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Entrepreneurship, Inequality, and Taxation

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Abstract

This paper confirms the conjecture that the evaluation of tax policy leads to very different conclusions once the role of entrepreneurs is considered. Contrary to previous literature, the author finds that switching from a progressive to a proportional income tax system has a negligible effect on wealth inequality in the United States. This surprising result arises because entrepreneurial activities moderate the effects of the policy change on the wealth distribution. The author shows that proportional income tax reform increases entrepreneurial investment and savings by reducing the marginal income tax rates paid by entrepreneurs. Within the model, an increase in business investment implies a higher demand for labour, which raises the wage rate of workers and drives down the average return to entrepreneurial activities. 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. While the elimination of progressive income taxation increases entrepreneurial investments, it has almost no effect on the number of entrepreneurs, as the costs of entrepreneurial activities rise with increasing wages. The model is also able to account for the substantial share of income and wealth held by entrepreneurs, the high savings rate of entrepreneurs relative to workers, and the high concentration of wealth observed in the data.

JEL classification: D31, E62, H23, H20
Bank classification: Fiscal policy; Economic models

Résumé

Cette étude confirme l’hypothèse voulant que l’analyse de la politique fiscale aboutisse à des conclusions fort différentes lorsque le rôle des entrepreneurs est pris en compte. Contrairement à ce que laissent croire les travaux antérieurs à ce sujet, l’auteur constate que le passage d’un impôt progressif à un impôt proportionnel a un effet négligeable sur l’inégalité de la richesse aux États-Unis. Ce résultat surprenant tient au fait que les activités des entrepreneurs atténuent les répercussions de cette modification de la politique fiscale sur la répartition de la richesse. L’auteur démontre qu’une réforme privilégiant un impôt proportionnel aurait pour effet d’accroître les investissements et l’épargne des entreprises, en réduisant le taux marginal d’imposition de ces dernières. Selon le modèle qu’il utilise, une augmentation des investissements des entreprises implique une plus forte demande de main-d’œuvre, ce qui entraîne une hausse du salaire des travailleurs et une baisse du taux de rentabilité moyen des activités des entreprises. Cet enchaînement d’effets, que permet de saisir un cadre d’équilibre général, se solde par un rétrécissement de l’écart des salaires et de l’épargne entre travailleurs et entrepreneurs, d’où une réduction de l’inégalité des revenus et de la richesse. Si l’abolition du caractère progressif de l’impôt accroît les investissements des entreprises, elle a un effet pratiquement nul sur le nombre d’entrepreneurs, puisque la hausse des salaires fait grimper les coûts d’exploitation. Le modèle utilisé permet également d’expliquer la part substantielle des revenus et de la richesse détenue par les entrepreneurs, le taux d’épargne élevé des entrepreneurs, par rapport à celui des travailleurs, et la forte concentration de la richesse que l’on observe dans les données.

Classification JEL : D31, E62, H23, H20
Classification de la Banque : Politique budgétaire; Modèles économiques

1 Introduction

One of the main arguments for retaining the system of progressive taxation currently in place in many industrialized countries is that the alternatives, including proportional and flat tax systems, appear to increase wealth and income inequality. However, critics of a progressive income tax system point out that substantial distortions result from high marginal tax rates paid by those in the top income tax bracket. Given these conflicting views, what are, in quantitative terms, the consequences of reducing the degree of progressivity in the tax system? More specifically, what are the aggregate and distributional effects of switching from a progressive income tax system to a proportional income tax system? There are several ways of addressing this question. One way, which is commonly used in the literature that evaluates the distributional effects of tax policy, assumes an exogenous distribution of labour efficiencies (e.g., Altig et al. 2001; Castañeda, Díaz-Giménez, and Ríos-Rull 1999; Ventura 1999).[1] In most of these model economies, individuals face uninsurable fluctuations in their income and must save to substitute for insurance against those unpredictable events that may occur.[2] Another way to approach this issue is to allow individuals to affect the stochastic process of earnings by accumulating human capital for themselves or for their offspring.[3] Although these approaches are undeniably valid, this study focuses on the less-explored role of entrepreneurial activities in affecting income and wealth distributions following tax reform.

Looking explicitly at entrepreneurship is important, because recent analysis shows that business ownership is essential for job creation, capital accumulation, income and wealth

[1] Altig and Carlstrom (1999) also study the distributional effects of reducing the degree of progressivity in the income tax system (Tax Reform Act of 1986). In their model, there is no uncertainty associated with labour efficiencies.

[2] See, for example, Aiyagari (1994) and Hugget (1996).

[3] See Trostel (1993) for more discussion of standard models of human capital.

distributions, and wealth mobility (e.g., Quadrini 1999; and Gentry and Hubbard 1999). However, the examination of this crucial element has been surprisingly neglected in most quantitative studies of tax policy. Such an omission is likely to be significant, since empirical studies (Carroll, Holtz-Eakin, Rider, and Rosen 1998a,b; Gentry and Hubbard 2000a,b) illustrate that entrepreneurs respond to tax incentives; that is, their decisions to save, invest, or hire workers are affected by the marginal income tax rate. Moreover, since entrepreneurs are generally located in the upper tail of income and wealth distributions, they may face a higher marginal tax rate under a progressive income tax schedule. Therefore, the effects of progressive income taxation on entrepreneurial households must be taken into account when discussing equality and efficiency.

