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Entrepreneurship, wealth inequality, and taxation ☆

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Abstract

This paper investigates the importance of entrepreneurship when quantifying the aggregate and distributional effects of switching from a progressive to a proportional income tax system. I find that the distributional consequences of the tax reform in a model economy with entrepreneurs contrast markedly from those in a model economy with no entrepreneurs. The elimination of progressive taxation has a negligible effect on wealth inequality when entrepreneurship is considered but has a large effect when entrepreneurship is omitted. The framework used is an occupational choice model, in which the decision to become an entrepreneur is determined by the ability to manage a firm and by asset holdings. The calibrated economy can account for the high savings rate of entrepreneurs relative to non-entrepreneurs, and the high concentration of wealth observed in the data.

JEL classification: D31; E62; H23; H20

Keywords: Entrepreneurship; Distribution of wealth; Progressive taxation; Proportional taxation; Financial constraints

1. Introduction

In this paper, I investigate the extent to which entrepreneurship is important in quantifying the aggregate and distributional effects of switching from a progressive to a propor-

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tional income tax system.[1] While the relationship between entrepreneurship, inequality and taxation has been examined qualitatively (e.g., Kanbur, 1982 and Boadway et al., 1991), entrepreneurship has been omitted in most quantitative general-equilibrium studies of tax policy.[2] Such an omission is likely to be significant for the following three reasons. First, entrepreneurship is often considered as a key source of job and economic growth.[3] Second, entrepreneurship is important in explaining wealth accumulation and its distribution.[4] Third, entrepreneurial decisions (such as entrepreneurial entry, savings, investment and changes in the scale of businesses) are greatly affected by progressive marginal tax rates.[5] To address the relationship between entrepreneurship, inequality and taxation, I contrast the steady-state implications of moving from progressive to equal-revenue proportional income taxation in two distinct model economies: one in which entrepreneurship decisions are modelled, and another that does not account for entrepreneurial activity.[6]

The main finding of the analysis is that switching from a progressive to an equal-revenue proportional income tax system has only a small impact on wealth inequality when entrepreneurship is explicitly modelled, while the same policy change has a large effect on wealth inequality in an economy with no entrepreneurs. In the economy without entrepreneurs, the Gini index of the distribution of wealth increases by 9.5 percent and the share of wealth held by the top 5 percent increases by 11.3 percent. This is consistent with previous research which omits entrepreneurship. For instance, Castañeda et al. (1999) find that a switch to proportional income taxation substantially increases wealth inequality, as measured by the Gini index, by 10.5 percent. By contrast, in the economy with entrepreneurs, the wealth Gini coefficient and the share of wealth held by the top 5 percent increase by only 1.4 and 4.3 percent, respectively.

I also find that the change from progressive to proportional income taxation increases capital accumulation, entrepreneurial investments and savings, and therefore aggregate output. The increases in capital accumulation and aggregate output—in both economies with and without entrepreneurs—are in line with findings of the literature that explores the impact of replacing the current US progressive income tax system by other forms of taxation (such as flat tax and proportional income tax).[7]

To arrive at these findings I use two models that can quantitatively account for the high concentration of wealth observed in the US data: the model with entrepreneurs and the model without entrepreneurs. First, the model with entrepreneurs is built on Quadrini (2000), who uses a calibrated general-equilibrium framework to show that modelling busi-

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[1] Entrepreneurship is defined as business ownership.

[2] See Castañeda et al. (1999), Altig and Carlstrom (1999), Altig et al. (2001), and most papers in the collection edited by Aaron and Gale (1996). None of these quantitative general-equilibrium studies of tax policy focus on entrepreneurship.

[3] See Haltiwanger and Krizan (1999) and Bednarzik (2000) for the link between job growth and entrepreneurship, and Schumpeter (1934) and Banerjee and Newman (1993) for the entrepreneurship-economic growth nexus.

[4] See Quadrini (1999) and Gentry and Hubbard (1999).

[5] See Carroll et al. (1998a, 1998b) and Gentry and Hubbard (2000a, 2000b).

[6] I have embarked on a research program on entrepreneurial activity and taxation in Meh (2001).

[7] This result is consistent with the findings of Altig et al. (2001), Castañeda et al. (1999), Heckman et al. (1998), Sarte (1997) and Ventura (1999), among others.

ness ownership can explain the high concentration of wealth.[8] Unlike the present paper, Quadrini (2000) does not consider tax reform issues. I extend his model by including a government sector that collects tax revenues via a progressive income tax system. In the model, the decision to undertake entrepreneurial activity is determined by the agent's business ability and his net worth. The ability to manage a business is modelled as a stochastic process where agents gradually acquire the ability to run larger businesses by first managing smaller ones. Net worth is important in the decision to undertake entrepreneurial activity because of borrowing constraints and financial intermediation costs. In such an environment progressive income taxation reduces the incentives to become an entrepreneur, since business ownership promotes income growth and moves the agent to a higher tax bracket. Because of borrowing constraints, costly external financing, and the risks associated with business ownership, the calibrated model is able to account simultaneously for the high savings rate of entrepreneurs relative to workers and the high concentration of wealth observed in the data. Second, the model without entrepreneurs is similar to the model with entrepreneurs, except that households do not have entrepreneurial opportunities. To account for the observed high concentration of wealth, I follow the approach used by Castañeda et al. (2003), where the stochastic process of earnings is calibrated to match the observed distribution of wealth.

In the model with entrepreneurs, replacing a progressive by a proportional income tax system has two opposing effects. First, the switch to proportional income taxes reduces the marginal income tax rate for wealthy households, but increases it for the poor, thus increasing the incentive to save faced by the wealthy and decreasing it for the poor. As a result, wealth inequality increases. This effect, which is also present in the model without entrepreneurs, has traditionally been emphasized in previous studies that do not model entrepreneurship. The second effect, which is the main focus of this paper, decreases wealth inequality following the tax reform. The reduction in the marginal income tax rates paid by entrepreneurs—as entrepreneurs are mostly located in higher tax brackets—leads to increased entrepreneurial investments and savings. Since labor and capital are complements in the production technology used by entrepreneurs, the increased business investment boosts the demand for labor, which, in turn, increases the wage rate, effectively driving down the average return to entrepreneurial activities and increasing the income of workers. This general-equilibrium feedback narrows the income and savings gap between workers and entrepreneurs, leading to a reduction in income and wealth inequality.[9] In the quantitative findings presented above, these two effects approximately offset each other and the overall wealth inequality increases only slightly. A crucial factor driving this result is the presence of borrowing constraints and costly financial intermediation, which lead en-

[8] Other models that have been able to replicate the observed concentration of wealth in the United States are, for example, Castañeda (1999, 2003), Cagetti and De Nardi (2002), De Nardi (2000), and Krussel and Smith (1998). See Quadrini and Ríos-Rull (1997) and Castañeda (2003, pp. 5–7) for an overview of the distributional consequences of economies with heterogeneous agents in terms of the distribution of wealth. Most of these models are either extensions of Aiyagari (1994)—an infinitely lived agents economy—or Huggett (1996)—a life-cycle economy.

[9] This general-equilibrium feedback has been put forward qualitatively by Kanbur (1982) in a static model. However, the effect has not been quantified.

trepreneurs to operate at a sub-optimal scale. The reduction in marginal tax rates—which increases entrepreneurial savings—relaxes the borrowing constraints and entrepreneurs are able to expand production and employ more capital and labor.[10]

The above findings suggest the importance of considering entrepreneurship when quantifying the aggregate and distributional effects of tax policy. To put it differently, it is necessary to account for entrepreneurial decisions (such as entrepreneurial entry, savings and investments) when measuring the trade-off between efficiency and equality of tax reforms.

Other researchers have quantified the effects of replacing the current US progressive income tax system with a proportional tax. Perhaps, the closest (in terms of matching inequality when looking at tax issues) are Castañeda et al. (1999) who use a dynastic model with exogenous human capital, and Erosa and Koreshkova (2003) who use a dynastic model with endogenous human capital. They find a substantial increase in wealth inequality after the elimination of progressive taxation. Altig et al. (2001) and Heckman et al. (1998) use an overlapping generation framework in which savings are driven solely by life-cycle motives. However, none of these models consider the role of entrepreneurial activity.

There is a large literature studying the effects of taxation on entrepreneurship. Gentry and Hubbard (2000b, Section 2, pp. 2–7) provide an excellent overview of tax policy and entrepreneurship. None of the models surveyed there examine inequality, taxation and entrepreneurship in a unified framework.[11]

The remainder of the paper is organized as follows. Section 2 first describes the model with entrepreneurs and then the model without entrepreneurs. Sections 3 and 4 present a description of the calibration and the calibration results. Section 5 presents the findings of the tax reform. Section 6 provides some sensitivity analysis, and Section 7 concludes.

2. Model with entrepreneurs

Given that the description of the model with entrepreneurs is roughly similar to the one of the model without entrepreneurs I mainly present the model with entrepreneurs and then discuss the model without entrepreneurs at the end of the section. The model economy is populated by a continuum of infinitely lived households of measure one. In each period, the agents decide whether to run a business or to supply their labor service to the market. The economy consists of four sectors: household, production, intermediation, and government.

[10] Gentry and Hubbard (1999) show that external financing to start and expand a business is very costly. Holtz-Eakin et al. (1994a, 1994b) show that the probability of becoming an entrepreneur increases with parental inheritance of wealth. These facts indicate the importance of borrowing constraints in entrepreneurship.

