)$ denote the measure of retirees, and like before $s = (j, \alpha_F, \epsilon, z, a)$ is the state space. We study a small open economy by fixing prices, w and r, since most of our empirical exercises is supposed to resemble U.S. states. We define a Stationary Recursive Competitive Equilibrium as follows:

1. For a given tax function with parameters of (θ_0, θ_1), transfers, Γ_g, social security, ω, risk-free interest rate, r, and wage, w, all households optimize. The value functions, $V^E(s)$, $V^W(s)$ and $V^R(s)$ and policy functions, $c^E(s)$, $k^E(s)$, $n^E(s)$, $a^E(s)$, $o^E(s)$, $c^W(s)$, $n^W(s)$, $a^W(s)$, $o^W(s)$, $c^R(s)$, $n^R(s)$ and $O^R(s)$ solve the households optimization problems as described above.

2. In the corporate sector, the first order conditions for factor demand are:

$$\begin{aligned} w &= (1-\alpha)\left(\frac{K}{N}\right)^{1-\alpha}, \\ r &= \alpha\left(\frac{K}{N}\right)^{-\alpha} - \delta. \end{aligned}$$

   Inflow of capital from the international market will ensure that these conditions hold.

3. The labor market clears:

$$\int \Phi h d\mu^W = N + \int n d\mu^E$$

   where $\int \Phi h d\mu^W$ is the total labor supply.

4. Total bequest-assets from the oldest cohort plus interests payments in the current period equals the total transfer to all others:

$$\left[\int_{j=J} a d\mu^R\right](1+r) = \Gamma_b\left[\int_{j<J} d\mu^W + \int_{j<J} d\mu^E + \int_{j<J} d\mu^R\right],$$

5. The government budget constraint balances in each period:

$$\int T(w\Phi h + ar)d\mu^W + \int T(\pi + ar)d\mu^E + \int T(\omega\alpha + ar)d\mu^R = G + \int \omega\alpha_i d\mu^R + \Gamma_g\left[\int d\mu^W + \int d\mu^E + \int d\mu^R\right]$$

A.5 Numerical Solution of the Model

Below we describe the numerical algorithm used to solve our model.

A.5.1 Grid Points

For the asset space, a, we use 50 grid points with more points closer to zero and then approximately linear spacing of grid points when a is sufficiently large. For the log of α_F, we use 5 evenly distributed grid points. We use the Rowenhurst method to approximate the stochastic AR(1) processes for ϵ and z with six discrete grid points for each, since the persistence parameters could be very high. The size of the state space, $(j, \alpha_F, \epsilon, z, a)$, is then $61 \times 5 \times 6 \times 6 \times 50$ points.

A.5.2 Household Optimization

For given tax parameters, (λ_0, θ), transfers, Γ_b and Γ_g, risk-free interest rate, r, and wage rate, w, households solve their optimization problem backwards. Starting from period $J-1$, for a given bequest utility (a function of assets) in period J, we use Golden search to solve the optimization problem conditional on each possible individual state $(j, \alpha_F, \epsilon, z, a)$. Overall, we find that the Golden search method delivers relatively fast and robust solutions.

A.5.3 Labor Supply

The worker's optimal choice of labor supply is characterized by the first-order conditions:

$$\begin{aligned} v'(h) &= \chi h^{\eta} \\ \chi h^{\eta} &= u'(c)\lambda_0 \left[ar + yhw_t\right]^{-\theta}(1-\theta)yw_t(AE)^{\theta} \end{aligned}$$

For given values of (c, a, r, y, w_t) and $\theta > 0, \eta > 0$, there is a unique solution for labor $h\,(c, a, r, y, w_t)$. Thus when searching for the optimal consumption, labor supply and savings for workers, we can search for the optimal level of consumption, using the implied optimal value of h. c and h also implies next period's savings, a'

A.5.4 Firm's Profit

We can pre-solve for the profit function: π

$$\begin{aligned} \pi(z, a; r, w, r^B) &= \max_{\{k,n\}} z(k^{1-\alpha}n^{\alpha})^{\nu} - (r^B + \delta)k - wn - \Gamma_f \\ k &\leq \Theta a. \end{aligned}$$

For the relaxed problem (without the constraint $k \leq \Theta a$), we have the below first order conditions:

$$\begin{aligned} k &: \quad Rk = \nu(1-\alpha)y = \nu(1-\alpha)z(k^{1-\alpha}n^{\alpha})^{\nu} \\ n &: \quad wn = \nu\alpha y = \nu\alpha z(k^{1-\alpha}n^{\alpha})^{\nu} \\ &\Rightarrow \quad n^{(1-\nu\alpha)} = \frac{\nu\alpha z}{w}k^{(1-\alpha)\nu} \end{aligned}$$

where $(y = (r^B + \delta) = R, z(k^{1-\alpha}n^{\alpha})^{\nu})$. Thus we have the solution for labor, $n^{(1-\nu\alpha)} = \frac{\nu\alpha z}{w}k^{(1-\alpha)\nu}$, for any given level of k (including constrained cases). With $\frac{Rk}{(1-\alpha)} = \frac{wn}{\alpha}$, we can further solve for the optimal unconstrained level of k :

$$\begin{aligned} n^{(1-\nu\alpha)} &= \frac{\nu\alpha z}{w}k^{(1-\alpha)\nu} \\ &\Rightarrow \left[\frac{R}{(1-\alpha)}\frac{\alpha}{w}k\right]^{(1-\gamma\alpha)} = \frac{\nu\alpha z}{w}k^{(1-\alpha)\nu} \\ &\Rightarrow k^{(1-\nu)} = \frac{\nu\alpha z}{w}\left[\frac{R}{(1-\alpha)}\frac{\alpha}{w}\right]^{(\nu\alpha-1)} \\ k^{(1-\nu)} &= \nu z\left[\frac{(1-\alpha)}{R}\right]^{(1-\nu\alpha)}\left[\frac{\alpha}{w}\right]^{(\nu\alpha)} \end{aligned}$$

If the optimal level of k is not available due to the collateral constraint, then we have $k = \Theta a$, and then we can solve for n.