Thus, the objective of this paper is to investigate the extent to which entrepreneurship is important in assessing the general-equilibrium consequences of a revenue-neutral tax reform, where the progressive income tax in the United States is replaced by a proportional income tax structure. For the findings to be meaningful, a quantitative theory of income and wealth is required that can account for both the substantial share of wealth and income held by entrepreneurs and the high concentration of wealth and income in the U.S. economy.[4] To this end, my analysis builds on Quadrini (2000), who uses a calibrated general-equilibrium framework to show the importance of business ownership in explaining the high concentration of wealth in the U.S. economy. I extend his model by including a government sector that collects tax revenues via a progressive income tax system. In this model, agents decide whether to be entrepreneurs (engaging in risky activities) or workers (engaging in low-risk

[4]Other models that have been successful in replicating the observed concentration of wealth in the United States are, for example, De Nardi (2000) and Castañeda, Díaz-Giménez, and Ríos-Rull (1999). See also Krussel and Smith (1998).

activities). The decision to undertake an entrepreneurial activity is determined by the agent's business ability as well as their net worth. The ability to manage a business is modelled as a stochastic process that implicitly incorporates a learning process through which agents gradually acquire the ability to run larger businesses by managing smaller ones. Because of borrowing constraints and financial intermediation costs, the level of asset holdings is an important determinant in an agent's decision to undertake an entrepreneurial activity (Evans and Jovanovic 1989). The potentially high returns available to entrepreneurs – coupled with borrowing constraints, costly external financing, and the additional risks associated with being a business owner – lead to their relatively high savings rates.

A significant finding in this study is that switching from a progressive income tax system to a proportional income tax system has only a small impact on wealth inequality. Specifically, the wealth Gini coefficient increases only by about one percentage point. This finding contradicts previous research (e.g., Altig et al. 2001 and Castañeda, Díaz-Giménez, and Ríos-Rull 1999), which found sizable effects of proportional tax reform on wealth inequality. This apparent discrepancy stems from the presence of entrepreneurs in the model. A reduction in the marginal income tax rates paid by entrepreneurs leads to increased business investment. Since labour and capital are complements in the production technology used by entrepreneurs, this business investment boosts the demand for labour, which, in turn, increases the wage rate, effectively driving down the average return to entrepreneurial activities and increasing the income of workers. The result is a general-equilibrium feedback that narrows the income and savings gap between workers and entrepreneurs, leading to a reduction in income and wealth inequality. These effects are magnified when entrepreneurs are subject to borrowing constraints. Previous research considers only the effects of the change in the tax system on the savings behaviour of poor and rich households, which leads to an increase in wealth inequality. In particular, a proportional income tax system reduces the marginal income tax rate paid by wealthy households and increases the marginal income tax rate faced by poor households, providing the rich with an incentive to accumulate more wealth, but discouraging the savings of the poor.

I also find that while the policy switch has a marked impact on entrepreneurial investments and savings, it has virtually no effect on the number of entrepreneurs. The tax reform discourages entry into entrepreneurship[5] because the increase in the wage rate reduces the profits of entrepreneurs, particularly those running small-scale projects (the projects run by new entrepreneurs), which, in turn, increases the opportunity cost of becoming an entrepreneur. However, at the same time, the exit rate out of entrepreneurship also drops, owing to the increased number of large-scale projects. The simultaneous drop in both entry and exit rates keeps the number of entrepreneurs relatively unchanged.

Finally, the proportional tax reform increases capital formation.[6] This increase in the capital stock decreases the interest rate and magnifies the increase in the wage rate. In this regard, the prediction of the model is in line with quantitative findings provided by the literature that explores the impacts of replacing the progressive income taxation by other forms of taxation (such as flat tax and proportional income tax).[7] The rise in capital formation is a consequence of the cut in marginal tax rates faced by rich households, which

[5]This small effect of the tax policy on entrepreneurial entry is in contrast with Gentry and Hubbard (2000a,b), who estimate, by using the panel study of income dynamics (PSID) for 1978-93, that progressive marginal tax rates discourage entry into self-employment. For instance, they estimate that the Omnibus Budget Reconciliation Act of 1993, which raised the top marginal tax rates, lowered the probability of entry into self-employment for upper-middle-income households by about 20 per cent.

[6]This result is consistent with the findings of Altig et al. (2001), Castañeda, Díaz-Giménez, and Ríos-Rull (1999), and Ventura (1999), among others.

[7]See Ventura (1999) for a study of a flat tax reform in a life-cycle framework.

is brought about by the policy change. The increase in capital formation and entrepreneurial investments implies a rise in output.

This paper is organized as follows. Section 2 describes the benchmark economy. Sections 3 and 4 present a description of the calibration and the calibration results. Section 5 presents the results of the tax reform, and section 6 analyzes the importance of entrepreneurship in studying the effect of taxation. Section 7 provides some sensitivity analysis, and section 8 concludes.

2 Benchmark Economy

This 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 labour service to the market. The economy consists of four sectors: household, production, intermediation, and government. The model builds on Meh (1999).