[11] Gravelle and Kotlikoff (1989, 1995) study the welfare effects of corporate taxation in an occupational choice model where the decision to become an entrepreneur—who operates in the non-corporate sector—depends on the agent's business ability, but not on his net worth. In a recent paper, Cagetti and De Nardi (2004) also study entrepreneurship, estate and income taxation, but they use a different modelling strategy and do not account for the wage effect on entrepreneurship which turns out to be important for the present paper.

2.1. Household sector

2.1.1. Preferences and labor efficiencies

Households maximize their expected discounted lifetime utility:

$$E_0\left\{\sum_{t=0}^{\infty}\beta^t u(c_t)\right\}, \tag{1}$$

E_0 is the expectation operator conditional on information at date 0, c_t is consumption, and β is the discount factor, where the momentary utility is given:

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

In each period, households are endowed with $\varepsilon \in \{\varepsilon_1, \dots, \varepsilon_{N_\varepsilon}\}$ units of labor efficiencies, which can either be supplied to the market in return for the wage rate, ω, or be directly employed in its own business. I assume that an entrepreneurial household is indifferent between employing its own labor service and hiring labor from the market. As a result, for simplicity, the household is assumed to supply all its labor to the market.[12] The labor efficiency is observed at the end of the period and follows a first-order Markov process with a transition probability $\Gamma(\varepsilon', \varepsilon)$.

2.1.2. Entrepreneurial ideas

The household can also run a business project by implementing an entrepreneurial idea, $\tilde{k}$, drawn at the end of each period from the set $\mathcal{K} = \{k_0, k_1, \dots, k_{N_k}\}$, where $k_{i-1} < k_i$ for $i = 1, \dots, N_k$. The first element of $\mathcal{K}$ is set at $k_0 = 0$ and corresponds to the case in which there is no entrepreneurial idea and the household is a worker.

The entrepreneurial idea, $\tilde{k}$, is a random variable with a probability distribution denoted by $P_k(\tilde{k})$, where the subscript k denotes the project implemented in the current period. More precisely, $P_{k_i}(\tilde{k})$ describes a "learning" process that requires the agent to have an idea, k_i, before receiving an idea, k_{i+1}.[13] In other words, the probability of getting better entrepreneurial ideas increases if the agent is running better projects. Specifically, it is assumed, on the one hand, that the probability of a new better idea is positive only for the next-highest project close to the one that is currently being run, and, on the other hand, that

[12] It is worth noting the following two elements. First, it can also be assumed that the entrepreneur uses his labor to manage the business and that his only source of income is profits. If the structure of the technology in the entrepreneurial sector is appropriately modified, the total income of the entrepreneur can have the same properties as the one he earns in the current version of the paper. And consequently, the results would not change. One advantage of assuming that entrepreneurs retain their labor income is that it is easier to see that becoming entrepreneurs increases income risks since it brings another source of income uncertainty in addition to the uncertainty in labor income. Second, if the entrepreneur uses his labor to manage the business, aggregate labor supply will be endogenous since it is determined by moves between the pools of workers and entrepreneurs (even though labor supply is inelastic at the individual level). This mechanism may imply a greater rise in the wage rate when entrepreneurs increase their demand for labor after the elimination of progressive taxation. Thus this may reinforce the main result of the paper regarding the distributional effects of switching to proportional taxation.

[13] This is consistent with the observation that on average "younger" firms are smaller than "older" firms (Evans, 1987).

the implemented project in the present period can always be run by the household. As a result, for all current business projects, k_i, where $i = 0, \ldots, N_k$, the probability distribution is such that

$$P_{k_i}(\tilde{k}) \begin{cases} > 0 & \text{if } \tilde{k} \in \{k_i, k_{i+1}\} \text{ and } i < N_k, \\ = 1 & \text{if } \tilde{k} = k_i \text{ and } i = N_k, \\ = 0 & \text{otherwise.} \end{cases} \tag{2}$$

Given the definition of $P_k(\tilde{k})$, the set of projects with which the household can run a business in the next period is given by $\{k, \tilde{k}\}$, where the first element is the project implemented in the current period and the second element is the idea obtained at the end of the period.

Finally, I assume that the amount of capital required for the realization of an entrepreneurial project is indivisible. In other words, if the household wants to run a business project, it has to invest the fixed amount of capital required by that project. This assumption, coupled with the fact that the set of ideas is discrete, implies that the entrepreneurial idea, $\tilde{k}$, is characterized by the amount of capital input required for its implementation.

2.2. *Production sector*

In reality, not all firms (particularly large firms) are managed by a single entrepreneur. Therefore, in the model there is one good which is produced by two distinct sectors: the non-entrepreneurial sector and the entrepreneurial sector. In this paper, the uninsurable entrepreneurial risk and the strictness of financial constraints are the main features that characterize and differentiate the entrepreneurial sector from the non-entrepreneurial sector (in the spirit of Fazzari et al., 1988, and Gertler and Gilchrist, 1994).

2.2.1. *Entrepreneurial sector*

The production function associated with a project, k, is given by

$$f(z, k, n) = z^{\nu} k^{\nu} n^{1-\nu}, \tag{3}$$

where $\nu \in (0, 1)$ is the capital income share, n is the number of efficiency units of labor input, and $z \in \mathcal{Z}_k = \{z_{1k}, \ldots, z_{N_z k}\}$ is an idiosyncratic technology shock that is observed at the beginning of the current period and that follows a first-order Markov process with transition probability $Q_k(z', z)$. The set from which the shock, z, takes values, as well as its probability distribution, depends on the implemented project, k. The first element of the set, $\mathcal{Z}_k$, is assumed to be a bad shock that is highly persistent; i.e., $Q_k(z_{1k}, z_{1k}) = 1$. As a result, if entrepreneurs receive it, they will exit from entrepreneurship.

The production plan in this sector is determined as follows:

(i) at the end of the period, the entrepreneur decides which project to run from the set of implementable projects, and
(ii) at the beginning of the next period, after observing the technological shock, z, the entrepreneur decides how much labor to use in production.

Hence, running a business project, k, in the current period means that its required k units of capital input had to be invested in the previous period before the technological shock, z, is observed, while the labor input, n, is chosen after the observation of z.

Finally, the amount of capital invested depreciates stochastically, based on the belief that the end-of-period value of the invested capital depends on the result of the entrepreneurial activity (which is the realization of the technological shock). If the entrepreneur receives a good shock, the value of the invested capital is high; if the shock is bad, then the value of the invested capital is low. The depreciation rate is denoted by δ_z, and it is a function of the shock, z. The introduction of stochastic depreciation allows for the possibility of large losses in entrepreneurial activities.

2.2.2. Non-entrepreneurial sector

The production function in the non-entrepreneurial sector is given by the following constant returns-to-scale production function:

$$F(K_c, N_c) = K_c^{\theta} N_c^{1-\theta}, \tag{4}$$

where θ is the capital income share in the non-entrepreneurial sector, K_c, and N_c are the aggregate capital and labor efficiencies used in this sector, respectively. Capital depreciates at rate δ.[14]

2.3. Intermediation sector and borrowing constraints

In the model economy, intermediaries collect deposits from households with positive balances (by paying the interest rate, r_d) to lend those funds to households and the non-entrepreneurial sector. While there is a positive proportional cost, γ, per unit of funds intermediated to households undertaking entrepreneurial activities, loans made to the non-entrepreneurial sector use no resources. Given the large number of banks behaving competitively, bank profits are zero. This assumption implies that the lending rate equals r_d for loans to the non-entrepreneurial sector and $r_l = r_d + \gamma$ for loans to the household sector.

The lending policy for intermediaries consists of lending up to the amount that the borrower will be able to repay with certainty at the end of the following period. For any given project $k \in \mathcal{K}$, let $z_{\min}$ be the lowest possible realization of the shock. If the agent devotes k units of capital in the project, then the minimum income at the end of the period, before paying back the debt, is given by

$$I_{\min}(k) = \max_n \left\{ z_{\min}^{\nu} k^{\nu} n^{1-\nu} - \omega n \right\} + (1 - \delta_{z_{\min}})k, \tag{5}$$

where $I_{\min}(k)$ denotes the disposable income associated with a project k when the shock takes the minimum possible value. Note that for $k = 0$ (worker), $I_{\min}(0) = 0$. To derive the limit imposed on the net worth, a, of an agent, it is assumed that $k > a$, which in turn implies that the applicable interest rate is the lending rate, r_l. Given this assumption and

[14] The average depreciation rate of aggregate capital in the whole economy is δ. In the calibration, it is assumed that the stock of aggregate capital employed in the two sectors depreciates at the same rate, δ.

the lending policy of the bank, $(1+r_l)(k-a)$ must be less than or equal to $I_{\min}(k)$. More precisely, the lower limit imposed on the net worth of an agent is given by[15]

$$a \geqslant k - \frac{I_{\min}(k)}{1+r_l}. \tag{6}$$

The above borrowing constraint also represents the constraint of an individual who decides to be a worker. In particular, in the event that $k = 0$ (worker), the net asset holding of a worker is constrained to be non-negative. In other words, the agent who decides to work for someone else and invests in financial assets must hold a positive net worth to self-insure against wage income uncertainty. Agents who decide, instead, to undertake entrepreneurial activity must carry a minimum, strictly positive level of net worth. This minimum capital requirement, together with costly financial intermediation, plays a major role in determining the savings patterns of entrepreneurs and workers who decide to undertake entrepreneurial activities.[16] In this economy, it is assumed that all debts must be repaid to the intermediation sector before the payment of taxes. Therefore, the tax does not directly affect the limit imposed on net worth in Eq. (6). This assumption is consistent with the fact that, in general, most business capital expenses are tax deductible.