A.5.5 Expected Value Functions

To compute the expected value functions. We use the following method. Define expected value functions as:

$$E[V^W(s,a)] \equiv E\left[\max\{V'^W(s',a'), V'^E(s',a')\}\right]|_{(s)}$$

$$E[V^E(s,a)] \equiv E\left[\max\{V'^W(s',a'), V^E(s',a')\}\right]|_{(s)}$$

Since the state variables for ϵ', z' are stochastic in the next period and both follow an AR(1) process, we can use numerical integration to compute $E[V^W(s,a')]$ and $E[V^E(s,a')]$. In particular, we choose N_ϵ points for the normal distribution of the innovations to ϵ and N_z points for the normal distribution of the innovations to z, and let w_{ϵ_i}, w_{z_j} are corresponding probability weights.

$$\begin{aligned}
E[V'^W(s',a')] &\equiv E\left[\max\{V^W(s',a'),V^E(s',a')\}\right]|_{(s)} \\
&\approx \sum_{i=1}^{N_\epsilon}\sum_{j=1}^{N_z} w_{\epsilon_i} w_{z_j}\left[\max\{V^W(j+1,\sigma,\alpha,\rho_\epsilon\epsilon+\eta_{\epsilon_i},\rho_z z+\eta_{z_j},a'),V^E(j+1,\sigma,\alpha,\rho_\epsilon\epsilon+\eta_{\epsilon_i},\rho_z z+\eta_{z_j},a')\}\right], \\
E[V'^E(s',a')] &\approx \sum_{i=1}^{N_\epsilon}\sum_{j=1}^{N_z} w_{\epsilon_i} w_{z_j}\left[\max\{V^W(j+1,\sigma,\alpha,\rho_\epsilon\epsilon+\eta_{\epsilon_i},\rho_z z+\eta_{z_j},a'),V^E(j+1,\sigma,\alpha,\rho_\epsilon\epsilon+\eta_{\epsilon_i},\rho_z z+\eta_{z_j},a')\}\right]
\end{aligned}$$

A.5.6 Algorithm for Computing General Equilibrium when Running Policy Experiments

For a given set of model parameters, we use the following procedure to compute general equilibrium. Partial equilibrium will be similar but without adjusting prices, r and w.

1. Guess the tax coefficient, θ_0, which is needed for government budget clearing, the bequests to households, Γ_b, and the average earnings in the economy, AE.
2. Guess prices, r and w:
3. Guess risk-free interest rate, r, and use the representative firm's first order condition to find the implied value on wage w
4. Solve for individual value functions using backward induction.
5. Simulate a large number of individuals forward, and obtain implied model moments, including total bequest assets and total tax revenues (net of social security payments).
6. Check the implied excess demand for capital and update the initial guess on interest rates r until excess demand converges to zero.
7. Update the guesses for the tax level, bequests and average earnings until they converge.