2.1 Household sector

2.1.1 *Preferences and labour efficiencies*

Households maximize their expected discounted lifetime utility:

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

where

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

In each period, households are endowed with $\varepsilon \in \{\varepsilon_1, ..., \varepsilon_{N_\varepsilon}\}$ units of labour 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 labour service and hiring labour from the market. As a result, for simplicity, the household is assumed to supply all its labour to the market. The labour 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 $\mathcal{K} = \{k_0, k_1, ..., k_{N_k}\}$, where $k_{i-1} < k_i$ for $i = 1, ..., N_k$. The first element of $\mathcal{K}$ is set at $k_0 = 0$ and corresponds to the case in which there is no entrepreneurial idea.[8]

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}. 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 the implemented project in the present period can always be run by the household. As a result, for all current business

[8]The first element, which has been set to zero, corresponds to the household being a worker.

projects, k_i, where $i = 0, ..., N_k$, 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 $\left\{k, \tilde{k}\right\}$, 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

Within the model economy, one good is produced by two distinct sectors of production: the corporate sector and the non-corporate sector. In this paper, the uninsurable entrepreneurial risk and the strictness of financial constraints are the main features that characterize and differentiate the non-corporate sector from the corporate sector (in the spirit of Fazzari, Hubbard, and Petersen 1998; and Gertler and Gilchrist 1994).[9]

[9] In the actual economy, there are small firms that are organized as corporations (S-corporations). In the calibration, S-corporations are included in the non-corporate sector, since their equities are, in general, owned by one family or by a very limited number of shareholders. Since most small firms are unincorporated and large firms are incorporated, the label "non-corporate sector" is used to characterize the entrepreneurial production sector and the label "corporate sector" is used for the other production activities.

2.2.1 ***Non-corporate sector***

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

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

where $\nu \in (0, 1)$ is the capital income share, n is the number of efficiency units of labour input, and $z \in \mathcal{Z}_k = \{z_{1k}, ..., z_{N_z k}\}$ 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 shock 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 labour 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 labour 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 *Corporate sector*

The production function in the corporate 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 corporate sector, K_c is the corporate capital input, and N_c is the corporate input of efficiency units of labour. Capital depreciates at rate δ.[10]

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 corporate sector. While there is a positive proportional cost, γ, per unit of funds intermediated to households undertaking entrepreneurial activities, loans made to the corporate 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 corporate 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. Therefore, in this economy, bankruptcy is not permitted.

[10]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.

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 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

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

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.[11]

[11]One can interpret the intermediation cost as an outcome of optimal contracts between lenders and borrowers in the presence of agency costs or moral hazard problems, and the borrowing limits as the minimum

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 equation (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 $y \leq 0$. 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 labour input.

Non-corporate sector: Given invested capital, k, from the previous period, entrepreneurial households choose the amount of labour input at the beginning of the current period after

value of collateral, such that these contracts are optimal for the lenders. Consequently, these costs can have implications not only for the distribution of wealth, but also for business fluctuations, as shown by Bernanke and Gertler (1989).

observing the technology shock, z, by solving the following profit-maximization problem:

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

with

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

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 $k \leq a$, 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 labour demand is given by

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

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

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

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

Corporate sector: Profit maximization in the corporate 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 labour, n, to hire.

End of the period: At the end of the period, households observe the entrepreneurial idea, $\tilde{k}$, and the labour productivity, ε'.[12] Then, knowing the set of potential projects, $\left\{k, \tilde{k}\right\}$, and the labour productivity, ε', households decide first whether to invest in the business activity, given the available project, and then how much to save.

2.7 A household's problem

The state of an individual at the beginning of the period is given by four variables: labour 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 $v(\varepsilon, a, k, z)$ to be the beginning-of-period value function of an individual who,

[12]Given the assumption that the labour 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.

at the end of the previous period, invested in the entrepreneurial project, k. Also, let $\widetilde{\upsilon}(\varepsilon, a, k, z, \tilde{k}, \varepsilon')$ 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:

$$\begin{aligned}
\widetilde{\upsilon}\left(\varepsilon, a, k, z, \tilde{k}, \varepsilon'\right) &= \max_{a',k'} \left\{ u\left(c\right) + \beta \sum_{z'} \upsilon\left(\varepsilon', a', k', z'\right) Q_k\left(z', z\right) \right\}, \qquad (13)\\
&\quad \text{subject to}\\
c &= a(1+r_d) + \pi(a,k,z) + \omega\varepsilon - \tau(y) - a',\\
a' &\geq k' - \frac{\nu z_{\min} k' \left(\frac{1-\nu}{\omega}\right)^{\frac{1-\nu}{\nu}} + (1-\delta_{z\min})\, k}{1+r_l},\\
k' &\in \left\{k, \tilde{k}\right\},\\
&\quad \text{with}\\
y &= \omega\varepsilon + \pi(a,k,z) + r_d a.
\end{aligned}$$

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 labour 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 $g_k(\varepsilon, a, k, z, \tilde{k}, \varepsilon')$.[13]

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

$$\upsilon(\varepsilon, a, k, z) = \sum_{\tilde{k},\varepsilon'} \widetilde{\upsilon}(\varepsilon, a, k, z, \tilde{k}, \varepsilon') P_k\left(\tilde{k}\right) \Gamma\left(\varepsilon', \varepsilon\right). \qquad (14)$$

[13]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.