2.4. *Government sector*

The government in the model economy taxes households' incomes to finance government consumption, G. I assume that income taxes are described by the function $\tau(y)$, where y denotes household income. The income tax system is progressive in the sense introduced by Musgrave and Thin (1948). Specifically, the average income tax rate $(\tau(y)/y)$ is increasing in income. Moreover, it is assumed that $\tau = 0$ for $y \leqslant 0$. Finally, it is assumed that the government operates under a balanced budget:

$$G = T, \tag{7}$$

where T denotes aggregate tax revenues.

2.5. *The cost of capital and business profits*

In this economy all firms behave competitively. That is, all firms take prices as given when they choose the labor input.

Entrepreneurial sector. Given invested capital, k, from the previous period, entrepreneurial households choose the amount of labor input at the beginning of the current period after observing the technology shock, z, by solving the following profit-maximization problem:

[15] Alternatively, the borrowing limits can arise endogenously as a feature of an optimal lending contract in environments characterized by enforcement problems (e.g., Albuquerque and Hopenhyan, 1997).

[16] Using data from 1983 and 1989 Federal Reserve Board Surveys of Consumer Finances, Gentry and Hubbard (1999) show that (i) business owners have high savings rates compared to non-business owners, and (ii) the portfolios of business owners are undiversified, with the bulk of assets held within their businesses.

$$\pi(a,k,z) = \max_n \left\{ z^\nu k^\nu n^{1-\nu} - \omega n - r(a)k - \delta_z k \right\}, \tag{8}$$

with

$$r(a) = \begin{cases} r_d, & \text{if } k \leqslant a \\ r_d + \left(\frac{k-a}{k}\right)\gamma, & \text{if } k > a. \end{cases}$$

The function $r(a)$ defined above denotes the cost of capital from internal and external source financing, and the definition of profit is net of the opportunity cost of capital. If $k \leqslant a$, the business project is entirely self-financed, and the cost of capital is given by the opportunity cost, r_d. If $k > a$, the business is partially financed with debt and the cost of capital increases with the debt-to-capital ratio (since the intermediation cost is positive). Because an entrepreneur is a price taker, the optimal labor demand is given by

$$n(k,z) = zk\left(\frac{1-\nu}{\omega}\right)^{1/\nu}. \tag{9}$$

Combining Eqs. (9) and (8), the ex post entrepreneur's profit, net of the opportunity cost of capital, is given by

$$\pi(a,k,z) = \nu z k\left(\frac{1-\nu}{\omega}\right)^{(1-\nu)/\nu} - (r + \delta_z)k. \tag{10}$$

Given that external financing is costly, the entrepreneur's profit is increasing in the ratio of net worth to capital invested (a/k).

Non-entrepreneurial sector. Profit maximization in the non-entrepreneurial sector leads to the following price functions:

$$\omega = (1-\theta)\left(\frac{K_c}{N_c}\right)^\theta, \tag{11}$$

$$r_d = \theta\left(\frac{K_c}{N_c}\right)^{\theta-1} - \delta. \tag{12}$$

2.6. Timing of events

Beginning of the period. At the beginning of the period, business households observe the technology shock, z, and, given the invested capital, k, they decide how much labor, n, to hire.

End of the period. At the end of the period, households observe the entrepreneurial idea, $\tilde{k}$, and the labor productivity, ε'.[17] Then, knowing the set of potential projects, $\{k, \tilde{k}\}$, and

[17] Given the assumption that the labor ability is observed at the end of the period, agents know with certainty their next period's incomes if they decide to become workers, but they do not know with certainty their incomes if they choose to become entrepreneurs, since the income depends on the realization of the shock in the next period. Therefore, by undertaking an entrepreneurial activity, agents face higher income uncertainty, which induces them to save more for precautionary purposes.

the labor productivity, ε', households decide first whether to invest in the business activity, given the available project, and then how much to save.

2.7. The household's problem

The state of an individual at the beginning of the period is given by four variables: labor productivity, ε; net worth, a; the implemented project, k (decided at the end of the previous period); and the technology shock, z, observed at the beginning of the period. Recall that if $k=0$, the household is a worker; if not, the household is an entrepreneur. The aggregate states of the economy are given by the distribution of agents over individual states represented by the measure $\mu(\varepsilon, a, k, z)$. This paper focuses on stationary equilibria, in which the distribution of agents over individual states is constant over time. As a result, the aggregate variables, such as prices, are constant and treated parametrically in solving the optimization problem of the household. The stationary equilibrium is defined in Appendix A.

I define $\upsilon(\varepsilon, a, k, z)$ to be the beginning-of-period value function of an individual who, at the end of the previous period, invested in the entrepreneurial project, k. Also, let $\tilde{\upsilon}(\varepsilon, a, k, z, \tilde{k}, \varepsilon')$ be the end-of-period value function after observing $\tilde{k}$ and ε'.

The agent's problem at the end of the period, after the realizations of the variables $\tilde{k}$ and ε', is given by:

$$\tilde{\upsilon}\big(\varepsilon, a, k, z, \tilde{k}, \varepsilon'\big) = \max_{a', k'} \Big\{ u(c) + \beta \sum_{z'} \upsilon\big(\varepsilon', a', k', z'\big) Q_k\big(z', z\big) \Big\}, \tag{13}$$

subject to

$$c = a(1+r_d) + \pi(a, k, z) + \omega\varepsilon - \tau(y) - a',$$

$$a' \geqslant k' - \frac{\nu z_{\min} k' (\frac{1-\nu}{\omega})^{\frac{1-\nu}{\nu}} + (1-\delta_{z\,\min})k'}{1+r_l},$$

$$k' \in \{k, \tilde{k}\},$$

with

$$y = \omega\varepsilon + \pi(a, k, z) + r_d a.$$

The agent's optimization is subject to budget and borrowing constraints. Furthermore, the agent's income, y, subject to taxation, is defined as the sum of labor income, net profit, and the return on assets. It is given by the last expression in problem (13). The solution is given by the policy functions $g_a(\varepsilon, a, k, z, \tilde{k}, \varepsilon')$ and $g_k(\varepsilon, a, k, z, \tilde{k}, \varepsilon')$.[18]

The beginning-of-period value function is the expected value of the end-of-period value function, $\tilde{\upsilon}$, conditional on the information available at the beginning of the current period:

$$\upsilon(\varepsilon, a, k, z) = \sum_{\tilde{k}, \varepsilon'} \tilde{\upsilon}\big(\varepsilon, a, k, z, \tilde{k}, \varepsilon'\big) P_k\big(\tilde{k}\big) \Gamma\big(\varepsilon', \varepsilon\big). \tag{14}$$

[18] Given the decision rules, $g_a(\varepsilon, a, k, z, \tilde{k}, \varepsilon')$ and $g_k(\varepsilon, a, k, z, \tilde{k}, \varepsilon')$, the optimal consumption $g_c(\varepsilon, a, k, z, \tilde{k}, \varepsilon')$ is determined by using the budget constraint.

2.8. Model without entrepreneurs

To understand the importance of entrepreneurship for the effects of progressive income taxation, I also consider an economy without entrepreneurs. The model is similar to the model with entrepreneurs except that there are no entrepreneurial opportunities available to households that is, $P_{k_0}(\tilde{k} = 0) = 1$ and $k = 0$. As a result, the good in the economy without entrepreneurs is produced only by the constant return to scale production function in the non-entrepreneurial sector. The borrowing constraint in the model is $a' \geqslant 0$ which is identical to the borrowing constraint faced by workers in the model with entrepreneurs. Both models are calibrated in the following section.

3. Calibration

The benchmark economies of both models with and without entrepreneurs are calibrated to the US economy, and the model period is one year. The parameters to be calibrated are related to the household's preferences, the process for labor efficiency, technology in the non-entrepreneurial and entrepreneurial sectors, technology in the intermediation sector, and the tax system. Given that the calibration procedure is similar in the two models, I mainly describe the calibration of the model with entrepreneurs and highlight the main differences in the two model economies when needed. Most of the choices for parameterizing the model are standard. Exceptions involve the special features of the framework, specifically the production sector and the tax codes. The numerical method used to solve for equilibria is described in Appendix B.

3.1. Preferences

Two parameters related to preferences have to be calibrated: the relative risk-aversion parameter, σ, and the discount factor, β. The relative risk-aversion parameter, σ, is set to be equal to 2.0. This value is in the range of estimates reviewed by Prescott (1986) and Auerbach and Kotlikoff (1987). The discount factor, β, is set endogenously so that, in the stationary equilibrium, the annual interest rate on deposits, r_d, equals the value representative of all financial investments. Mehra and Prescott (1985) find that the returns on government bonds, representative of risk-free assets, in the post war period, averaged 0.5 percent while the same period the return on risky on assets averaged 6.5 percent. In the model economy developed in this analysis, deposits are representative of risky and risk-free financial assets. Because the average return on these deposits should be between 0.5 and 6.5 percent, I use the mean value, and I set $r_d = 0.035$.