A.6 Structural Estimation

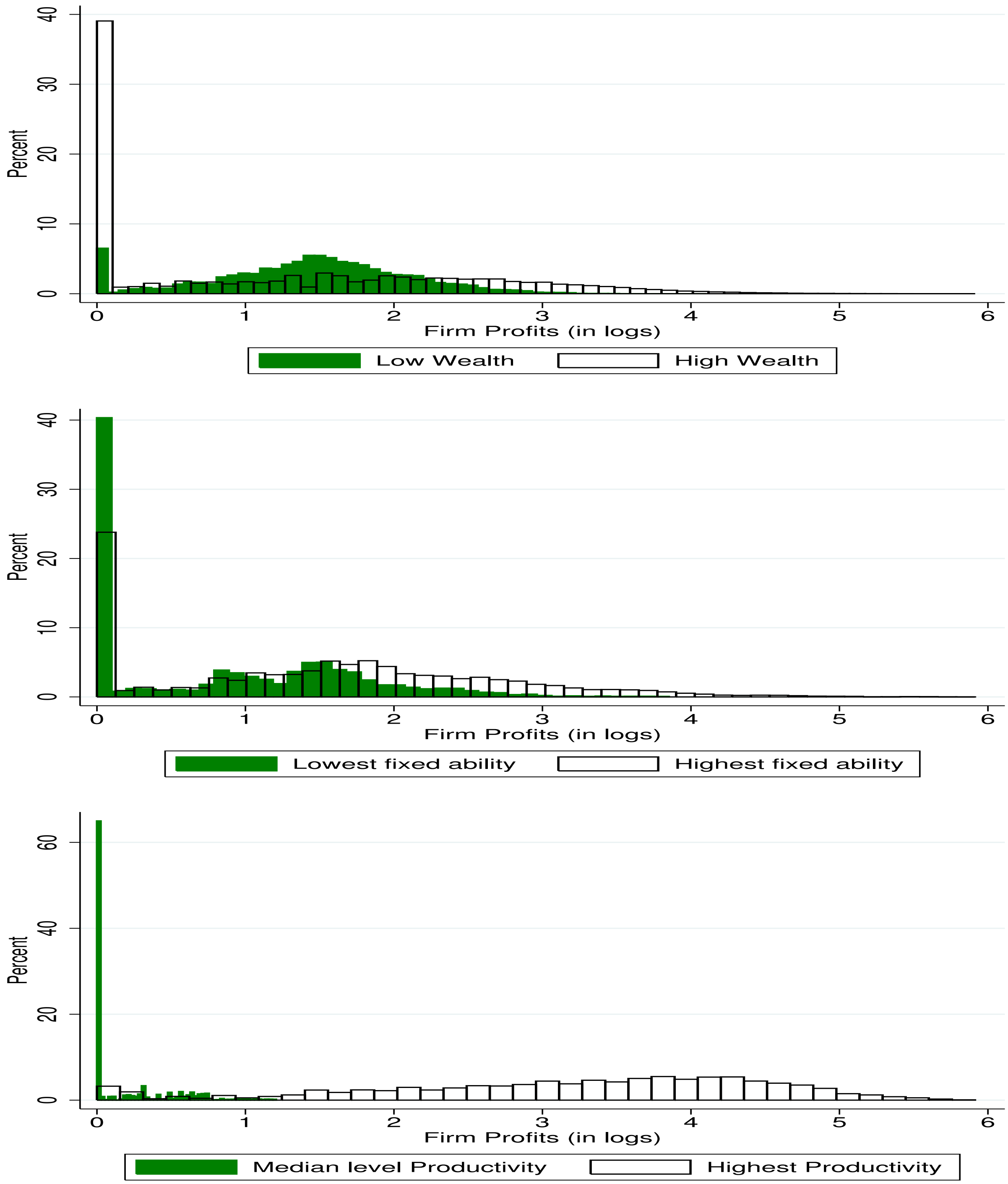
As noted in the main text, we use a Simulated Method of Moments approach to endogenously estimate 7 model parameters. Denote the model moments, a 24×1 vector, by $g(\omega)$ and the parameter vector by ω. We search over the space for ω and minimize the distance, $[g(\omega)-m]^\top W [g(\omega)-m]$, where m is the corresponding data moments, W is a 24×24 diagonal weighting matrix. It has the same weight for all moments, except the aggregate wealth to output ratio and the population share of entrepreneurs. We believe these moments are crucial to our study so we assign them 10 times higher weight. The estimation is roughly similar to Lee and Ingram (1991) and Hansen (1982). In particular, for each given choice of parameters, we simulate the whole equilibrium economy with 100000 households, each living for 61 periods. We then compute the 24 equilibrium moments based on the simulated panel data of households. This is $g(\omega)$. We then use a variety of algorithms to obtain the optimal estimate, including partitioning the space, using Sobol sequences, and obtaining some rough estimate first, and then using the Nelder Mead algorithm for finer estimates. Since we use several different data sources to obtain moments, some of them not from micro-level data sets, we do not report standard errors from the estimation.

A.7 Calibration and Estimation - Additional Tables and Figures

Table A8: Exogenously Calibrated Parameters

Parameter	Description	Value	Source
		Preferences	
η	Inverse of Labor supply Elas.	1.0	Literature; see text
κ_b	Bequest motive	0.02	Γ_b/Y
		Wages	
ρ_ϵ	$\epsilon' = \rho_\epsilon \epsilon + u$	0.929	Chang and Kim (2007)
σ_u	$u \sim N(0, \sigma_u^2)$	0.227	Chang and Kim (2007)
$\gamma_1, \gamma_2, \gamma_3$	$\chi_j = \gamma_1 j + \gamma_2 j^2 + \gamma_3 j^3$	$0.265,\ -0.005,\ 3.3 * 10^{-5}$	Brinca et al. (2016)
σ_{α_F}	$\alpha_F \sim N(0, \sigma_{\alpha_F}^2)$	0.13	var(log(w))
		Life-cycle	
J	Total model life periods	60	Average life-span
J^W	Total working periods	45	Public retirement age
		Government	
ω_R	Social security payment	0.40	40% for average earner
$\theta_0,\ \theta_1$	$ya/AE = \theta_0 (y/AE)^{1-\theta_1}$	0.82, 0.13	Section 3
Γ_g	Transfers to households	0.1	10% of average earnings
		Technology	
δ_k	Capital depreciation rate	0.1	Literature; see text
α	Labor share	0.66	Literature; see text
ν	Decreasing return to scale	0.85	Literature; see text
Θ	Collateral to Assets ratio	0.35	Literature; see text

Figure A12: Simulated Model Distribution of Firm Profits: by Wealth, Ability (α) and Stochastic Productivity (z)



NOTE: We plot the histograms for the distribution of firm profits in the simulated benchmark economy. When firm profit is 0 or negative, it is replaced as 0 in the histograms; when firm profit is strictly positive, we use the transformation $log(1 + x)$ for $x > 0$. We then make plots conditioning on the different state variables of the entrepreneurs: by wealth (upper panel), by α (middle panel), by z (lower panel).