3 Calibration of Benchmark Economy

The benchmark economy is calibrated to the U.S. economy, and the model period is one year. The parameters to be calibrated are related to the household's preferences, the process for labour efficiency, technology in the corporate and non-corporate sectors, technology in the intermediation sector, and the tax system. 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 0.035.

3.2 Labour efficiency

The labour 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 labour ability follows a first-order autoregressive process:

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

The autocorrelation coefficient, ρ, and the standard deviation, σ_ξ, of the earnings process are taken from Aiyagari (1994) and Quadrini (2000); that is, $\rho = 0.496$ 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 labour productivity are evenly spaced in the log scale, ranging from -$2\left(\frac{\sigma_\xi^2}{1-\rho^2}\right)^{1/2}$ to $2\left(\frac{\sigma_\xi^2}{1-\rho^2}\right)^{1/2}$.

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 U.S. Economy (1990), aggregate capital is defined as the sum of plants and equipment, inventories, land at market value, and residential structures.[14] As a second step, the share of total capital employed in the two sectors of production (corporate and non-corporate sectors) must be determined. Using the flow of funds cccount, Quadrini (2000) reports that the fraction of capital used in the corporate 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.[15]

[14]The Federal Reserve Board, with the flow of funds account in the Balance Sheet for the U.S. Economy, provides an estimate of the stock of private tangible assets.

[15]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 0.36.

Corporate technology: The capital income share in the corporate sector is set at $\theta = 0.33$, to mimic the actual data of the U.S. economy. This value is consistent with the estimates reported by Poterba (1997).

Non-corporate 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. 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 U.S. 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, the medium-scale project, and the large-scale project are run by 60 per cent, 30 per cent, and 10 per cent 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 per cent, 30 per cent, or 10 per cent. 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 non-corporate 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 $Q_k(z' \mid z)$:

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

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 equation (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, $\bar{z}$, of the shock is calibrated such that the fraction of total income earned by entrepreneurs is 22 per cent, which is the value found in the PSID data. Given $\bar{z}$ and the transition probabilities, the second value of the shock, z_{2k}, is derived from the following equation:

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

The probability distribution, $P_k\left(\tilde{k}\right)$, of the entrepreneurial idea $\tilde{k} \in \{0, k_1, k_2, k_3\}$, is defined in equation (2). Given this definition, there are only three parameters to be calibrated: $P_0\left(\tilde{k} = k_1\right)$, $P_{k_1}\left(\tilde{k} = k_2\right)$, and $P_{k_2}\left(\tilde{k} = k_3\right)$. 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 per cent, 30 per cent, and 10 per cent, respectively. The total fraction of entrepreneurs equals 0.12, which is the same fraction found in the PSID data for the period 1970-92 and in the SCF data for 1989-92.

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. The second depreciation value is then determined by the following equation:

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

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, Prescott, Fitzgerald, and Alvarez (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 nominal interest rate spread at 5.5 per cent. In the benchmark economy, I set $r_l - r_d = \gamma = 0.045$.

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). In particular, they characterize the 1989 U.S. effective personal tax function as follows[16]:

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

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, Díaz-Giménez, and Ríos-Rull (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.

[16] In their study, the authors present a range of parameter estimates obtained from cross-sectional regressions involving U.S. individual income and tax data for 1979-89.

4 Results of the Benchmark Economy

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 3 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 approximatively 0.131, which is less than the value of 0.195 observed in the U.S. economy. This result is owing to the fact that the model economy considers only the personal income tax, while the U.S. government obtains tax revenues from sources other than income taxes.

Table 4 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 equation (19).[17] It can be seen that average and marginal tax rates increase with income.

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 U.S. economy.

Table 5 presents the average wealth-to-income ratio for workers and entrepreneurs in the

[17] 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.

benchmark and U.S. 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 per cent 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 5 shows that these findings are consistent with the empirical evidence for the U.S. 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 6 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 U.S. economy. Overall, in the benchmark equilibrium, entrepreneurs own about 35 per cent of the total wealth. These statistics are very similar to the ones observed in the PSID and SCF. Additionally, Gentry and Hubbard (2000a,b) report that entrepreneurs hold 39 per cent of the total wealth in the SCF, and Quadrini (2000) finds that the fraction of net worth held by business owners is 40 per cent 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 U.S. economy. The first row of Table 7 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 concentration of wealth observed in the U.S. economy.[18] 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 per cent of agents in the model economy hold, respectively, 33.6 per cent and 55.2 per cent of total wealth. According to the PSID data, the top 1 and 5 per cent of agents owned 25 per cent and 47 per cent 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 per cent of families is 35.7 per cent and 58.0 per cent, respectively. The second row of Table 7 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 per cent of income earners possess 11.2 per cent and 21.1 per cent of total income, respectively.

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 are identical across economies. The results of the policy experiment are reported for both a

[18] This result is consistent with Quadrini (2000), who shows that entrepreneurial activities are significant in explaining the high concentration of wealth observed in the data.

closed economy and a small open economy.

5.1 Aggregate effects

Table 8 reports some aggregate statistics of the benchmark and the proportional income tax model economies.