3.2. Labor efficiency

The labor ability, ε, is assumed to follow a four-state Markov process with transition probability Γ. To calibrate Γ, it is assumed that the logarithm of the household's labor ability follows a first-order autoregressive process:

$$\ln(\varepsilon_{t+1}) = \rho \ln(\varepsilon_t) + \xi_{t+1}, \quad \xi_{t+1} \sim N\big(0, \sigma_\xi^2\big). \tag{15}$$

Using PSID data from the period 1970–1992, Quadrini (2000) estimates the persistence and the standard deviation of labor efficiency. He finds that the persistence and the standard deviation are 0.496 and 0.332, respectively. These estimations are close to those of Abowd and Card (1989) that are obtained using several data sets other than the PSID. Thus I set $\rho = 0.496$ and $\sigma_\xi = 0.332$. Given (ρ, σ_ξ), the procedure described in Tauchen (1986) is used to approximate the above autoregression by a four-state Markov chain. The four values of the labor productivity are evenly spaced in the log scale, ranging from $-2(\sigma_\xi^2/(1-\rho^2))^{1/2}$ to $2(\sigma_\xi^2/(1-\rho^2))^{1/2}$.

3.3. Production technology

To begin calibrating the production technology parameters, a notion of the aggregate stock of capital must be adopted. Given that in the model economies the government only consumes, and that services from government-owned capital are excluded from taxation in practice, this study abstracts from public capital and considers only private tangible assets. Consumer durables are also excluded from the measurement of aggregate capital, since they are not taxed in practice, and because it is difficult to quantify their market values and the values of their services. Therefore, using the flow of funds account in the Balance Sheet for the US Economy (Federal Reserve Board, 1990), aggregate capital is defined as the sum of plants and equipment, inventories, land at market value, and residential structures. As a second step, the share of total capital employed in the two sectors of production (non-entrepreneurial and entrepreneurial sectors) must be determined. Since most small firms are unincorporated and large firms are incorporated, I assume that the "non-corporate sector" characterizes the entrepreneurial sector and the "corporate sector" characterizes the non-entrepreneurial sector. Using the flow of funds account, Quadrini (2000) reports that the fraction of capital used in the non-entrepreneurial sector is 0.70. (This value is also consistent with Gravelle and Kotlikoff, 1995.)

It is assumed that the aggregate stock of capital in both sectors depreciates at the same rate, $\delta = 0.062$. Moreover, it is assumed that capital income shares in the two sectors of production are identical. (As part of a sensitivity analysis, I also consider the cases when the capital income share in the entrepreneurial production, ν, takes the values of 0.3 and 0.38.)

Non-entrepreneurial technology. The capital income share in the non-entrepreneurial sector is set at $\theta = 0.33$, to mimic the actual data of the US economy. This value is consistent with the estimates reported by Poterba (1997).

Entrepreneurial technology. In this sector there are three business projects, characterized by the capital inputs k_1, k_2, and k_3, which are calibrated by using the distribution of business wealth among households. (A sensitivity analysis is conducted with respect to the number of business projects, where 9 business project sizes are considered instead of 3.) Table 1 presents the decile distribution of business wealth among households reporting a positive net value of their businesses, using data from the 1989 and 1992 US Survey of Consumer Finance (SCF). As the table shows, business wealth is very concentrated. This skewness of the distribution of business capital is approximated by attaching smaller fractions of entrepreneurs to larger projects. In particular, the small-scale project,

Table 1
Percentage of business wealth owned by percentiles in the SCF

	Decile									
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1989 SCF	0.02	0.12	0.33	0.75	1.30	1.91	3.08	5.35	10.53	76.61
1992 SCF	0.08	0.28	0.52	0.91	1.45	2.34	3.65	6.22	11.71	72.84

Source: Quadrini (2000).

the medium-scale project, and the large-scale project are run by 60, 30, and 10 percent of entrepreneurs, respectively. To determine the ratios among the capital inputs of the three projects, business households are divided into three classes, according to their business wealth, with each class counting 60, 30, or 10 percent. The relative distribution of business capital is obtained by calculating the ratios among the average values of business wealth in each group. Combining 1989 and 1992 data, these ratios are set as follows: $k_2/k_1 = 10$ and $k_3/k_1 = 100$. Given the distribution of entrepreneurs among the projects, the size of the smallest project, k_1, is set endogenously, such that the fraction of total capital used in the entrepreneurial sector is 0.30.

The technological shock is assumed to take two values, $z \in \{z_1, z_2\}$, and it follows a first-order Markov process with a transition probability matrix $Q_k(z' \mid z)$:

$$Q_k(z' \mid z) = \begin{pmatrix} 1 & 0 \\ 1-\phi_k & \phi_k \end{pmatrix}, \quad \text{for } k = k_1, k_2, k_3, \tag{16}$$

where ϕ_k is the probability of receiving the second value of the shock in the next period, conditional on observing the value of z_2 in the current period for a given project, k. The calibration of ϕ_{k_1}, ϕ_{k_2}, and ϕ_{k_3} is based on the exit rates from entrepreneurship for agents with different levels of business experience. First, as Quadrini (2000) documents, the exit rate from entrepreneurship declines with entrepreneurial tenure. For example, he reports that the exit rates from entrepreneurship are 0.447, 0.308, and 0.134 for business owners with one year, two years, and three or more years of entrepreneurial tenure, respectively. According to the process for obtaining entrepreneurial ideas described in Eq. (2), households running larger businesses have higher entrepreneurial tenure. Hence, larger probabilities of the low shock should be assigned to smaller projects. Second, because the probability of becoming an entrepreneur increases with business experience, exit rates from entrepreneurship underestimate business duration. To account for this issue, high values are assigned to the probability of the good shock. Based on these grounds, the probabilities are set as follows: $\phi_{k_1} = 0.75$ for the smallest project, $\phi_{k_2} = 0.92$ for the mid-sized project, and $\phi_{k_3} = 0.97$ for the largest project. This calibration process gives an average exit rate from entrepreneurship of 0.20.

To determine the specific values of the technological shock for the different projects, two assumptions are made: $z_{1k} = 0$ for all projects, and the mean of the technological shock to entrepreneurial projects is the same for all entrepreneurs, conditional on survival (that is, conditional on observing the second realization of the shock), and is given by $\bar{z}$. The mean of the shock, $\bar{z}$, is calibrated such that the fraction of total income earned by entrepreneurs is 22 percent, which is the value found in the Panel Study of Income Dynamics (PSID) of

1970–1992. Given $\bar{z}$ and the transition probabilities, the second value of the shock, z_{2k}, is derived from the following equation:

$$z_{2k} = \frac{\bar{z}}{\phi_k}, \quad \text{for } k = k_1, k_2, k_3. \tag{17}$$

The probability distribution, $P_k(\tilde{k})$, of the entrepreneurial idea $\tilde{k} \in \{0, k_1, k_2, k_3\}$, is defined in Eq. (2). Given this definition, there are only three parameters to be calibrated: $P_0(\tilde{k} = k_1)$, $P_{k_1}(\tilde{k} = k_2)$, and $P_{k_2}t(\tilde{k} = k_3)$. They are set endogenously such that the distribution of entrepreneurs in the stationary equilibrium with a progressive income tax system equals the imposed distribution of entrepreneurs among the three projects: 60, 30, and 10 percent, respectively. The total fraction of entrepreneurs equals 0.12, which is the same fraction found in the PSID data for the period 1970–1992 and in the SCF data for 1989–1992.

The calibration of the stochastic depreciation rate, δ_z, is made under the following assumption: the average depreciation rate for each project, conditional on survival, is given by the aggregate depreciation rate, δ. In the benchmark equilibrium, the depreciation rate assigned to the bad shock is $\delta_{z_{1k}} = 0.1$ for all projects. (I conduct a sensitivity analysis with respect to this parameter in Section 6.) The second depreciation value is then determined by the following equation:

$$\delta_{z_{2k}} = \frac{\delta - (1 - \phi_k)\delta_{z_{1k}}}{\phi_k}, \quad \text{for all } k = k_1, k_2, k_3. \tag{18}$$

3.4. Intermediation sector

The proportional intermediation cost, γ, charged by intermediaries, particularly banks, to entrepreneurs, represents the difference between the interest rate on loans, r_l, and the interest rate on deposits, r_d. Díaz-Giménez et al. (1992) report the average interest rates paid on several types of household borrowing and lending to banks and other intermediaries for selected years. Based on these data, they calibrate the interest rate spread at 5.5 percent. In the benchmark economy, I set $r_l - r_d = \gamma = 0.055$. A sensitivity is conducted with respect to this parameter.

3.5. Government

In the model economy, the government uses the function, $\tau(y)$, to tax individuals' incomes to finance its consumption, G. The functional form of the tax function, τ, is based on the effective household income tax function estimated by Gouevia and Strauss (1994). This tax function is chosen for both its tractability and simplicity (Castañeda et al., 1999 and Sarte, 1997 have also suggested its use). In particular, Gouevia and Strauss (1994) characterize the 1989 US effective personal tax function as follows[19]:

$$\tau(y) = \alpha_0\big(y - \big(y^{-\alpha_1} + \alpha_2\big)^{-1/\alpha_1}\big), \tag{19}$$

[19] In their study, the authors present a range of parameter estimates obtained from cross-sectional regressions involving US individual income and tax data for 1979–1989.