Figure A13: Sensitivity Analysis: Model Moments for Different Values of the Discount Factor, β

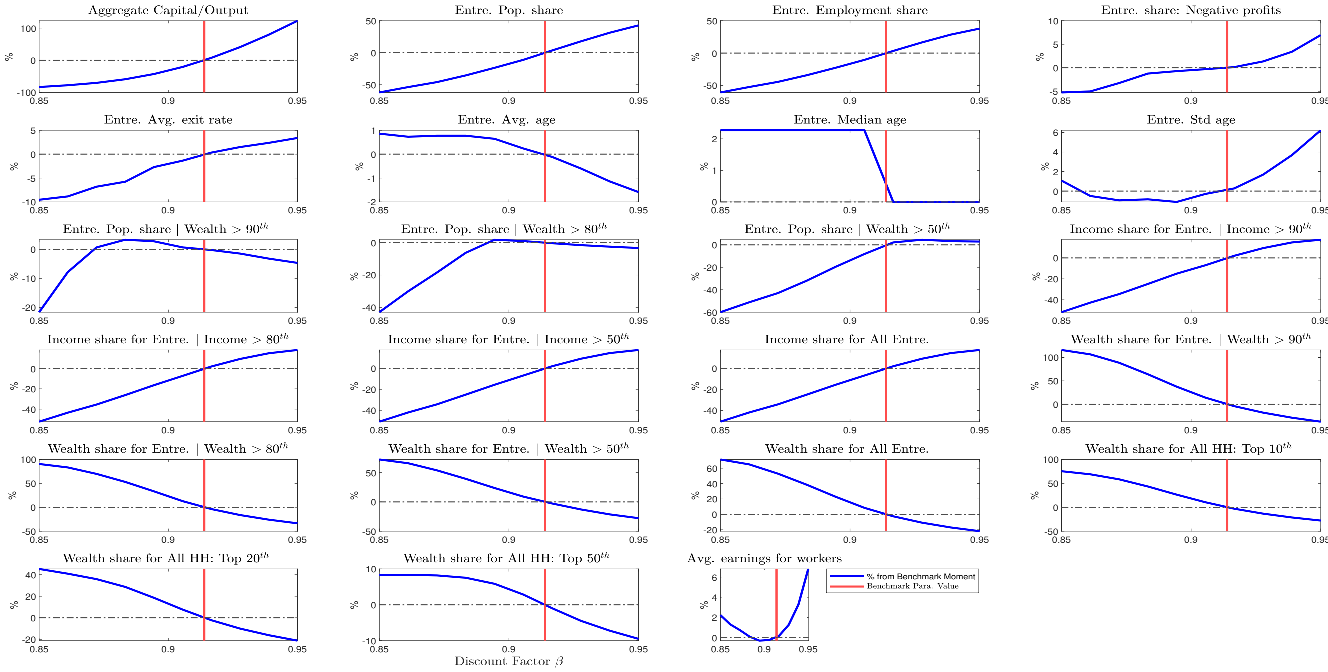
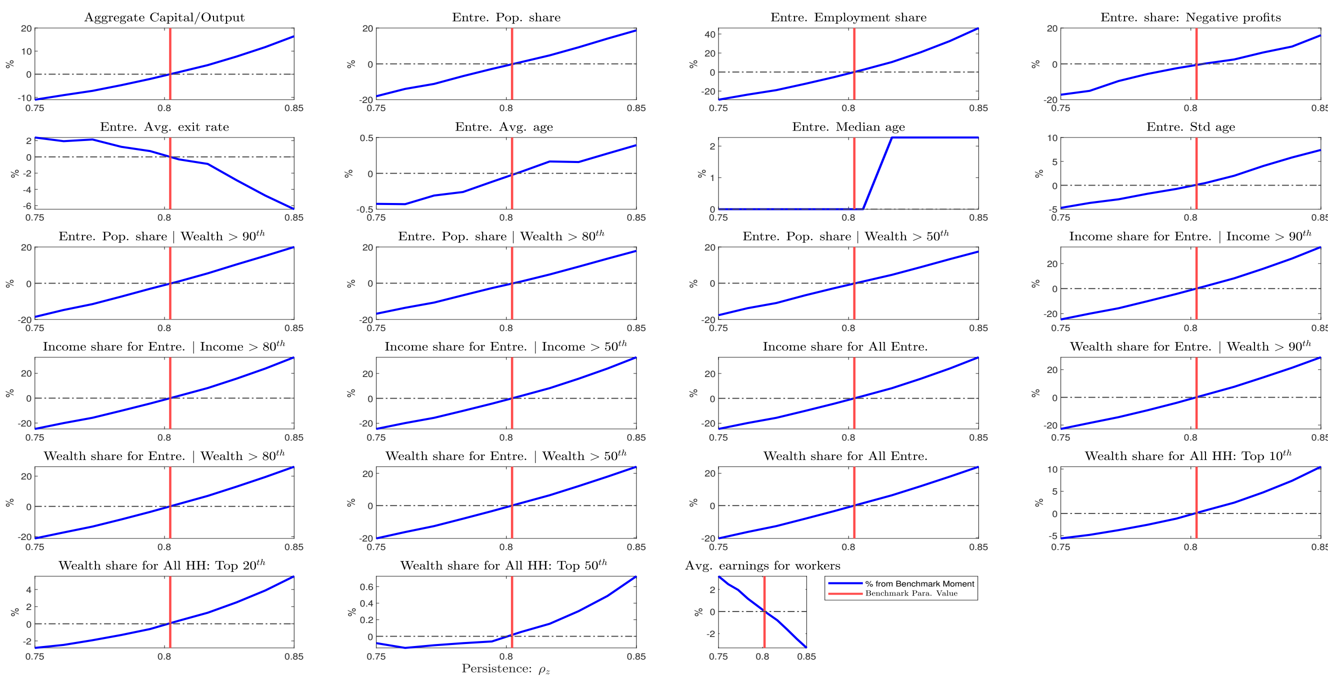


Figure A14: Sensitivity Analysis: Model Moments for Different Values of the Persistence of Productivity, ρ_z



NOTE: For each moment, data values are in black long dashed lines, model implied values are in red circled lines, and the blue dashed line is for the benchmark model implied values. The benchmark value for the parameter is highlighted with green line.