I find that switching to a proportional income tax system increases aggregate output by about 5.5 per cent. This result is mainly caused by the fact that the proportional income tax increases entrepreneurial investment and the aggregate capital stock.

An important finding is that switching to a proportional income tax leads to a sizable increase in entrepreneurial investment and capital accumulation. It is apparent from the table that the average capital per entrepreneurial business increases by about 17 per cent, while the aggregate stock of capital rises by 6 per cent. This increase occurs because proportional income taxes reduce the distortions associated with the high marginal tax rates paid by high-income households, particularly entrepreneurs running small-scale and medium-scale projects. Entrepreneurs react much more to a cut in their marginal tax rates, because the cut gives them more income to expand their businesses and to reduce the cost associated with external financing. 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, Holtz-Eakin, Rider, and Rosen (1998a), who estimate that high personal income taxes significantly affect the investment decisions of small firms. To be exact, they find that a percentage point increase in marginal tax rates reduces the proportion of entrepreneurs who make new capital investments by 10.4 per cent, and decreases mean investment expenditures by 9.9 per cent.

Both the aggregate capital stock and the capital input in the entrepreneurial production sector increase, as does corporate capital.[19] This rise in corporate capital, coupled with the high demand for labour input in the non-corporate sector, raises the capital-labour ratio in the corporate sector, which, in turn, decreases the interest rate and increases the wage rate. More precisely, as indicated in Table 8, the interest rate drops by about 16 per cent and the wage rate rises by 4 per cent.

Table 9 reports the number of entrepreneurs, the distribution of entrepreneurs among business projects (also called the distribution of business wealth), and the entry rate into and the exit rate out of entrepreneurship.[20] 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 number of entrepreneurs. Specifically, the number of entrepreneurs moves from 11.26 per cent to 11.25 per cent. Second, the policy switch discourages entry into business ownership. For example, the entry rate into entrepreneurship decreases by about 17 per cent. Finally, even though the number of business owners is almost unchanged, business wealth becomes less concentrated after the policy change. In other words, more entrepreneurs are running large-scale projects, which confirms the increase in entrepreneurial investments mentioned above.

The decrease in entrepreneurial entry results from the increase in the wage rate. This increase drives down the expected profit of entrepreneurs, particularly those running small-scale projects, which, in turn, increases the opportunity cost of becoming an entrepreneur.

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

[20] 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.

Notice that the small effect of the policy change on the number of entrepreneurs is explained by the fall in both the entry rate into and exit rate out of entrepreneurship. To understand the drop in the exit rate, recall that, according to the calibration, large-scale projects are safer than small-scale projects. Therefore, since more entrepreneurs are operating large-scale projects after the policy switch, the exit rate out of entrepreneurship decreases. This sizable negative effect of a switch to a proportional income tax on entrepreneurial entry is in direct contrast with the findings of Gentry and Hubbard (2000a), who estimated that "the Omnibus Budget Reconciliation Act of 1993, which raised the top marginal tax rate, lowered the probability of entry into self employment for the upper-middle-income households by about 20 per cent."

5.2 Distributional effects

Table 10 reports the distributional consequences of the policy experiment. Panel A summarizes the statistics of the distribution of wealth. These statistics show that a switch to a proportional income tax leaves the distribution of wealth almost unchanged.

The Gini coefficient of wealth moves from 0.76 to 0.77, an increase of only one percentage point. The share of wealth held by the top percentiles of wealth holders increases only slightly. For example, the share of wealth held by the top 5 per cent of agents increases by only 4 per cent. This is a key result, because previous literature finds that a switch to a proportional income tax leads to a significant increase in wealth inequality. For instance, Castañeda, Díaz-Giménez, and Ríos-Rull (1999) find that the Gini index of the distribution of wealth increases by 10.5 per cent after the policy switch.

Panel B presents statistics on the distribution of income. The panel shows that switching from a progressive income tax system to a proportional income tax system also has almost no impact on income inequality. The Gini coefficient of income rises slightly from 0.467 to 0.474. Households in the top percentiles of the income distribution barely increase the share of income that they own. This result is mainly caused by the increases in the wage rate, which benefits workers and hurts entrepreneurs by reducing their business profit. Castañeda, Díaz-Giménez, and Ríos-Rull (1999) also find that the elimination of the progressive income tax has a small effect on the distribution of earnings.[21]

The small effects of the policy change on income and wealth inequality can be explained by the fact that entrepreneurial activities moderate the effects of the policy switch on the distribution of wealth. Specifically, the high increase in entrepreneurial investments brought about by the decrease in tax rates paid by entrepreneurs boosts the demand for labour,[22] which increases the wage rate of workers and drives down the expected profits of entrepreneurs. This general-equilibrium feedback narrows the income and savings gap between workers and entrepreneurs (e.g., Kanbur 1982). These effects are magnified when entrepreneurs are borrowing-constrained.

5.3 Small open economy

To understand the importance of the general-equilibrium consequences described above, this subsection presents the results of a revenue-neutral policy change in a partial-equilibrium analysis. In this experiment, the before-tax interest rate and the wage rate are fixed at

[21]Labour supply is endogenous in Castañeda, Díaz-Giménez, and Ríos-Rull (1999). The small impact on income inequality in their model, after a switch to a proportional tax system, is caused by the substitution and income effects.