Table 2
Calibration of parameters of the model with entrepreneurs

Description	Parameters	Values
Relative risk aversion	σ	2.0
Discount factor	β	0.934
Tax parameters	$\{\alpha_0, \alpha_1, \alpha_2\}$	{0.258, 0.768, 0.299}
Non-entrepreneurial capital income share	θ	0.33
Entrepreneurial capital income share	ν	0.33
Depreciation rate of aggregate capital	δ	0.062
Intermediation cost	γ	0.055
Entrepreneurial size projects	k	{0, 1.7, 17, 170}
Mean technological shock	$\bar{z}$	2.374
Values of the shock	z_{2k}	$\begin{Bmatrix} 3.17 \\ 2.58 \\ 2.45 \end{Bmatrix}$
Probability transition	ϕ_k	$\begin{Bmatrix} 0.75 \\ 0.92 \\ 0.97 \end{Bmatrix}$
Arrival probability of new entrepreneurial ideas	$P_k(\tilde{k})$	$\begin{Bmatrix} 0.024 \\ 0.110 \\ 0.075 \end{Bmatrix}$
Stochastic depreciation	δ_z	$\begin{Bmatrix} 0.1 & 0.049 \\ 0.1 & 0.059 \\ 0.1 & 0.061 \end{Bmatrix}$

with the values of the parameters $\alpha_0 = 0.258$, $\alpha_1 = 0.768$, and $\alpha_2 = 0.031$.

However, their estimates cannot be used, because the marginal tax rates are not unit-free. To solve this problem, I follow Castañeda et al. (1999), by using their estimates for α_0 and α_1, and then calibrate α_2 such that the average tax rates paid by a household that earns the mean household income both in the United States and in the artificial economy are identical.

After calibrating the tax function, the value of government consumption is determined endogenously by the government budget constraint (7). As a result, the interpretation of G in the model economy under the progressive income tax system is the size of the tax collection. The parameters' values for the benchmark economy are summarized in Table 2.

3.6. *Economy without entrepreneurs*

The calibration of the model without entrepreneurs is similar to the model with entrepreneurs. A key difference regarding the calibration of the two model economies is the calibration of labor efficiency. In contrast to the model with entrepreneurs, the stochastic process of earnings is now such that the distribution of wealth matches the one in the model with entrepreneurs (and in the US data). To do so, I follow the approach used by Castañeda et al. (2003), where the stochastic process of earnings is such that individuals face a low probability of obtaining a non-persistent productivity shock that is more than 1000 times their median income in the economy. They then show that the desire to smooth

Table 3
Calibration of parameters of the model without entrepreneurs

Description	Parameters	Values
Relative risk aversion	σ	2.0
Discount factor	β	0.927
Tax parameters	$\{\alpha_0, \alpha_1, \alpha_2\}$	{0.258, 0.768, 0.35}
Non-entrepreneurial capital income share	θ	0.33
Depreciation rate of aggregate capital	δ	0.062

consumption results in a high wealth concentration. The parameters' values are reported in Table 3.

4. Calibration results

4.1. Economy with entrepreneurs

This section reports the calibration results of the benchmark economy that features a progressive personal income tax regime. Appendix B provides a detailed description of the techniques for solving the model.

Table 4 reports aggregate steady-state statistics of the benchmark equilibrium. As the table shows, the model replicates most of the targets. In particular, the model is able to match the number of entrepreneurs and the share of income that they earn. The high concentration of business capital in the data is also quite closely replicated by the model. The average share of government consumption in output generated by the benchmark economy is approximately 0.131, which is less than the value of 0.195 observed in the US economy. This result is owing to the fact that the model economy considers only the personal income tax, while the US government obtains tax revenues from sources other than income taxes.

Table 5 describes the average and marginal tax rates by income quintiles in the benchmark economy. These tax rates are calculated by using the calibrated tax function defined in Eq. (19).[20] It can be seen that average and marginal tax rates increase with income.

Table 4
Some aggregate statistics

	Benchmark economy	Targets
Interest rate	0.037	0.035
Share of capital in the non-corp.	0.28	0.30
Entrepreneurs	0.113	0.120
Distr. of entrepreneurs (%)	(60, 29.9, 10.1)	(60, 30, 10)
Share of income held by entrep.	0.23	0.22

[20] The tax rates are calculated for the lowest income in each quintile. The lowest income in the first quintile is negative because of business losses.

Table 5
Average and marginal tax rates in the benchmark economy

	Quintile				
	1st	2nd	3rd	4th	5th
Marginal tax rate	0.0	0.081	0.111	0.152	0.193
Average tax rate	0.0	0.050	0.070	0.102	0.140

Table 6
Wealth-to-income ratios for workers and entrepreneurs

	Workers	Entrepreneurs
Model economy		
1st quintile	1.37	−20.0
2nd quintile	0.98	2.04
3rd quintile	2.02	2.06
4th quintile	2.20	2.57
9th decile	1.26	2.75
90–95 percentile	1.59	2.41
95–99 percentile	3.04	9.98
99–100 percentile	6.26	20.14
Overall	2.80	5.34
SCF data		
1st quintile	4.20	41.10
2nd quintile	3.70	15.40
3rd quintile	3.10	11.8
4th quintile	2.60	9.40
9th decile	3.10	7.30
90–95 percentile	4.10	8.30
95–99 percentile	4.80	10.20
99–100 percentile	5.30	6.70
Overall	3.60	8.10

Note: SCF data are from Gentry and Hubbard (1999).

In addition to matching standard aggregate variables, the benchmark equilibrium must account for the main differences in asset holdings between workers and entrepreneurs, for the distribution of entrepreneurs over wealth classes, for the substantial share of wealth held by business owners, and for the concentration of wealth and income observed in the US economy. Thus, in these aspects I am replicating the results of Quadrini (2000), which are displayed in Tables 6–8.

Table 6 presents the average wealth-to-income ratio for workers and entrepreneurs in the benchmark and US economies by income groups. Income is broken down into quintiles, with four groups being in the highest-income quintile. One interesting result is the contrast in the ratio of wealth to income between workers and entrepreneurs in all income groups. Another important difference between the wealth-to-income patterns of entrepreneurs and non-entrepreneurs is that the ratios are consistently higher for entrepreneurs of all income levels, but rise with income for non-entrepreneurs. The wealth-to-income ratio of entrepreneurs in the top 1 percent of income earners is about three times higher than that of workers. This result suggests that entrepreneurs have higher marginal savings rates. The last panel of Table 6 shows that these findings are consistent with the empirical evidence for the US economy. Overall, in the benchmark economy, entrepreneurs have an average wealth-to-income ratio that is almost twice as large as that of workers; in the 1989 SCF, it is just over twice as large for entrepreneurs.

Table 7 lists the number of workers and entrepreneurs in each wealth class for the benchmark economy and for the PSID data, where each wealth group includes one-third of the population. The table shows that the percentage of business households in the model economy, as well as in the PSID data, increases as we move to higher wealth classes.

The benchmark economy also performs reasonably well in terms of the share of wealth held by business families in the US economy. Overall, in the benchmark equilibrium, entrepreneurs own about 35 percent of the total wealth. These statistics are very similar to the ones observed in the PSID and SCF. Additionally, Gentry and Hubbard (2000a, 2000b) report that entrepreneurs hold 39 percent of the total wealth in the SCF, and Quadrini (2000) finds that the fraction of net worth held by business owners is 40 percent in the PSID.

The model economy is able to match the main differences in asset holdings between workers and entrepreneurs. We must next determine whether the benchmark equilibrium is capable of generating the distributions of wealth and income observed in the US economy. The first row of Table 8 reports the top percentiles and the Gini index for the distribution of wealth. As the first row shows, the model economy is able to replicate the high concentra-

Table 7
Distribution of agents among wealth classes

	Benchmark economy		PSID data	
	Workers	Entrepr.	Workers	Entrepr.
Wealth class I	31.96%	1.37%	31.6%	1.8%
Wealth class II	29.30	4.04	29.8	3.5
Wealth class III	27.49	5.85	24.9	8.4
Overall	88.74	11.26	86.4	13.6

Note: PSID data are from Quadrini (2000).

Table 8
Distributions of wealth and income in the benchmark economy with entrepreneurs and in the data

	Top percentiles					Gini index
	1%	5%	10%	20%	30%	
Benchmark model (with entrepreneurs)						
Wealth	33.6	55.2	64.7	76.6	85.2	0.761
Income	11.2	21.1	30.7	49.2	65.1	0.467
SCF data 1989						
Wealth	35.7	58.0	70.1	83.7	91.8	0.860
Income	16.9	31.7	42.3	57.2	68.8	0.540
PSID data 1989						
Wealth	29.2	49.5	62.8	78.3	87.7	0.770
Income	7.9	20.4	31.5	48.1	61.1	0.450

Note: PSID and SCF data are from Quadrini (2000).

Table 9
Distribution of wealth in the benchmark model without entrepreneurs and in the data

	Top percentiles					Gini index
	1%	5%	10%	20%	30%	
No entrepreneurs	33.1	55.8	64.7	76.6	85.3	0.767
US data	29.2	49.5	62.8	78.3	87.7	0.770

Note: PSID data are from Quadrini (2000).

tion of wealth observed in the US economy. To be more specific, the Gini index of wealth is about 0.76 in both the model economy and the 1989 PSID data, while it is 0.86 in the 1989 SCF data. The top 1 and 5 percent of agents in the model economy hold, respectively, 33.6 and 55.2 percent of total wealth. According to the PSID data, the top 1 and 5 percent of agents owned 25 and 47 percent of total household wealth in 1989, respectively. When the 1989 SCF data are used, the percentage of total wealth owned by the top 1 and 5 percent of families is 35.7 and 58.0 percent, respectively. The second row of Table 8 reports distributional statistics for income. The model's concentration of income is almost identical to the observed concentration of income. For example, in the benchmark economy, the Gini of income takes the value of 0.47 and the top 1 and 5 percent of income earners possess 11.2 and 21.1 percent of total income, respectively. The benchmark economy is thus successful at replicating the asset holdings of entrepreneurs, the high concentration of wealth and the progressivity of the tax system in the US economy.