Figure A15: Sensitivity Analysis: Model Moments for Different Values of Std., σ_z

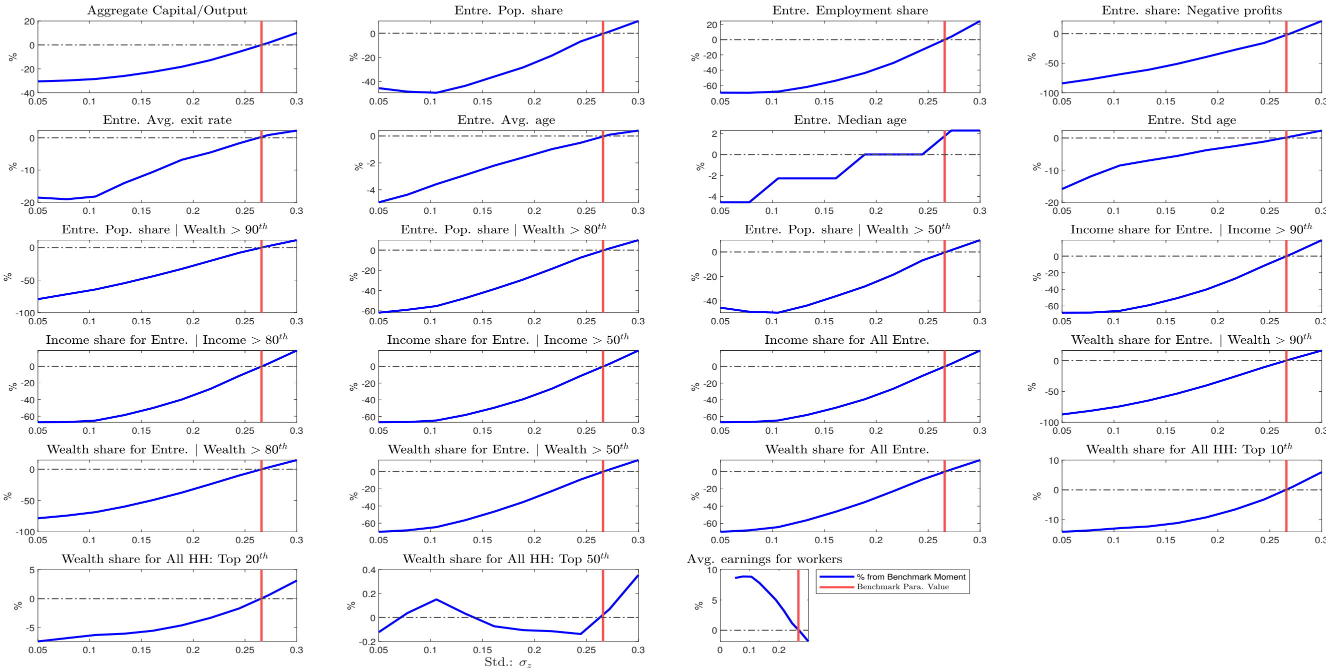
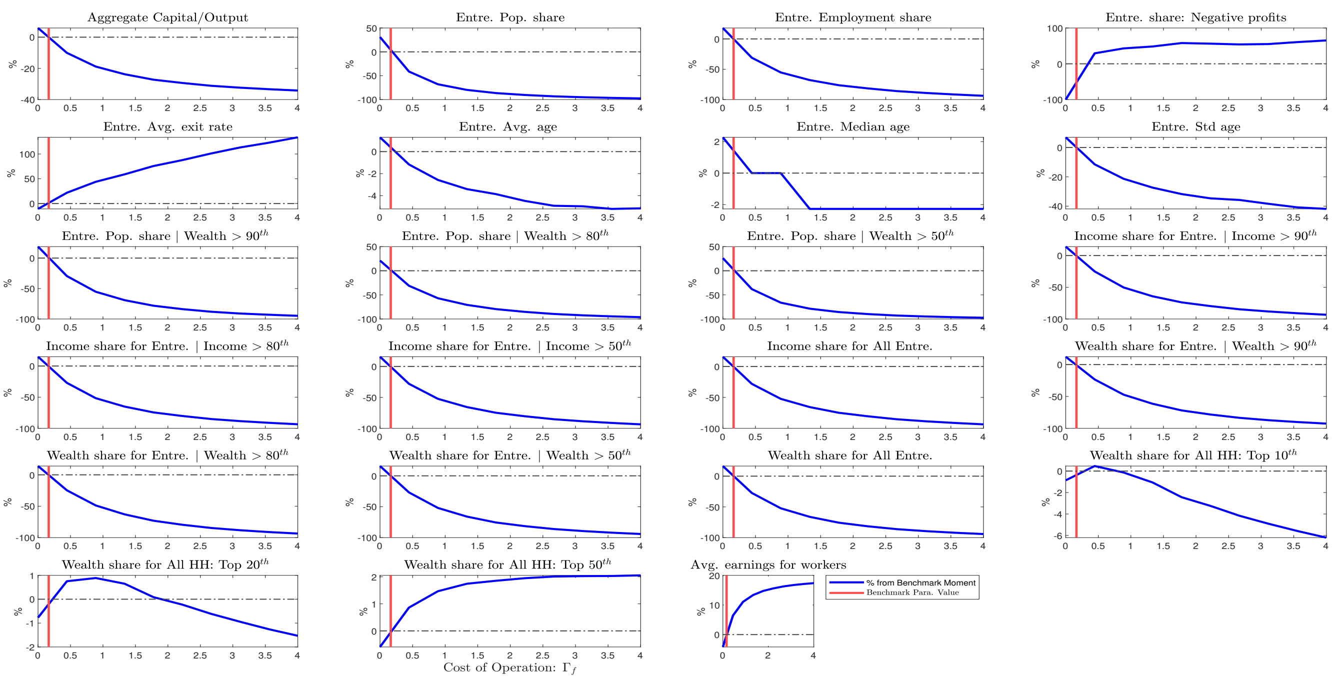