[22]The demand for labour increases because capital and labour are complements in the production technology used by business owners.

their benchmark values (as they would be in a small open economy). I show that general-equilibrium feedbacks are important in quantifying the effects of switching from progressive to proportional income taxation. Table 11 summarizes the aggregate effects of replacing the current progressive income tax system in the United States with a proportional income tax system. The capital stock increases by 68 per cent and output by 16 per cent.

Interestingly, the table reveals that the number of entrepreneurs increases by about 5 per cent after the policy switch when factor prices are fixed. According to the second column, this result contradicts the prediction in the general-equilibrium framework, where the number of entrepreneurs is almost unchanged after the policy change.

Table 12 presents the distributional features of the benchmark economy, proportional tax model, and small open economy. Contrary to the closed-economy example (the second row), the small open economy shows a sizable increase in wealth inequality after the policy change. For example, the Gini index of wealth increases by 5.3 per cent, increasing from 0.76 to 0.80. The top 5 per cent of wealth holders increase their share of total wealth by about 9 per cent. The policy change also leads to a substantial increase in income inequality. The income Gini increases by 5.8 per cent and the fraction of total income held by the top 5 per cent of the income distribution rises from 21.2 per cent to 25.8 per cent after the switch to a proportional income tax system.

Thus, the prediction of the proportional tax reform may change dramatically when we abstract from the possible general-equilibrium feedbacks, especially in the presence of entrepreneurship. More precisely, the impacts of the policy tax reform on entrepreneurial entry and the wealth distribution in a closed economy and in a small open economy differ significantly.

6 The Importance of Entrepreneurship in Studying the Effects of Progressive Taxation

This section examines the importance of entrepreneurship in analyzing the effects of reducing the degree of progressivity in the personal income tax system, and shows that modelling business ownership dramatically changes the impact of switching from a progressive to a proportional income tax system on the wealth distribution.

To quantify the effects of the policy reform, a version of the model that abstracts from entrepreneurial activities is calibrated. More precisely, this alternative model consists only of workers facing the same earnings uncertainty and liquidity constraints faced by workers in the original model, which contains entrepreneurs. The production sector is represented by a Cobb-Douglas production function with a capital income share of $\theta = 0.33$. The discount factor and the tax parameters are calibrated to the same observations as in the benchmark. The discount factor is $\beta = 0.957$ and the tax parameter is $\alpha_2 = 0.35$. The aggregate capital stock depreciates at the same rate as in the previous model.

Table 13 summarizes the distributional aspects of the model economy with entrepreneurs and the model economy with only workers. Not surprisingly, the benchmark in Panel B indicates that wealth is more equally distributed in the model without entrepreneurs than in the economy with entrepreneurs. This result is consistent with model economies (e.g., Aiyagari 1994), where wealth inequality arises only from uninsurable idiosyncratic shocks to labour efficiency. It is also shown that the proportional tax reform leads to a sizable increase in wealth inequality.[23] The Gini index increases by about 8 per cent. The top 5 per cent of

[23] I perform another experiment where I calibrate the wealth Gini index by using an unrealistic distribution of earnings. This approach is also used by Castañeda, Díaz-Giménez, and Ríos-Rull (1999). When switching from a progressive income tax system to a proportional income tax system, the coefficient of wealth Gini

wealth holders increase their share of total wealth by 7 per cent.

Comparing Panel A with Panel B, one can see that the policy change in the model with entrepreneurs has virtually no effect on wealth distribution, while in the model with only workers the effect on wealth inequality is large. The intuition behind this result 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. 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. More precisely, an increase in business investment brought about by the reduction in entrepreneurs' marginal tax rates induces a higher demand for labour, which raises the wage rate of workers and drives down the average return to entrepreneurial activities. This general-equilibrium feedback narrows the income and savings gap between workers and entrepreneurs, and, in turn, leads to a reduction in wealth inequality. These two conflicting effects offset each other and the overall wealth inequality remains almost unchanged.

The last sections of Panel A and Panel B report the distributions of income. As with the figures in Panel A, Panel B reveals that the income distribution is hardly affected when switching to a proportional income tax system.

increases from 0.767 to 0.769. This result suggests that the main finding in this paper is robust to the calibration of the economy with no entrepreneurs.

7 Sensitivity Analysis to Changes in Entrepreneurial Capital Income Share

The numerical findings in the previous section 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 labour or capital income share in the production technology used by entrepreneurs. This section presents some computational experiments with two alternative values for ν that are set slightly below ($\nu = 0.3$) and slightly above ($\nu = 0.36$) 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. This business investment increases the demand for labour, as capital and labour are complementary in production. Table 14 shows the results from two economies that depart from the benchmark economy only in the capital income share in entrepreneurial production.

Interestingly, the table shows that the effects on wealth inequality of a switch from a progressive to a proportional income tax system are not sensitive to ν. More specifically, the policy switch increases the wealth Gini index by just about 2 per cent when $\nu = 0.36$, and by about 1 per cent in the benchmark case ($\nu = 0.33$).

Table 14 indicates that wealth inequality increases with the capital intensity of entrepreneurial business. More precisely, the wealth Gini coefficients in the economies with progressive taxation are, respectively, 0.71, 0.77, and 0.82 when ν takes the values of 0.3, 0.33, and 0.36. It is intuitive that, the more-capital intensive entrepreneurial businesses are, the more important entrepreneurial savings are in the presence of borrowing constraints.