4.2. Economy without entrepreneurs

The distribution of wealth is represented in Table 9. The table shows that the model without entrepreneurs is able to match the distribution of wealth observed in the US data.

5. The policy experiment

Having presented a quantitative theory of inequality and entrepreneurship, I use it to study the consequences of switching from a progressive to a proportional income tax system. The policy change is done in a revenue-neutral fashion, in the sense that government revenues after the reform are the same as before the reform.

5.1. Aggregate effects

Table 10 reports the aggregate effects of the policy experiment in the economies with and without entrepreneurs.

I find that, in the economy without entrepreneurs, switching to proportional income taxation, increases output by 3.7 percent and aggregate capital by 11.6 percent. Given that labor supply is inelastic, the increase in output comes directly from the increase in capital accumulation. There is an increase in capital stock because proportional income taxes reduce the distortions associated with the high marginal tax rates paid by high-income households.

Table 10
Aggregate effects of the policy experiment in the models with and without entrepreneurs

	With entrepreneurs	No entrepreneurs
	(Change)	(Change)
Output	5.5%	3.7%
Capital stock	6.1%	11.6%
Capital input per entrepreneur	16.5%	–
Labor input per entrepreneur	7.0%	–
Interest rate	−16.2%	−19.0%
Wage rate	4.1%	3.7%
Average marginal tax rate	−6.90%	−7.01%
Average tax rate	−2.00%	−2.02%

In the economy with entrepreneurs, proportional income tax reform increases aggregate output by 5.5 percent. This result is mainly caused by both the 17 percent increase in entrepreneurial investments and the 6 percent increase in aggregate capital.[21] There is an increase in the capital stock in the economy with entrepreneurs because after the tax reform, the marginal tax rate on rich individuals falls. Given that existing entrepreneurs are mostly high-income individuals, they increase their savings and this relaxes their borrowing constraints. As a result of these higher savings, entrepreneurs increase their investments, and hence expand their businesses by running larger and better projects. Most entrepreneurs running small and medium-sized businesses before the reform are now running larger scale businesses. Consequently, there is a better allocation of entrepreneurs over project sizes. As explained in the next section, this can lead to a rise in total factor productivity (TFP) which, in turn, augments output (see also Erosa, 2001).

When entrepreneurship is modelled explicitly, both the aggregate capital stock and the capital input in the entrepreneurial production sector increase, as does non-entrepreneurial capital.[22] This rise in non-entrepreneurial capital, coupled with the high demand for labor input in the entrepreneurial sector, raises the capital–labor ratio in the non-entrepreneurial sector, which, in turn, decreases the interest rate and increases the wage rate. More precisely, as indicated in Table 10, the interest rate drops by about 16 percent and the wage rate rises by 4 percent. In the model without entrepreneurs, the increase in the capital stock directly translates into a rise in the aggregate capital–labor ratio, and therefore, a decrease in the interest rate by 19 percent and an increase in the wage rate by 3.7 percent.

Table 11 reports the fraction of entrepreneurs, the distribution of entrepreneurs among business projects (also called the distribution of business wealth), and the entry rate into

[21] The increase in business investment after the elimination of progressive taxation that cuts the marginal tax rate paid by entrepreneurs is in line with the finding of Carroll et al. (1998a), who estimate that high personal income taxes significantly affect the investment decisions of small firms. To be specific, they find that a percentage point increase in marginal tax rates reduces the proportion of entrepreneurs who make new capital investments by 10.4 percent, and decreases mean investment expenditures by 9.9 percent.

[22] Recall that the market-clearing conditions are given by $K_c = K - K_n$ and $N_c = N - N_n$, for capital and labor markets, respectively. The variables K_n and N_n denote the aggregation of capital and labor inputs used in the entrepreneurial sector, respectively.

Table 11
Statistics on entrepreneurial activities

	Benchmark model	Proportional model
Entrepreneurs (%)	11.26	11.25
Distribution of entrepreneurs		
Small-scale project	0.60	0.58
Medium-scale project	0.30	0.28
Large-scale project	0.10	0.11
Entry rate (%)	2.37	1.97
Exit rate (%)	20.10	16.80

and the exit rate out of entrepreneurship.[23] Three interesting results emerge from this table. First, a switch from a progressive to a proportional income tax system has virtually no effect on the fraction of entrepreneurs in the population; 11.26 versus 11.25 percent. Second, the policy switch discourages entry into business ownership. For example, the entry rate into entrepreneurship decreases by about 17 percent. Finally, even though the fraction of business owners is almost unchanged, the distribution of business wealth is shifted to the right after the policy change, that is, entrepreneurs are better allocated over project sizes (a better allocation of resources). In other words, more entrepreneurs are running large-scale projects, which confirms the increase in entrepreneurial investments mentioned above.

The number of entrepreneurs does not change much because of the following three factors. First, the increase in the wage rate—brought about by the increase in aggregate capital stock and the increase in labor demand generated by the expansion of existing entrepreneurial firms—after the reform leads to a reduction in entrepreneurial profits. This fall in entrepreneurial profits reduces the incentive to become an entrepreneur. Second, under progressive income taxation, low-income households are subject to a lower marginal income tax rate than high-income households. After moving from progressive to proportional taxation, low-income individuals face a higher marginal tax rate. New entrepreneurs are mostly low-income individuals since they run small-scale projects. As a result, they face relatively low after-tax entrepreneurial profits, which discourages business formation. These two factors—the increase in the wage rate and the high income tax rate on some entrepreneurs—contribute to reduce entry into business ownership. Finally, existing entrepreneurial firms are becoming larger (since their borrowing constraints are relaxed) and as a result their exit rate is lower. In the model, the larger is the firm, the lower is the exit rate. This is because in the calibration, the Markov process of the shocks associated with a project size is such that the bigger is the project size, the lower is the probability of receiving bad shocks. This is consistent with empirical regularities of firm size dynamics: smaller firms fail more than large firms. The fall in both the average entry rate into and the average exit rate out of entrepreneurship leads to a small change in the number of entrepreneurs.

[23] The entry rate is defined as the number of workers who become entrepreneurs in the following period divided by the number of workers in the current period. The exit rate is the ratio of the number of entrepreneurs leaving entrepreneurship to the current total number of entrepreneurs.

5.1.1. Discussion

Although the increase in aggregate capital is higher in the model without entrepreneurs, the increase in aggregate output is higher in the model with entrepreneurs than in the model without entrepreneurs. The intuition behind this result is as follows. Contrary to the model without entrepreneurs, there is a better allocation of resources in addition to the increase in capital in the model with entrepreneurs. This improvement in resource allocation leads to a rise in total factor productivity (TFP) which, in turn, boosts aggregate output. To see the increase in TFP after the policy reform, I consider the following thought experiment. Suppose that aggregate output (Y) is produced by an aggregate Cobb–Douglas production function $(Y = AK^{\theta}N^{1-\theta})$ with a capital income share, $\theta = 0.33$ where A represents TFP. Note that aggregate labor (N) is fixed. Knowing the capital income share and changes in K, N, and Y, one can compute changes in TFP through a growth accounting exercise. In the model with entrepreneurs, because aggregate output and capital increase by 5.5 and 6.1 percent respectively, total factor productivity increases by 3.5 percent. The contribution of capital—capital income share times changes in capital—to the 5.5 percent rise in output is 2 percent, while the contribution of TFP is 3.5 percent. Approximately, $2/3$ of the increase in output comes from the rise in TFP and $1/3$ from the increase in capital. Consequently, total factor productivity contributes more than capital to the increase in aggregate output. In the model without entrepreneurs, on the other hand, there is no change in total factor productivity, and hence the increase in output comes mainly from the increase in capital.

In sum, in this paper switching from progressive to proportional income taxation increases total factor productivity.

5.2. Distributional effects

Table 12 reports the distributional consequences of the policy experiment in the models with and without entrepreneurs.

The table shows that switching from a progressive to an equal-revenue proportional income tax system has only a small impact on wealth inequality when entrepreneurship is explicitly modelled, while the same policy change has a large effect on wealth inequality in an economy with no entrepreneurs. In the economy without entrepreneurs, the Gini index of the distribution of wealth increases by 9.5 percent and the share of wealth held by the top 5 percent increases by 11.3 percent. This is in line with previous research which omits

Table 12
Distribution of wealth in the model with entrepreneurs and in the model without entrepreneurs

	Top percentiles					Gini index
	1%	5%	10%	20%	30%	
With entrepreneurs						
Benchmark model	33.6	55.2	64.7	76.6	85.2	0.761
Proportional model	36.3	57.6	66.1	77.8	86.2	0.772
No entrepreneurs						
Benchmark model	33.1	55.8	64.7	76.6	85.3	0.767
Proportional model	38.8	62.1	70.1	81.3	88.6	0.840

entrepreneurship. For example, Castañeda et al. (1999) find that a switch to proportional income taxation substantially increases wealth inequality, as measured by the Gini index, by 10.5 percent. By contrast, in the model with entrepreneurs, the wealth Gini index and the share of wealth held by the top 5 percent increase by only 1.4 and 4.3 percent, respectively.