Figure A16: Sensitivity Analysis: Model Moments for Different Values of the Operating Cost, Γ_f



NOTE: For each moment, data values are in black long dashed lines, model implied values are in red circled lines, and the blue dashed line is for the benchmark model implied values. The benchmark value for the parameter is highlighted with green line.

Figure A17: Sensitivity Analysis: Model Moments for Different Values of the Entry Cost, c_e

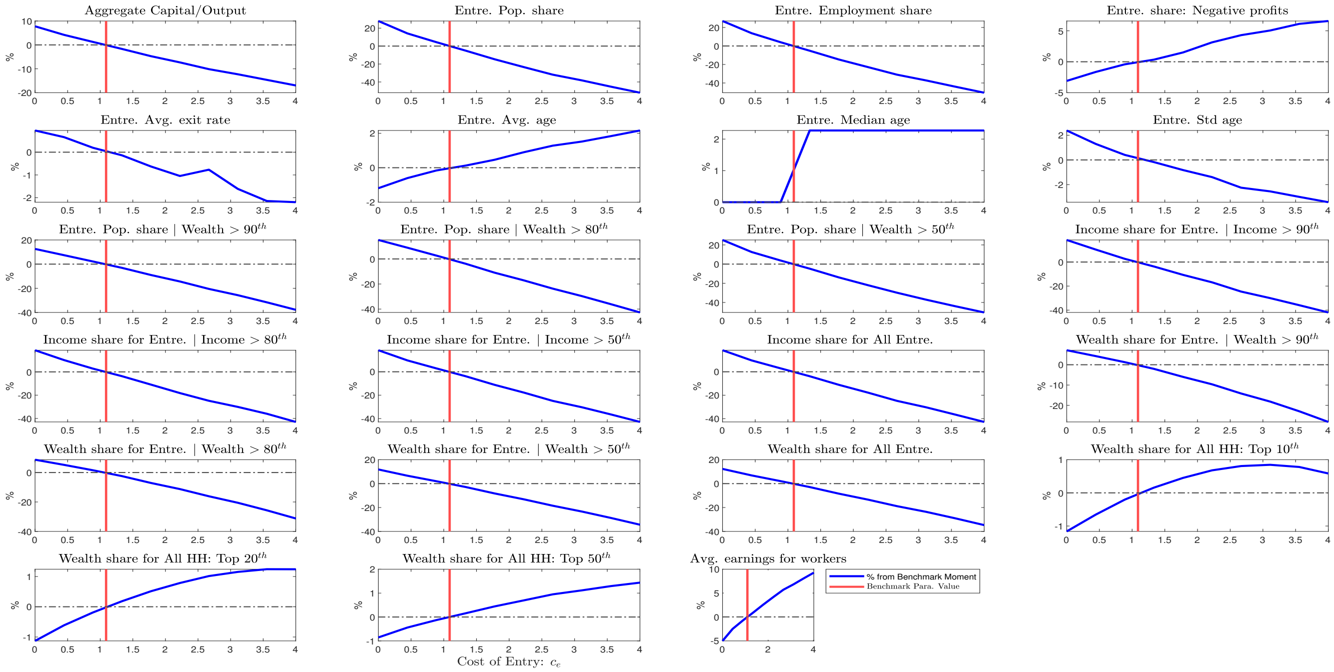
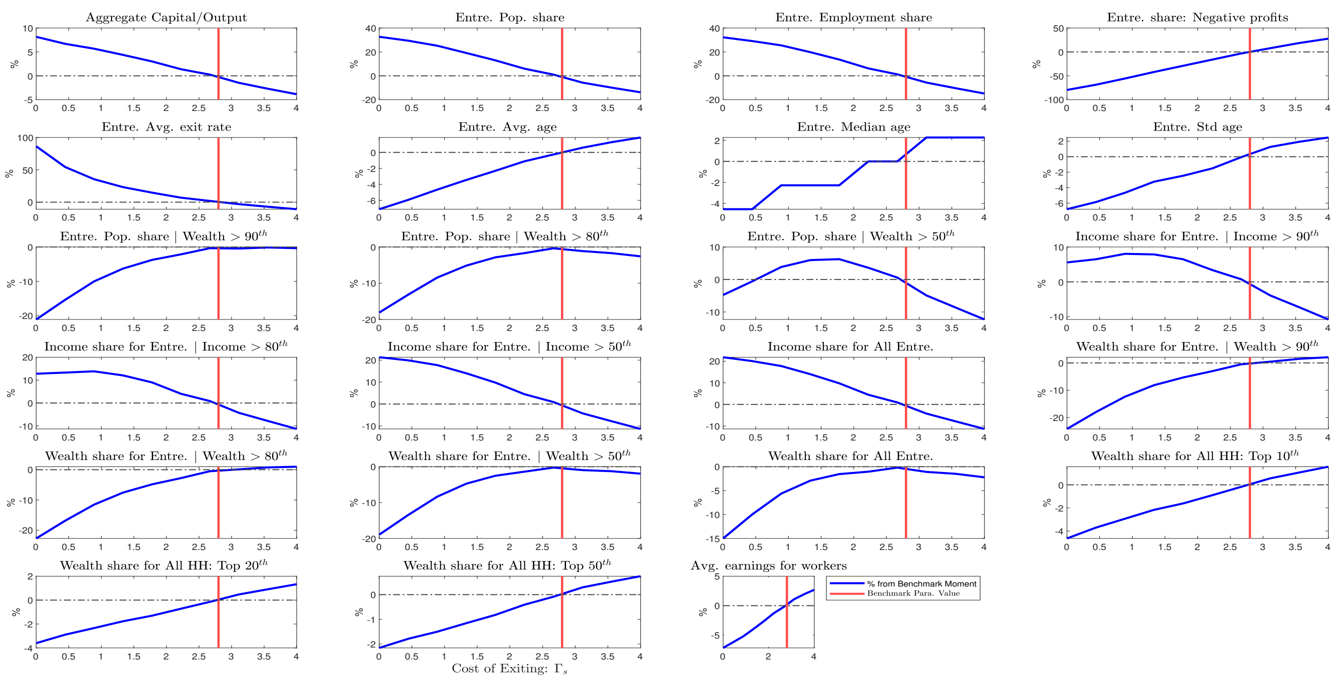