8 Conclusion

This paper has demonstrated 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 wide range of 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 labour, 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. 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 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 (e.g., Barro and Sahasakul 1983). This extension is left for future work.

Table 1: Percentage of Business of 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).

Table 2: Calibration of Parameters of the Benchmark Economy

Description	**Parameters**	**Values**
Relative risk aversion	σ	2.0
Discount factor	β	0.934
Tax parameters	$\{\alpha_0, \alpha_1, \alpha_2\}$	$\{0.258, 0.768, 0.299\}$
Corporate capital income share	θ	0.33
Non-corporate capital income share	ν	0.33
Depreciation rate of aggregate capital	δ	0.062
Intermediation cost	γ	0.045
Non-corporate size projects	k	$\{0, 1.7, 17, 170\}$
Mean technological shock	$\bar{z}$	2.374
Values of the shock	z_{2k}	$\left\{\begin{array}{c} 3.17 \\ 2.58 \\ 2.45 \end{array}\right\}$
Probability transition	ϕ_k	$\left\{\begin{array}{c} 0.75 \\ 0.92 \\ 0.97 \end{array}\right\}$
Arrival probability of new entrepreneurial ideas	$P_k\left(\tilde{k}\right)$	$\left\{\begin{array}{c} 0.024 \\ 0.110 \\ 0.075 \end{array}\right\}$
Stochastic depreciation	δ_z	$\left\{\begin{array}{cc} 0.1 & 0.049 \\ 0.1 & 0.059 \\ 0.1 & 0.061 \end{array}\right\}$

Table 3: 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 (%)	(68, 26, 6)	(60, 30, 10)
Share of income held by entrep.	0.23	0.22

Table 4: 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 5: 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).

Table 6: 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 7: Distributions of Wealth and Income in the Benchmark Economy and in the Data

	Top percentiles					Gini
	1%	5%	10%	20%	30%	index
Benchmark economy						
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 8: Aggregate Effects of the Policy Experiment

	Benchmark economy	Proportional tax regime
Output	2.37	2.50
Capital stock	5.87	6.23
Capital input per entrepreneur	1.64	1.91
Labour input per entrepreneur	5.71	6.11
Interest rate	0.037	0.031
Wage	1.21	1.26
Average marginal tax rate	0.160	0.149
Average tax rate	0.152	0.149

Table 9: Statistics on Entrepreneurial Activities

	Benchmark economy	Proportional tax regime
Entrepreneurs (%)	11.26	11.25
Distribution of entrepreneurs		
Small-scale project	0.68	0.66
Medium-scale project	0.26	0.27
Large-scale project	0.06	0.07
Entry rate (%)	2.37	1.97
Exit rate (%)	20.10	16.80

Table 10: Distributions of Wealth and Income in Benchmark and Proportional Income Tax Model Economies

	Top percentiles					Gini
	1%	5%	10%	20%	30%	index
Panel A: Wealth						
Benchmark model	33.6	55.2	64.7	76.6	85.2	0.761
Proportional tax model	36.3	57.6	66.1	77.8	86.2	0.770
Panel B: Income						
Benchmark model	11.2	21.1	30.7	49.2	65.1	0.467
Proportional tax model	12.0	21.9	31.5	50.1	65.6	0.474

Table 11: Some Aggregate Statistics in Benchmark, Proportional Tax, and Small Open Economies

	Benchmark economy	Proportional tax regime	Small open economy (proport.)
Output	2.370	2.501	2.761
Capital stock	5.870	6.230	9.471
Capital input per entrepreneur	1.640	1.910	2.230
Labour input per entrepreneur	5.711	6.110	7.880
Entrepreneurs	11.260	11.250	12.000
Interest rate	0.037	0.031	0.037
Wage	1.210	1.251	1.210
Average marginal tax rate	0.160	0.149	0.137
Average tax rate	0.152	0.149	0.137

Table 12: Distributions of Wealth and Income in Benchmark, Proportional Tax, and Small Open Economies

	Top percentiles					Gini	Entr.	Income
	1%	5%	10%	20%	30%	index		tax rate
Wealth								
Benchmark model	33.6	55.2	64.7	76.6	85.2	0.76	11.26	-
Proportional tax model	36.3	57.6	66.1	77.8	86.2	0.77	11.25	0.149
Small open economy	32.0	60.4	69.2	79.7	87.0	0.80	12.00	0.137
Income								
Benchmark model	11.2	21.2	30.7	49.2	65.1	0.467	11.26	
Proportional tax model	12.0	21.9	31.5	50.1	65.6	0.474	11.25	
Small open economy	14.5	25.8	34.8	51.7	67.0	0.494	12.00	

Table 13: Distributions of Wealth and Income in the Model with Entrepreneurs and in the Model with No Entrepreneurs

	Top percentiles					Gini
	1%	5%	10%	20%	30%	index
Panel A: With entrepreneurs						
Wealth						
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
Income						
Benchmark model	11.2	21.1	30.7	49.2	65.1	0.467
Proportional model	12.0	21.9	31.5	50.1	65.6	0.474
Panel B: No entrepreneurs						
Wealth						
Benchmark model	3.6	15.3	27.7	48.3	64.9	0.490
Proportional model	3.9	16.4	29.6	51.1	67.9	0.531
Income						
Benchmark model	2.5	11.8	22.9	43.5	59.3	0.399
Proportional model	2.5	11.9	23.0	43.6	59.4	0.401