5.2.1. Discussion

The intuition behind the result in the previous section can be summarized as follows: in the model with only workers, the large increase in wealth inequality when switching from a progressive to a proportional income tax system is mainly caused by the decrease in marginal tax rates paid by rich households and the increase in marginal tax rates faced by low-income households. Wealthy households save more and poor households save less leading to higher wealth inequality. In the model with entrepreneurs, there are two conflicting effects on wealth inequality. In addition to the impact found in the economy without entrepreneurs, there is an offsetting effect that reduces wealth inequality. The main difference in the effects on wealth inequality between the two economies is in the wage effect. More specifically, in the economy without entrepreneurs, the increase in the wage rate benefits all individuals (low or high-income individuals). In the economy with entrepreneurs, on the other hand, the increase in the wage rate tends to reduce entrepreneurial profits while it increases the wage income of workers. The fall in entrepreneurial profits reduces the incentive of existing entrepreneurs—who are mostly richer—to invest and to save. The increase in the wage income of workers—who are most likely to be poor—raise their savings. As a result, the rise in the wage rate decreases wealth inequality between the group of workers and entrepreneurs. This effect, which is only present in the economy with entrepreneurs, partially offsets the increase in wealth inequality observed in the model without entrepreneurs so that the overall wealth inequality in the economy with entrepreneurs increases only slightly.

6. Sensitivity analysis

This section presents some computational experiments to determine the sensitivity of the numerical findings of the previous section: a version of the model with a higher number of business size, a higher and a lower elasticity of capital in the entrepreneurial production, and the borrowing constraints and the stochastic properties of the technological shock.

6.1. Increasing the number of business projects

The specification of the set of business size as a set of three elements may seem restrictive. In this section I report the results for specifications with more business sizes. More specifically, I consider 9 business project sizes in three clusters of three. Let's denote these clusters by cluster 1, cluster 2 and cluster 3. Given the initial three project sizes—k_1, k_2, and k_3—in the original model, a cluster i (for $i = 1, 2, 3$) consists of three elements with an average business size of k_i where the first element is Δ_i percent less than k_i, the second

Table 13
Higher number of business sizes: effects of proportional tax reform on wealth distribution, number of entrepreneurs, and prices

	Entrepr.	Wealth Gini index	Top 5%	Proport. tax rate	Wage rate	Interest rate
Benchmark model	11.67%	0.776	59.99%	–	1.22	3.52%
Proportional model	11.65%	0.781	61.70%	14.75%	1.28	2.69%

element is equal to k_i and the third element is Δ_i percent greater than k_i. In this analysis I set $\Delta_i = 0.1$ for all clusters.[24]

As in the original model, cluster 1, cluster 2, and cluster 3 in the benchmark economy with more business projects contain 60, 30, and 10 percent of entrepreneurs respectively. Conditional on being in a given cluster entrepreneurs are equally distributed across the three projects. I recalibrate β so that the interest rate is the same as before.

Table 13 focuses on reporting the effects of the proportional reform on the distribution of wealth, the fraction of entrepreneurs and prices. The table shows that switching from progressive to proportional income taxation has a small effect on the distribution of wealth and the fraction of entrepreneurs. These findings thus confirm the ones in the previous sections. Hence, the results are not sensitive to the number of business sizes and thus, three business project sizes can serve as a good benchmark.[25]

6.2. *Fixed factor prices*

To understand the importance of the general-equilibrium consequences described in the previous sections, I have considered a revenue-neutral policy change in a partial-equilibrium framework (where prices are fixed at their benchmark values). Table 14 shows that the predictions of proportional tax reform change dramatically when we abstract from the possible general-equilibrium feedbacks. Specifically, the Gini index of the distribution of wealth, aggregate output, and the fraction of entrepreneurs increase by 5.3, 16.5 and 6.6 percent respectively, compared to 1.4, 5.5 and 0.0 respectively in general equilibrium. These results confirm the importance of considering general equilibrium effects.

[24] I also consider a case where $\Delta_1 \neq \Delta_2 \neq \Delta_3$ and the results do not change. In this particular case, the distances between clusters are smaller. For economy of space, I do not report the results in the paper.

[25] I consider another alternative in the construction of the set of 9 business sizes that do not use the approach of cluster. The strategy is identical to the calibration of the project size in the previous section. More specifically, to capture the skewness of the business wealth in the data smaller fractions of entrepreneurs are attached to larger projects. To determine the ratios among the capital inputs of the nine projects, business households are divided into 9 classes, according to their business wealth, with each class counting 25, 20, 15, 12, 10, 8, 6, and 1 percent. The relative distribution of business capital is obtained by calculating the ratios among the average values of business wealth in each group. Using SCF 1998 data, the ratio between two consecutive business projects is a factor of 2.5: $k_i / k_{i-1} = 2.5$ for $i = 2, \ldots, 9$. The results in the previous section still hold and are not reported for economy of space.

Table 14
Partial equilibrium: effects of proportional tax reform on wealth distribution, output, number of entrepreneurs, and prices

	Benchmark model	Proportional model (general equilibrium)	Proportional model (partial equilibrium)
Entrepreneurs (%)	11.26	11.25	12.00
Output	2.37	2.50	2.76
Wealth Gini index	0.761	0.772	0.801
Top 5% (%)	55.2	57.6	60.4
Proport. tax rate (%)	–	14.75	13.75
Wage rate	1.21	1.25	1.21
Interest rate (%)	3.70	3.12	3.70

6.3. *Entrepreneurial capital income share*

The numerical findings in the previous sections work through the demand for workers when entrepreneurial investments rise. Consequently, it is necessary to verify whether these results are excessively sensitive to changes in labor or capital income share in the production technology used by entrepreneurs. This subsection presents some computational experiments with two alternative values for ν that are set below ($\nu = 0.3$) and above ($\nu = 0.38$) the benchmark level presented in Table 2. When ν is higher, entrepreneurial businesses become more capital-intensive, and, as a result, entrepreneurial investments increase substantially when entrepreneurs face a cut in marginal tax rates, particularly in the presence of financial constraints. This business investment increases the demand for labor, as capital and labor are complementary in production. The first two rows of Table 15 show the results from two economies that depart from the baseline (in Section 5) only in the capital income share in entrepreneurial production.

Table 15 indicates that wealth inequality (in the benchmark with progressive taxation) increases with the capital intensity of entrepreneurial businesses. The Gini coefficients of the distribution of wealth in the economies with progressive taxation are 0.71, 0.77, and 0.82 when ν takes the values of 0.30, 0.33, and 0.38, respectively. It is intuitive that, the more-capital intensive entrepreneurial businesses are, the more important entrepreneurial savings are in the presence of borrowing constraints.

Table 15
Sensitivity analysis of the change in the Gini index of wealth when moving from progressive to proportional income taxation

	Progressive income tax	Proportional income tax	Change (%)
Low capital income share in the entrepr. sector ($\nu = 0.3$)	0.711	0.741	4.2
High capital income share in the entrepr. sector ($\nu = 0.38$)	0.824	0.831	0.9
Low business risk ($z_1 = z_2 = \bar{z}$)	0.680	0.704	3.5
High business risk ($2\delta_{z_1}$)	0.805	0.814	1.1
No intermediation cost ($\gamma = 0$)	0.651	0.684	5.1
Baseline	0.761	0.772	1.4

Further, the table reveals that the size of the increase in wealth inequality after the elimination of progressive taxation is negatively related to ν. More specifically, the policy switch increases the wealth Gini index by 4.2, 1.4, and 0.9 percent when ν takes the value of 0.30, 0.33, and 0.38, respectively. This is due to the fact that as the production technology becomes less (more) capital intensive, the effects on wages driven by changes in entrepreneurial savings behavior become less (more) important.

6.4. Borrowing constraints and business risk

The borrowing limits (the minimum of assets necessary to start or to expand a business) are determined by the stochastic properties of the technological shocks. Therefore the sensitivity analysis with respect to this parameter provides a *joint* evaluation of the importance of the riskiness of the business and the borrowing limits. The third and fourth rows of Table 15 display the Gini coefficient of the distribution of wealth for both progressive and proportional income taxes and the change in this coefficient that results from the policy reform when business risk is high and low. Low business risk arises when the idiosyncratic technological shock takes the mean value, that is $z_1 = z_2 = \bar{z}$, while high business risk corresponds to a case where the depreciation rate associated with a low realization of the shock is being doubled. In the current context low (high) business risk implies that borrowing limits are less (more) binding.

As the table indicates, wealth inequality in the benchmark economies (with progressive income tax system) is quite sensitive to changes in the stochastic properties of the technological shock. For example, when the riskiness of business is high (or the tightness of borrowing constraints is severe) the Gini coefficient of wealth in the progressive tax steady state increases from 0.76 to 0.81. When business risk is low (or borrowing constraints are less tight) the Gini index of wealth decreases from 0.76 to 0.68. The direction of the change is natural since high business risk and tighter borrowing limits increase the incentive of individuals to save more for precautionary motives and for overcoming the borrowing constraints (see Quadrini, 2000).

Interestingly, as can be seen from the third and fourth rows of the table the impact of a switch from progressive to proportional income taxation depends on the riskiness of the business activity and the tightness of borrowing limits. For example, when the borrowing constraints are binding and business risks are high the Gini coefficient of wealth increases by only 1.1 percent, while it increases by 3.5 percent when these constraints are less severe. This is intuitive because when the borrowing limits are binding, the cut in entrepreneurs' marginal tax rate relaxes the borrowing constraints and entrepreneurs are able to make the discrete investments that are required. Because of the complementarity of labor and capital in entrepreneurial production function, the demand for labor increases which results in an increase in the wage rate. This increase in the wage rate reduces profits of entrepreneurs and increase earnings of workers. This mechanism narrows wealth inequality between workers and entrepreneurs.