Figure A18: Sensitivity Analysis: Model Moments for Different Values of the Exit Cost, Γ_s



NOTE: For each moment, data values are in black long dashed lines, model implied values are in red circled lines, and the blue dashed line is for the benchmark model implied values. The benchmark value for the parameter is highlighted with green line.

A.8 Additional Numerical Results

Figure A19: The Impact of Tax Progressivity in Different z, α_F, e and Assets Groups

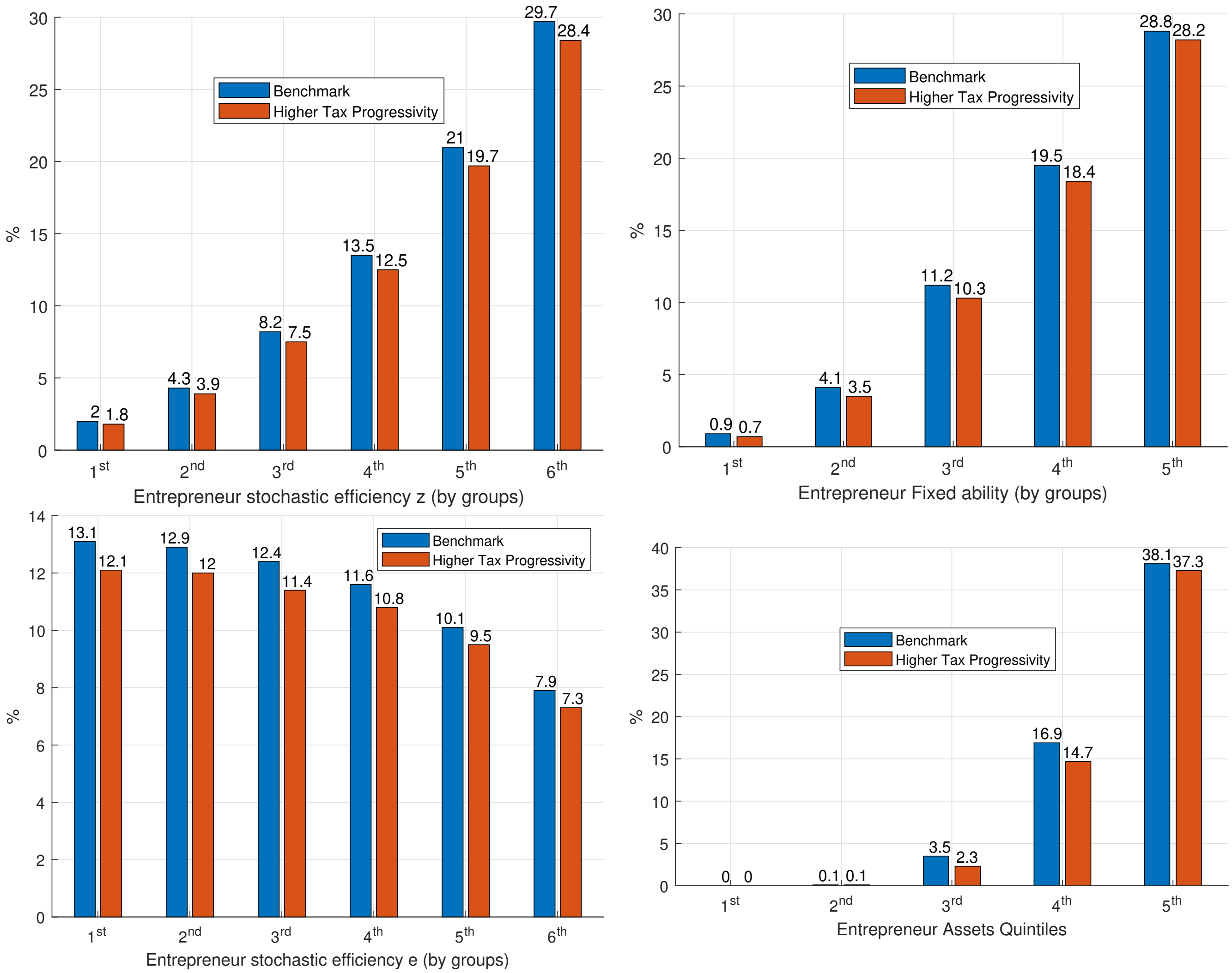


Table A9: Changes in Risk Environments and Population Share of Entrepreneurs

Age groups	21-30	31-40	41-50	51-60	60+
High Risk Environment baseline	0.22%	3.30%	5.36%	3.07%	0.45%
θ_1 increase	0.20%	3.16%	5.22%	2.95%	0.42%
θ_1 decrease	0.23%	3.39%	5.46%	3.17%	0.47%
Low Risk Environment baseline	0.16%	3.05%	5.05%	2.58%	0.35%
θ_1 increase	0.15%	2.93%	4.89%	2.47%	0.33%
θ_1 decrease	0.17%	3.13%	5.16%	2.67%	0.38%

Table A10: Comparing Elasticities Across Different Model Environments

Benchmark Model	Pop. Share	Entre. Employment
θ_1 increase	-1.78%	-2.11%
θ_1 decrease	1.66%	2.05%
High Risk Environment		
θ_1 increase	-1.26%	-1.73%
θ_1 decrease	1.50%	1.87%
Low Risk Environment		
θ_1 increase	-1.88%	-2.21%
θ_1 decrease	1.79%	2.23%

Table A11: Changes in the Mean and Standard Deviation of Entrepreneurial Productivity

	Profit: mean	Profit: std	Pop. share	Entre. Emp.	Y	C
Relative to Benchmark						
σ_ν +1%	0.7%	1.9%	1.6%	2.5%	0.1%	0.4%
σ_ν +2%	1.6%	3.9%	2.9%	5.0%	0.3%	0.8%
m_z +1%	0.6%	1.4%	4.7%	5.5%	0.1%	0.7%
m_z +2%	1.3%	2.8%	9.1%	11.0%	0.1%	1.3%
With θ_1 increase						
Benchmark	-4.1%	-8.1%	-7.2%	-7.6%	-0.2%	-3.4%