Table 14: Distributional Features in the Economies when $\nu = 0.3$ and $\nu = 0.36$ and in the Benchmark Economy

	Top percentiles					Gini
	1%	5%	10%	20%	30%	index
Panel A: $\nu = 0.33$						
Wealth						
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
Income						
Benchmark model	11.2	21.1	30.7	49.2	65.1	0.467
Proportional model	12.0	21.9	31.5	50.1	65.6	0.474
Panel B: $\nu = 0.3$						
Wealth						
Benchmark model	28.4	47.1	57.5	71.6	81.8	0.711
Proportional model	31.3	51.1	60.8	74.5	84.2	0.741
Income						
Benchmark model	8.7	18.4	28.1	46.8	63.6	0.446
Proportional model	9.7	19.4	29.2	48.1	64.2	0.455
Panel C: $\nu = 0.36$						
Wealth						
Benchmark model	40.6	66.6	74.9	84.0	90.1	0.824
Proportional model	37.9	70.1	77.6	85.9	91.5	0.842
Income						
Benchmark model	14.7	24.9	34.0	51.4	67.2	0.492
Proportional model	14.8	25.4	34.4	51.8	67.5	0.499

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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 $\widetilde{\upsilon}\left(\varepsilon, a, k, z, \tilde{k}, \varepsilon'\right)$; decision rules, $\left\{n(k, z),\ g_a(\varepsilon, a, k, z, \tilde{k}, \varepsilon'),\ g_k(\varepsilon, a, k, z, \tilde{k}, \varepsilon')\right\}$; a government policy, $\{G,\ \tau(y)\}$; prices, $\{\omega,\ r_d,\ r_l\}$; aggregate capital and labour 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, $\widetilde{\upsilon}(\cdot)$ 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,

$$\omega = (1-\theta)\left(\frac{K_c}{N_c}\right)^{\theta} \tag{20}$$

$$r_d = \theta\left(\frac{K_c}{N_c}\right)^{\theta-1} - \delta \tag{21}$$

$$r_l = r_d + \gamma. \tag{22}$$

3. The government budget constraint is satisfied; that is,

$$G = \sum_{\varepsilon,,k,z}\left\{\int_a \tau\left(y\left(\varepsilon, a, k, z\right)\right)\mu\left(\varepsilon, a, k, z\right) da\right\}. \tag{23}$$

4. Capital and labour markets clear; that is,

$$\sum_{\varepsilon,k,z}\left\{\int_a k\mu\left(\varepsilon, a, k, z\right) da\right\} + K_c = \sum_{\varepsilon,k,z}\left\{\int_a a\mu\left(\varepsilon, a, k, z\right) da\right\} \tag{24}$$

$$\sum_{\varepsilon,k,z}\left\{\int_a n\left(k, z\right)\mu\left(\varepsilon, a, k, z\right) da\right\} + N_c = \sum_{\varepsilon,k,z}\left\{\int_a \varepsilon\mu\left(\varepsilon, a, k, z\right) da\right\}. \tag{25}$$

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

$$\mu'\left(S_\varepsilon, S_a, S_k, S_z\right) = \Psi\left(S_\varepsilon, S_a, S_k, S_z\right) = \sum_{\tilde{k}} \sum_{\varepsilon' \in S_\varepsilon} \sum_{k' \in S_k} \sum_{z' \in S_z} \tag{26}$$

$$\left\{ \int_{a' \in S_a} \sum_{\varepsilon,k,z} \left\{ \int_a I(\varepsilon, a, k, z, \tilde{k}, \varepsilon') P_k\left(\tilde{k}\right) \Gamma\left(\varepsilon', \varepsilon\right) Q_k\left(z', z\right) \mu\left(\varepsilon, a, k, z\right) da \right\} da' \right\},$$

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

$$I(\varepsilon, a, k, z, \tilde{k}, \varepsilon') = \begin{cases} 1, \text{ if } g_a(\varepsilon, a, k, z, \tilde{k}, \varepsilon') \in S_a \text{ and } g_k(\varepsilon, a, k, z, \tilde{k}, \varepsilon') \in S_k \\ 0, \text{ otherwise.} \end{cases} \tag{27}$$

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 non-corporate sector, $\bar{z}$; the tax parameter, α_2; the smallest size of business project, k_1; and the probabilities $P_0\left(\tilde{k}=k_1\right)$, $P_{k_1}\left(\tilde{k}=k_2\right)$, and $P_{k_2}\left(\tilde{k}=k_3\right)$.

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-labour ratio generated in this equilibrium is equal to the one resulting from the calibration of the corporate 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 per cent, 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 U.S. economy are equal,

   (e) the fraction of capital employed in the non-corporate 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 $\left\{\beta, \bar{z}, \alpha_2, k_1, P_0\left(\tilde{k}=k_1\right), P_{k_1}\left(\tilde{k}=k_2\right), P_{k_2}\left(\tilde{k}=k_3\right)\right\}$, 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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