When borrowing constraint faced by entrepreneurs are less binding, the cut in their marginal tax rate leads to a modest increase in entrepreneurial investments. This results in a modest increase in the wage rate given the complementarity of labor and capital.

6.5. No intermediation costs

Another important parameter that explains the high saving rate of entrepreneurs is the intermediation cost, γ. The fifth row displays the results when $\gamma = 0$. As expected, decreasing γ from 0.055 to 0.0 decreases the wealth Gini index from 0.76 to 0.65. The effects on wealth inequality of the policy reform also hinge on the intermediation cost. With zero intermediation costs, a shift from progressive to proportional income taxation increases the Gini coefficient of the distribution of wealth by 5.1 percent, compared to the increase of 1.4 percent in the benchmark experiment. This is natural because when intermediation costs are zero the change in capital investment that results from a cut tax rates faced by entrepreneurs is relatively small.

It is worth pointing out that when financial constraints faced by entrepreneurs are relaxed or when there is costless financial intermediation the increase in wealth inequality that results from the switch from progressive to proportional income taxation is relatively large. This suggests that a model of entrepreneurship in which financial constraints and business risks are severe is crucial to explain the distributional and aggregate effects of eliminating progressive taxation. Many empirical studies show that financial constraints play an important role in business creation (see Evans and Jovanovic, 1989; Holaltz-Eakin et al. 1994a, 1994b; Quadrini, 1999; and Gentry and Hubbard, 1999).

7. Conclusion

This paper has shown that entrepreneurship is important in quantifying the aggregate and distributional effects of reducing the degree of progressivity in the income tax system. Contrary to previous literature, I find that under a reasonable parameter configurations, switching from a progressive to a proportional income tax system has a negligible effect on wealth inequality. This surprising result is accounted for by the moderating effect of entrepreneurial activities on changes in wealth distribution arising from the policy switch. More precisely, an increase in entrepreneurial investments implied by the policy switch induces a higher demand for labor, which raises the wage rate of workers and drives down the average return to business ownership. This general-equilibrium feedback narrows the income and savings gap between workers and entrepreneurs, and, in turn, leads to a reduction in income and wealth inequality. A crucial factor driving this result is financial constraints faced by entrepreneurs. A cut in the tax rate brought about by the switch to proportional taxation relaxes the financial constraints of entrepreneurs and are able to operate their business with higher capital investment and therefore higher labor given that capital and labor are complements in the production.

The framework used is an occupational choice model, in which the decision to become an entrepreneur is determined by the ability to manage a firm and by asset holdings. The model also accounts for the high concentration of wealth and the high saving rate of entrepreneurs observed in the data.

An interesting extension of this model would be to study the effects of progressive taxation in an economy characterized by endogenous tax deductions (e.g., excessive business expenses). This avenue of research is promising, as it has long been argued that entrepreneurs or self-employed individuals have more flexibility in making deductions and reclassifying their income (e.g., Barro and Sahasakul, 1983 and Gordon, 1997). Another important extension is to endogenize the borrowing constraint faced by entrepreneurs in an environment of limited contract enforceability. By doing so it is possible to study quantitatively the insurance aspect of progressive taxation in the presence of entrepreneurial activity.[26] Finally, given the high risk in entrepreneurship and the fact that personal bankruptcy provides partial insurance, an important research agenda is the investigation of the consequences of personal bankruptcy on entrepreneurship and welfare. These extensions are left for future research.

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Appendix A. Definition of a stationary equilibrium

A stationary recursive equilibrium is a pair of value functions, $\upsilon(\varepsilon, a, k, z)$ and $\tilde{\upsilon}(\varepsilon, a, k, z, \tilde{k}, \varepsilon')$; decision rules, $\{n(k, z),\ g_a(\varepsilon, a, k, z, \tilde{k}, \varepsilon'), g_k(\varepsilon, a, k, z, \tilde{k}, \varepsilon')\}$; a government policy, $\{G,\ \tau(y)\}$; prices, $\{\omega,\ r_d, r_l\}$; aggregate capital and labor demands in the corporate sector, $\{K_c, N_c\}$; and a function, $\Psi(\mu)$, that maps the space of households' distribution, μ, into the next period distribution, such that:

(1) The decision rules, $g_a(\cdot)$ and $g_k(\cdot)$, solve the agent's problem described in (13), and the functions, $\tilde{\upsilon}(\cdot)$ and $\upsilon(\cdot)$, are the associated value functions, the employment decision for an entrepreneur solves his profit maximization (8).
(2) Prices are competitive; that is,

$$\omega = (1-\theta)\left(\frac{K_c}{N_c}\right)^{\theta}, \tag{A.1}$$

$$r_d = \theta\left(\frac{K_c}{N_c}\right)^{\theta-1} - \delta, \tag{A.2}$$

[26] Krueger and Perri (1999) have started investigating the consequences of redistributive taxation, such as progressive taxation, in an endogenous incomplete market that stems from limited enforceability of private contracts. However, they do not consider how the insurance aspect of progressive taxation affects entrepreneurial risk-taking.

$$r_l = r_d + \gamma. \tag{A.3}$$

(3) The government budget constraint is satisfied; that is,

$$G = \sum_{\varepsilon,k,z} \left\{ \int_a \tau\big(y(\varepsilon,a,k,z)\big)\mu(\varepsilon,a,k,z)\,\mathrm{d}a \right\}. \tag{A.4}$$

(4) Capital and labor markets clear; that is,

$$\sum_{\varepsilon,k,z} \left\{ \int_a k\mu(\varepsilon,a,k,z)\,\mathrm{d}a \right\} + K_c = \sum_{\varepsilon,k,z} \left\{ \int_a a\mu(\varepsilon,a,k,z)\,\mathrm{d}a \right\}, \tag{A.5}$$

$$\sum_{\varepsilon,k,z} \left\{ \int_a n(k,z)\mu(\varepsilon,a,k,z)\,\mathrm{d}a \right\} + N_c = \sum_{\varepsilon,k,z} \left\{ \int_a \varepsilon\mu(\varepsilon,a,k,z)\,\mathrm{d}a \right\}. \tag{A.6}$$

(5) The distribution of the households, μ, is the fixed point of the law of motion, Ψ. This law of motion is consistent with individual decision rules, and given the subsets S_ε, S_a, S_k, S_z, is defined by the functional equation

$$\begin{aligned} \mu'(S_\varepsilon,S_a,S_k,S_z) &= \Psi(S_\varepsilon,S_a,S_k,S_z) \\ &= \sum_{\tilde{k}} \sum_{\varepsilon'\in S_\varepsilon} \sum_{k'\in S_k} \sum_{z'\in S_z} \left\{ \int_{a'\in S_a} \sum_{\varepsilon,k,z} \left\{ \int_a I\big(\varepsilon,a,k,z,\tilde{k},\varepsilon'\big) P_k\big(\tilde{k}\big)\Gamma(\varepsilon',\varepsilon) \right.\right. \\ &\qquad \left.\left. \times\, Q_k(z',z)\mu(\varepsilon,a,k,z)\,\mathrm{d}a \right\} \mathrm{d}a' \right\}, \end{aligned} \tag{A.7}$$

where $I(\varepsilon,a,k,z,\tilde{k},\varepsilon')$ is an indicator function defined by

$$I\big(\varepsilon,a,k,z,\tilde{k},\varepsilon'\big) = \begin{cases} 1, & \text{if } g_a(\varepsilon,a,k,z,\tilde{k},\varepsilon') \in S_a \text{ and } g_k(\varepsilon,a,k,z,\tilde{k},\varepsilon') \in S_k, \\ 0, & \text{otherwise.} \end{cases} \tag{A.8}$$

Appendix B. Computation of an equilibrium

This appendix describes the algorithm used to compute the stationary equilibria of the benchmark economy. The algorithm also computes the parameter values that are consistent with the targets.

(1) Guess seven parameters: the discount factor, β; the mean technology in the entrepreneurial sector, $\bar{z}$; the tax parameter, α_2; the smallest size of business project, k_1; and the probabilities $P_0(\tilde{k}=k_1)$, $P_{k_1}(\tilde{k}=k_2)$, and $P_{k_2}(\tilde{k}=k_3)$.
(2) Solve the household's problem by iterating on the value functions.
(3) Use the decision rules to compute a stationary distribution by iterating on the measure, μ.
(4) Check the following conditions:
   (a) the capital-to-labor ratio generated in this equilibrium is equal to the one resulting from the calibration of the non-entrepreneurial technology,

(b) the distribution of entrepreneurs among the four projects, generated in the stationary equilibrium, equals the targeted distribution (7.2, 3.6, and 1.2 percent, respectively),
(c) the share of income earned by entrepreneurs in the stationary equilibrium is 0.22,
(d) the tax rates paid by a household that earns the mean household income in the stationary equilibrium and in the US economy are equal,
(e) the fraction of capital employed in the entrepreneurial sector is 0.30.

If conditions (a), (b), (c), (d), and (e) are all satisfied, then an equilibrium is found.

If not, make new guesses of $\{\beta, \bar{z}, \alpha_2, k_1, P_0(\tilde{k}=k_1), P_{k_1}(\tilde{k}=k_2), P_{k_2}(\tilde{k}=k_3)\}$, and go to step 2.

The code is written in Fortran and uses the routine AMOEBA to solve for the parameters (see Press et al., 1994). It can be provided by the author upon request.

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