σ_ν +1%	-4.1%	-8.1%	-7.4%	-7.7%	-0.2%	-3.5%
σ_ν +2%	-4.3%	-8.3%	-6.6%	-7.2%	-0.3%	-3.5%
m_z +1%	-4.2%	-8.2%	-6.5%	-7.0%	-0.2%	-3.4%
m_z +2%	-4.4%	-8.4%	-5.8%	-6.5%	-0.3%	-3.5%

Table A12: Distribution of Entrepreneurs Across Different Model Environments

Age groups	21-30	31-40	41-50	51-60	60+
Benchmark Model	0.19%	3.15%	5.18%	2.81%	0.40%
Unequal starting wealth	0.19%	3.15%	5.18%	2.81%	0.40%
Higher starting wealth	1.15%	5.24%	7.29%	4.50%	0.65%
Worse Financing Environment	0.15%	2.83%	4.87%	2.62%	0.37%
Better Financing Environment	0.21%	3.34%	5.38%	2.93%	0.42%
Worse Entry Environment	0.17%	3.00%	5.05%	2.74%	0.39%
Easier Entry Environment	0.21%	3.30%	5.35%	2.89%	0.41%
Business loss offset: Mild	0.20%	3.16%	5.19%	2.86%	0.44%
Business loss offset: Heavy	0.20%	3.17%	5.22%	3.01%	0.56%

Table A13: Comparing Elasticities Across Different Model Environments

Benchmark Model	Pop. Share	Entre. Employment
θ_1 increase	-1.78%	-2.11%
θ_1 decrease	1.66%	2.05%
Worse Financing Environment		
θ_1 increase	-2.03%	-2.39%
θ_1 decrease	2.04%	2.36%
Better Financing Environment		
θ_1 increase	-1.63%	-1.93%
θ_1 decrease	1.42%	1.79%
Worse Entry Environment		
θ_1 increase	-1.69%	-2.06%
θ_1 decrease	1.64%	2.06%
Easier Entry Environment		
θ_1 increase	-1.88%	-2.13%
θ_1 decrease	1.59%	1.95%
Business loss offset: Mild		
θ_1 increase	-1.75%	-2.07%
θ_1 decrease	1.70%	2.07%
Business loss offset: Heavy		
θ_1 increase	-1.76%	-2.06%
θ_1 decrease	1.76%	2.10%
Unequal starting wealth		
θ_1 increase	-1.78%	-2.11%
θ_1 decrease	1.66%	2.05%
Larger wealth		
θ_1 increase	-0.77%	-1.35%
θ_1 decrease	0.76%	1.32%